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D6 ETISplus Database

Content and Methodology

January 2013

Project acronym: ETISPLUS
Project full title: European Transport policy Information System-
 Development and implementation of data collection
 methodology for EU transport modelling.
Call Identifier: FP7-SST-2008-TREN-1
Duration: 32 Months
Start Date: 1st September 2009

ETIS PLUS Consortium

	Beneficiary name	Acronym	Country
1.	NEA Transport research and training	NEA	Netherlands (NL)
2.	ISIS Institute of Studies for the Integration of Systems	ISIS	Italy (IT)
3.	TRT Trasportieteritorio	TRT Trasportieteritorio	Italy (IT)
4.	MKmetric Gesellschaft fuer Systemplanung mbH	MKmetric	Germany (D)
5.	NESTEAR	NESTEAR	France (FR)
6.	IWW, Institute for Economic Policy Research	IWW	Germany (D)
7.	TML, Transport & Mobility Leuven NV	TMLeuven	Belgium (B)
8.	STRATEC	STRATEC	Belgium (B)
9.	NTU Strategic Development and Consulting	NTU	Denmark (DK)
10.	STRATA Gesellschaft für Daten- und Informationsmanagement mbH	STRATA	Germany (D)
11.	TiS.pt - Consultores em Transportes, Inovação e Sistemas, s.a.	TiS.pt	Portugal (PT)
12.	TNO	TNO	Netherlands (NL)
13.	TETRAPLAN	TETRAPLAN	Denmark (DK)
14.	NTUA National Technical University	NTUA	Greece (GR)
15.	OBET, Research Institute for Transport Economics	OBET	Poland (PL)
16.	ITC, Institute of transport and Communications Ltd.	ITC	Bulgaria (BG)
17.	DEMIS B.V.	DEMIS	Netherlands (NL)
18.	UNIZA University of Žilina, Department of Highway Engineering	UNIZA University of Zilina	Slovakia (SK)

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1 Introduction to D6 deliverable

ETISplus Abstract

ETISplus sets out to build upon the strengths of the ETIS project (2005) and to address the lessons learnt. Many of the original design goals remain the same but greater emphasis is required upon the frameworks.

Several innovations and extensions are agreed:

- The widening of the geographical scope.
- The use of a specified data model.
- Inclusion of explanatory and impact related transport data.
- Updates of the reference database to 2005 and 2010.
- Inclusion of intra-zonal data for traffic flows.
- A server based data repository, using existing, proven software.
- A strong focus on achieving long-term stakeholder commitment.
- Inclusion of a dedicated process for data validation.
- The use of intelligent transport systems as new sources of data.
- New methods for data collection in accession and neighbouring countries.
- The development of a business model, by which the system can be self-supporting.

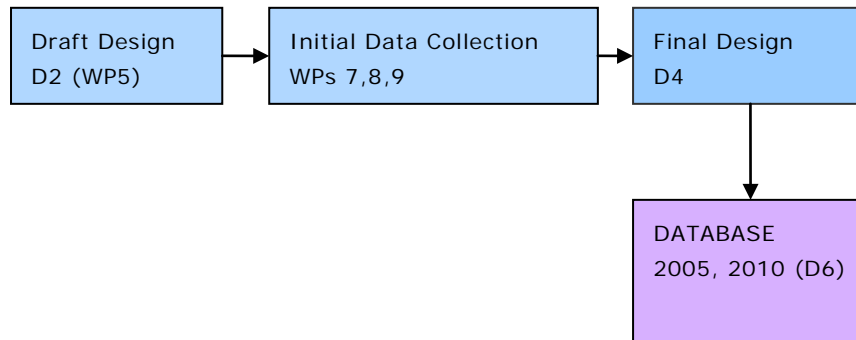
This Deliverable (D6 – Database Manual) describes the database construction methodology and the database content.

Please refer to ETISplus D4 for a description of the database structure.

1.1 Role of D6 in ETISplus

D6 describes the content of the database, and the methodologies used to create each part. It therefore follows the D4 document which describes the database specification (structure and scope).

Figure 1-1: Overview of Design/Implementation Process



ETISplus has two reference years 2005, and 2010. This document primarily describes the 2010 database, which is the key output of the project.

Online meta-data for both years is available on the online document repository:

2005:

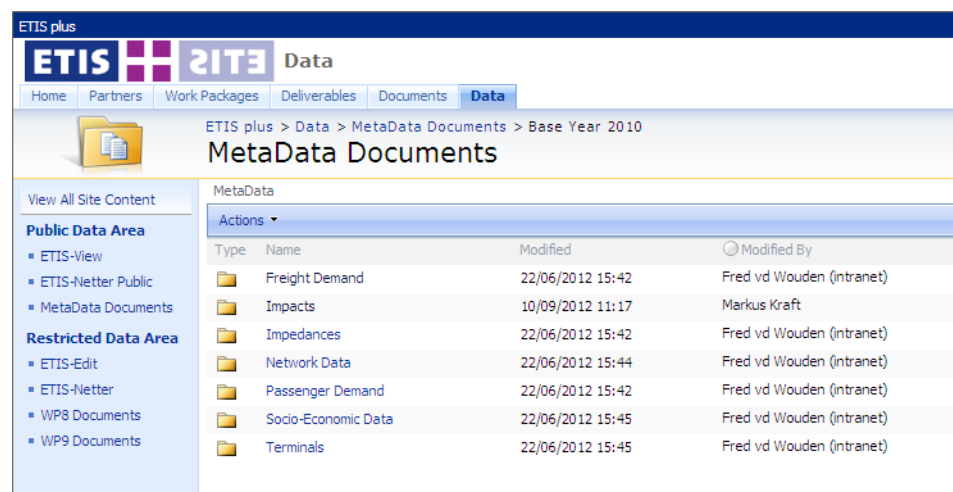
<http://www.etisplus.eu/data/MetaData%20Documents/Base%20Year%202005/>

2010:

<http://www.etisplus.eu/data/MetaData%20Documents/Base%20Year%202010/>

These reports are organised into main themes, as shown below.

Figure 1-2: Access to Database Meta Data



The data, structures and access tools being referred to in this document, can also be accessed online at <http://www.etisplus.eu>.

1.2 Structure of D6 Document

Following the introduction, each of the main data themes is described in a separate chapter. Each chapter describes:

- Scope
- Data Sources
- Methodology
- Results

The themes are organised as follows:

- Socio-economic Data
- Networks
 - Road
 - Rail
 - Waterway
 - Air
- Terminals
 - Airports
 - Freight Terminals
 - Ports
- Impedances
 - Air Passengers
 - Air Freight
 - Road Passengers
 - Rail Passengers
 - Freight transport (all modes)
- Impacts
- Freight
 - Road
 - Rail
 - Waterway
 - Aviation
 - Maritime
 - Input-Output Data
 - Trade Data
 - Trade/transport Chains
- Passengers
 - Aviation
 - Bus and Coach
 - Car
 - Rail
 - Tram and Metro
 - Cycling and Waterway
- Modelling

2 About ETISplus

2.1 Concept

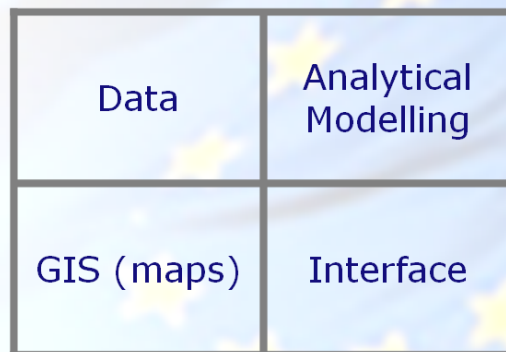
DG-MOVE has an on-going requirement for good quality input data to support models, evaluation methodologies and indicator frameworks. Without information integration, DG-MOVE lacks a consistent transport data source, and encounters problems of data interpretation arising from the heterogeneous methodologies associated with the available data sources. This is a fundamental and widespread problem, requiring effort and innovation in terms of knowledge management as well as data collection, storage and retrieval.

This has led to the concept of a common database to be used by modellers and policy makers, as first implemented through the framework project ETIS in 2005.

ETIS is a European Transport policy Information System, combining data, analytical modelling with maps (GIS), a single interface for accessing the data (Figure 2-1: ETIS Concept). It aims therefore to provide a bridge between official statistics and application within the transport policy theme.

Figure 2-1: ETIS Concept

Original ETIS Concept



ETIS: European Transport policy Information System

The original ETIS-Base contained transport related variables related to the year 2000 as well as a forecast for the year 2020 (originating from the TEN-STAC projects). It was used as the statistical basis for the TRANSTOOLS project.

TRANSTOOLS v3, the European transport network model, is the key application that ETISplus must support. The presence of TRANSTOOLS also simplifies the role of this task, by allowing it to focus more on the data, and less upon the need to calculate indicators, a major task within the original ETIS project. TRANSTOOLS contains detailed input data specifications, so ETISplus needs to fulfil the role of updating these inputs according to the given specifications.

Policy evolution, and in particular, the enlargement of Europe is a key consideration. Changes can easily render a geographical data system obsolete, such as the extension of the geographical scope over time and the evolution of administrative boundaries. Although the precise nature of these changes and their timing may be unpredictable, it is certain that they will occur, so this kind of future-proofing needs to be a core part of the database updating strategy.

Key milestones of the ETISplus project were:

- Design of the ETISplus knowledge base.
- Development of collaborative online data sharing tools.
- Development of a draft data specification.
- Collection of 2005 data and testing of the draft data specification.
- Publication of the Final Data Specification
- Construction 2010 ETISplus data collection.

The first data collections for the year 2005, as a means of testing the design. The second is 2010 in this final data delivery¹.

2.2 Design Overview

Design Goals

Goal 1: ETISplus attempts to be a multi-purpose and inclusive transport knowledge base, able to hold all the relevant information data *types* for the domain.

Goal 2: It attempts to make data from a range of sources *inter-operable*, allowing them to be combined.

Goal 3: It attempts to provide documentation and meta data to accompany the statistical information, indicating the *pedigree* of the data, and allowing results to be traced.

Goal 4: It attempts to create a purpose-built *data exchange format*, as a common standard for data upload and download.

The decisions made to reach these goals are summarised in the following sections.

2.3 Data Types

There are three main data categories that need to be handled within ETISplus:

- Tabular data

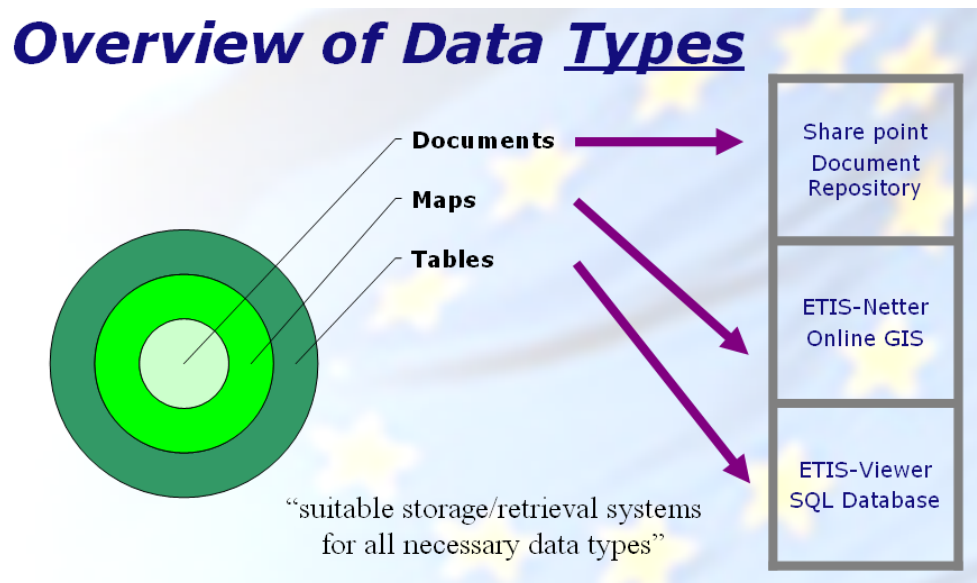
¹ Two reference year databases are being constructed, 2005 and 2010. If 2010 data is not available for any specific item, this will be estimated from the most recent available year. It is not possible to include an additional reference year. Since the final data collection is taking place in 2012, approximately a year and a half after the end of 2010, it is expected that only a minority of data will not be from 2010 itself.

- Graphical data (e.g. maps)
- Documents (human readable, including certain meta-data documents)

Thus, the ETISplus website uses three main data access/viewing technologies:

- SQL relational database with View/Edit functions.
- Netter, interactive online GIS
- SharePoint document repository.

Figure 2-2: Overview of Data Types



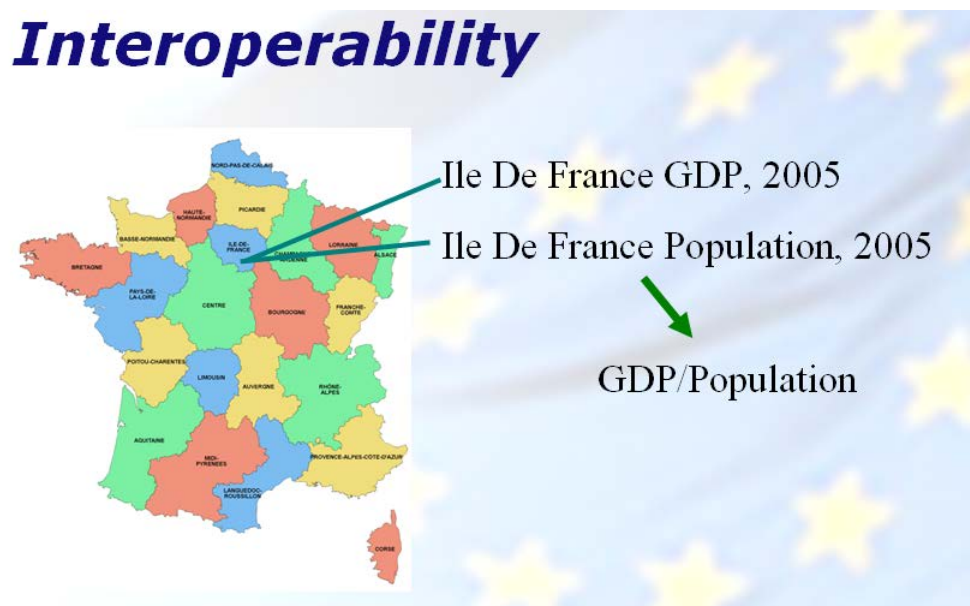
This approach adapted directly from REORIENT and WORLDNET attempts to match the form of the data contents to three different storage and access technologies, providing a greater degree of flexibility. To be useful, a formal relational database structure needs to follow strict rules about data formats. Having a document repository provides an additional storage place for data that does not need or does not fit those structures.

Each data category is considered equally important in the ETISplus system.

2.4 Interoperability and Harmonisation

One of the fundamental differences between working with European transport data and national transport data is the need to harmonise data between sources. For an undertaking such as a transport model, where socio-economic data, network data and transport data are combined, it is also necessary to make data from different themes interoperable, and thus based upon the same underlying definitions e.g. the same regional definitions. This in turn makes it possible to calculate indicators.

Figure 2-3: Interoperability of Data Layers



One source may describe freight transport in terms of main modes such as road and rail. Another may split rail into different categories. If these are to be combined, they must be pre-processed.

There is a compromise being made between maintaining the integrity of the original data, and re-stating the information according to another format, where some important details may be lost, or alternatively estimation is needed. Grouping data from individual rail modes to total rail involves a loss of detail. Splitting total rail into rail categories potentially risks accuracy.

When data is stored for more than a single time period, additional complication arises because the standard classification rules change. A particular problem for transport modellers has been the evolution of the different definitions for territorial units (NUTS codes). Some models use time-series data, in which case a consistent set of units is required. Others are applied to data for a reference year, in which case new model versions can be modified to work with new data standards.

In ETISplus, the decision has been made to organise the data according to reference years, matching for example a 2005 road network to a 2005 traffic matrix, using the statistical definitions valid in 2005. Thus, it has been chosen to keep a stronger link between the original data source and the data stored in ETISplus, rather than to enforce a single set of definitions for all time periods.

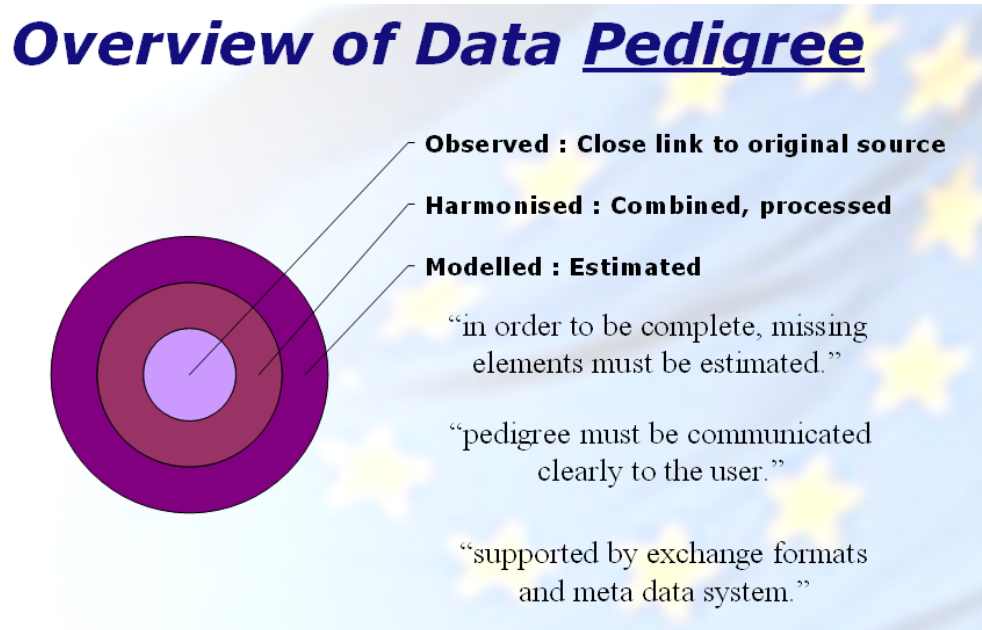
When comparing the 2005 and 2010 datasets it is therefore important to understand that although the contents are similar, the data is only harmonised within a reference year, and not between reference years. Although this makes it harder to work across time periods, it makes the system easier to maintain, and requires less manipulation of otherwise useable data. Adding data to the system does not then require historical revision.

For many users, the most important data will be the most recent reference year. However, the only way to ensure harmonisation between the most recent year and previous reference years is to convert the recent data back to the older formats. Data from the present cannot be constructed according to a future unknown specification. Potentially older reference years can be converted to become harmonised with the current data year, but this is never likely to be a priority, and since data structure changes are not necessarily improving the usability of the data for all possible applications, ETISplus has selected to keep the data definitions intact for the given reference year. Thus political changes such as the recognition of Kosovo as a separate country in 2008, or methodological changes such as the reclassification of NST product codes after 2007 are followed by ETISplus. Each reference year contains the data that "you expect".

2.5 Data Pedigree (Provenance) and Meta Data

It is impossible to satisfy the simultaneous objectives of providing full coverage, and of using only observed data samples. In order to fulfil the scope it is necessary to complete the datasets with estimation, and in order to make the data interoperable there needs to be harmonisation.

Figure 2-4: Data Pedigree (provenance)



The pedigree, meaning the history or provenance of a person or thing¹ must therefore be communicated clearly to the potential user.

Thus, the data tables are organised into collections marked “observed”, “harmonised” and “modelled”.

Table 2-1 Data Pedigree (provenance)

<i>Pedigree</i>	<i>Description</i>
Observed	Directly linked to a named source which is an official statistical publication, e.g. Eurostat.
Harmonised	Based on combining, aggregating or splitting one or more observed sources (e.g. combining Eurostat flows by origin with Eurostat flows by destination to make an O/D matrix)
Modelled	Estimated with an analytical method, including the estimation of network impedances or a synthetic OD.

For the tabular data accessed via ETIS-View, the classification can be built into the structure of the database. When the user downloads the data, they must choose which collection of data to access, so the category is communicated at the first opportunity.

The second level of data documentation is provided in the form of a template describing at a glance the main characteristics of the dataset.

¹ OED.

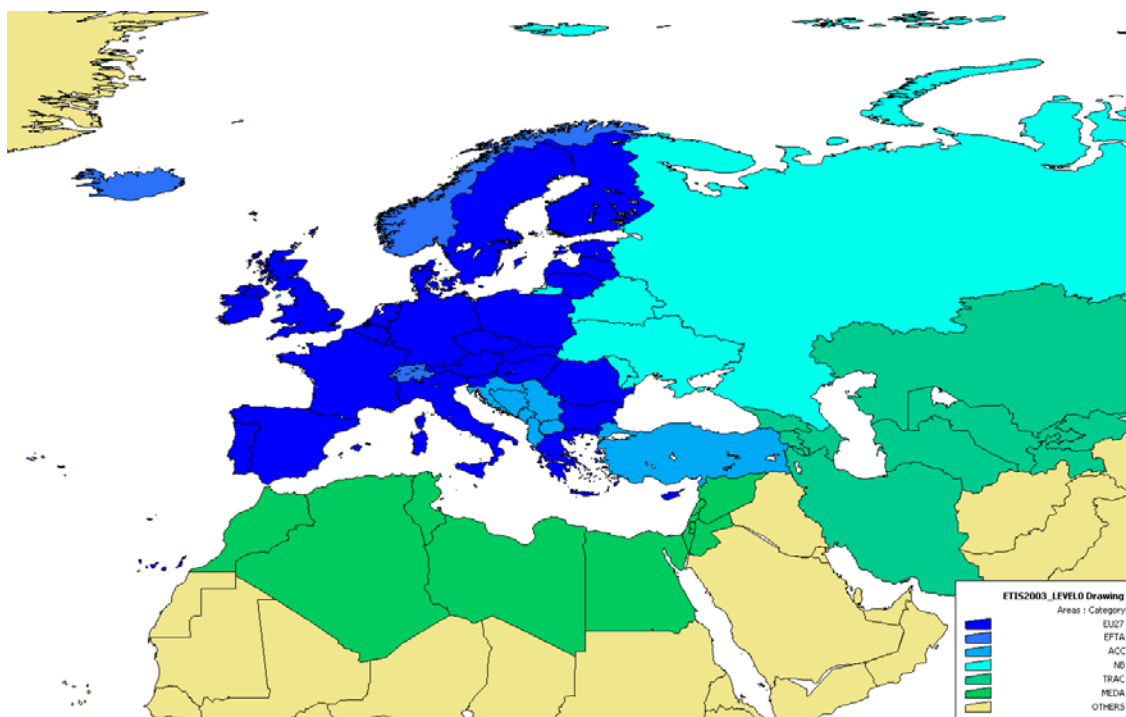
Table 2-2: Main Characteristics of Dataset (template)

Title																														
Data feature	Data specification					Remarks																								
Base year																														
Scope of data	Link <input type="checkbox"/>	Terminal <input type="checkbox"/>	O/D relation <input type="checkbox"/>	Region <input type="checkbox"/>	Other <input type="checkbox"/>																									
GIS data	Yes <input type="checkbox"/>	No <input type="checkbox"/>																												
Country coverage	<table border="1"> <thead> <tr> <th></th> <th>Com-pletely</th> <th>Par-tially</th> </tr> </thead> <tbody> <tr> <td>EU 27</td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> </tr> <tr> <td>Candidate countries & EFTA</td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> </tr> <tr> <td>Neighbouring countries</td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> </tr> <tr> <td>TRACECA</td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> </tr> <tr> <td>MEDA</td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> </tr> <tr> <td>Other countries</td> <td><input type="checkbox"/></td> <td><input type="checkbox"/></td> </tr> <tr> <td>Total number of countries covered:</td> <td colspan="2">XXX</td> </tr> </tbody> </table>						Com-pletely	Par-tially	EU 27	<input type="checkbox"/>	<input type="checkbox"/>	Candidate countries & EFTA	<input type="checkbox"/>	<input type="checkbox"/>	Neighbouring countries	<input type="checkbox"/>	<input type="checkbox"/>	TRACECA	<input type="checkbox"/>	<input type="checkbox"/>	MEDA	<input type="checkbox"/>	<input type="checkbox"/>	Other countries	<input type="checkbox"/>	<input type="checkbox"/>	Total number of countries covered:	XXX		
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Total number of countries covered:	XXX																													
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Pedigree	<table border="1"> <tbody> <tr> <td>Observed</td> <td><input type="checkbox"/></td> </tr> <tr> <td>Harmonised</td> <td><input type="checkbox"/></td> </tr> <tr> <td>Modelled</td> <td><input type="checkbox"/></td> </tr> </tbody> </table>					Observed	<input type="checkbox"/>	Harmonised	<input type="checkbox"/>	Modelled	<input type="checkbox"/>																			
Observed	<input type="checkbox"/>																													
Harmonised	<input type="checkbox"/>																													
Modelled	<input type="checkbox"/>																													

Table 2-3 Data Characteristics

<i>Pedigree</i>	<i>Description</i>
Base Year	The year to which the dataset refers.
Scope	The type of object described in the data. This can be: <ul style="list-style-type: none"> • Terminal: point, such as a terminal, a station, a port. • Region: region (or polygon) such as a country. • OD: pair of regions (an origin destination relation) • Link: sequence of points (or link), such as a road or a ferry connection. • Other.
GIS Data	GIS (geographical information system) data: Yes – if it contains geo-spatial information (co-ordinates) No.
Country Coverage	Which countries are covered by the data? See Figure 2-5.
Main data sources	Which sources have been used?
Pedigree	Which category best describes the data?

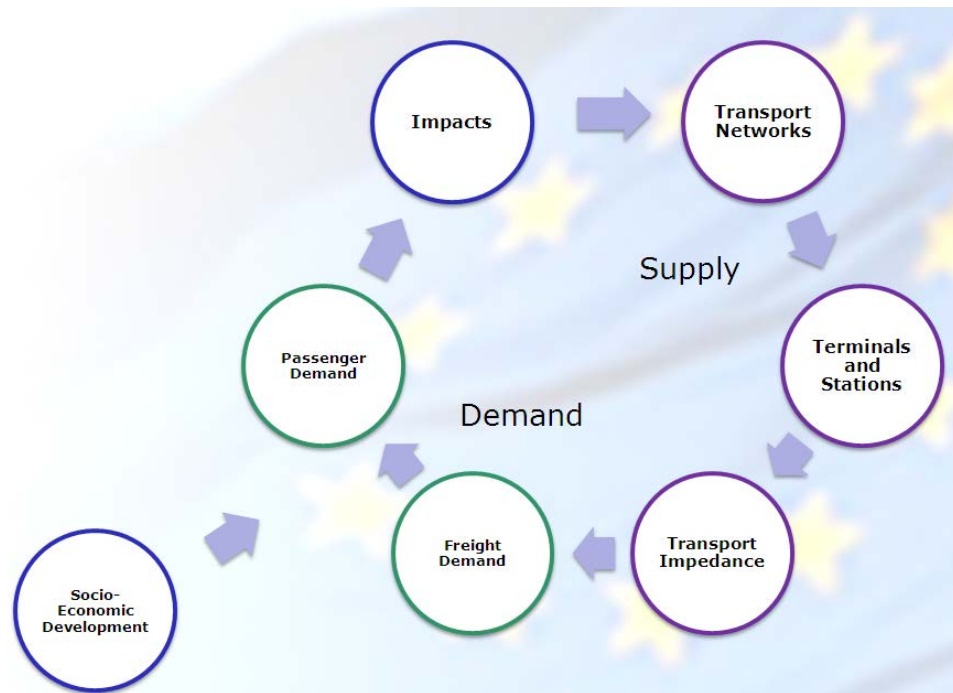
The map below shows the prioritisation used for data collection.

Figure 2-5: Country Coverage


3 Overview of Data Themes

ETISplus is designed to be comprehensive, covering the transport theme in a systematic way:

Figure 3-1: ETISplus - Main Data Themes



This section summarises the key results for each theme and indicates how the information can be accessed online.

3.1 Quick reference

Theme: SOCIO ECONOMIC DATA

Access via	Collection	Group	Description
ETIS-View	Observed Data	Socio-Economic	Indicators per EZ2006 -level3 region.
2010	http://viewer.etisplus.net/ select collection: ETISplus-2010-Observed highlight: Socio-economic		
2005	http://viewer.etisplus.net/ select collection: ETISplus-2005-Observed highlight: Socio-economic		

Theme: TRANSPORT NETWORKS

Sub-theme 1: ROAD NETWORK

Access via	Location	Folder	Description
ETIS Bulk Download	Data Bulk Downloads ETIS Data	Additional data Resources	Road network as SHP file
2010	http://www.etisplus.eu/data/Public/Downloads.aspx Additional data resources: Land_networks_2005_2010.zip File: ETISplus_road_network_2_1_final_2010.mdb (Access/SHP)		
2005	http://www.etisplus.eu/data/Public/Downloads.aspx Additional data resources: Land_networks_2005_2010.zip File: ETISplus_road_network_model_2005_v_3_1.mdb (Access/SHP)		

Access via	Location	Toolbar	Description
ETIS NETTER	http://netter.etisplus.net/	Network - Link - Road	2010 Road network as Editable GIS layer.

Sub-theme 2: RAIL NETWORK

Access via	Location	Folder	Description
ETIS Bulk Download	Data Bulk Downloads ETIS Data	Additional data Resources	Rail network as SHP file
2010	http://www.etisplus.eu/data/Public/Downloads.aspx Additional data resources: Land_networks_2005_2010.zip ETISplus_rail_network_2_1_final_2010.mdb		
2005	http://www.etisplus.eu/data/Public/Downloads.aspx Additional data resources: Land_networks_2005_2010.zip ETISplus_rail_netw_2005_fin.mdb		

Access via	Location	Toolbar	Description
ETIS NETTER	http://netter.etisplus.net/	Network - Link - Rail	2010 Rail network as Editable GIS layer.

Sub-theme 3: WATERWAY NETWORK

Access via	Location	Folder	Description
ETIS Bulk Download	Data Bulk Downloads ETIS Data	Additional data Resources	Water network as SHP and MIF/MID (MapInfo) formats.
2010	http://www.etisplus.eu/data/Public/Downloads.aspx Additional data resources: Land_networks_2005_2010.zip ETISplus_water_network_3_0_final_2010.zip (both MapInfo and ESRI formats) <i>(There is no additional data available in the earlier version of the network)</i>		

Access via	Location	Toolbar	Description
ETIS NETTER	http://netter.etisplus.net/	Network - Link - Inland Waterway	2010 Waterway network as Editable GIS layer.

Sub-theme 4: AIR NETWORK

Access via	Location	Folder	Description
ETIS Bulk Download	Data Bulk Downloads ETIS Data	Additional data Resources	Air network as XLSX Format
2010	http://www.etisplus.eu/data/Public/Downloads.aspx Additional data resources: Air_networks_2005_2010.zip Air_network_2010_082012.xlsx (passenger and cargo combined)		
2005	http://www.etisplus.eu/data/Public/Downloads.aspx Additional data resources: Air_networks_2005_2010.zip Air_passenger_network_2005.xlsx Air_cargo_network_2005.xlsx		

Theme: Airports, Ports, and Inland Terminals

Sub-theme 1: Airports

Access via	Location	Folder	Description
ETIS Bulk Download	Data Bulk Downloads ETIS Data	Additional data Resources	Airports as XLS Format (Includes volumes)
2010	http://www.etisplus.eu/data/Public/Downloads.aspx Additional data resources: Air_networks_2005_2010.zip eplus_aps_with_ind_2010.xls		
2005	http://www.etisplus.eu/data/Public/Downloads.aspx Additional data resources: Air_networks_2005_2010.zip eplus_aps_with_ind_2005.xls		

Access via	Location	Toolbar	Description
ETIS NETTER	http://netter.etisplus.net/	Network - Node - Type: terminal - NetworkType: air	2010 Airport database as Editable GIS layer.

Sub-theme 2: Freight Terminals

Access via	Location	Folder	Description
ETIS Bulk Download	Data Bulk Downloads ETIS Data	Additional data Resources	2010 Inland Freight Terminals as SHP file.
2010	http://www.etisplus.eu/data/Public/Downloads.aspx Additional data resources: Land_networks_2005_2010.zip ETISplus_inland_terminals_3_0_final_2010.zip		
2005	Not available.		

Access via	Location	Toolbar	Description
ETIS NETTER	http://netter.etisplus.net/	Network - Node - Type: terminal - NetworkType: rail or inland waterway	2010 Terminals database as Editable GIS layer.

Sub-theme 3: Railway Stations

Access via	Location	Folder	Description
ETIS Bulk Download	Data Bulk Downloads ETIS Data	Additional data Resources	2010 Rail Passenger Stations
2010	http://www.etisplus.eu/data/Public/Downloads.aspx Additional data resources: Land_networks_2005_2010.zip ETISplus_rail_stations_final_2010.mdb		
2005	http://www.etisplus.eu/data/Public/Downloads.aspx Additional data resources: Land_networks_2005_2010.zip RailPassengerTerminals2005.mdb		

Sub-theme 4: Ports

Access via	Location	Folder	Description
ETIS Bulk Download	Data Bulk Downloads ETIS Data	Additional data Resources	2010 Seaports as GIS Layer MapInfo Mif/Mid
2010	http://www.etisplus.eu/data/Public/Downloads.aspx Additional data resources: Land_networks_2005_2010.zip ETISplus_ports_2_10_final_2010.zip (mif/mid format)		
2005	Not available.		

Access via	Location	Toolbar	Description
ETIS NETTER	http://netter.etisplus.net/	Network - Node - Type: port	2010 seaport database as Editable GIS layer.

Theme: Transport Impedances

Sub-theme 1: Air Passenger Impedances

Access via	Collection	Group	Description
ETIS View	Modelled Data	Passenger	Flight times, flight distances and travel costs per O/D.
2010	http://viewer.etisplus.net/ select collection: ETISplus-2010-Modelled highlight: Passenger open table: Air Impedances - Passenger		
2005	http://viewer.etisplus.net/ select collection: ETISplus-2005-Modelled highlight: Passenger open table: Air Impedances - Passenger		

Sub-theme 2: Air Freight Impedances

Access via	Collection	Group	Description
ETIS View	Modelled Data	Freight	Flight times, flight distances and number of connections per O/D.
2010	http://viewer.etisplus.net/ select collection: ETISplus-2010-Modelled highlight: Freight open table: Air Impedances - Freight		
2005	http://viewer.etisplus.net/ select collection: ETISplus-2005-Modelled highlight: Freight open table: Air Impedances - Freight		

Sub-theme 3: Road Passenger Impedances (cars)

Access via	Collection	Group	Description
ETIS View	Modelled Data	Passenger	Travel times, distances and estimated costs for passenger car transport.
2010	http://viewer.etisplus.net/ select collection: ETISplus-2010-Modelled highlight: Passenger open table: Road Impedances - Passenger		
2005	http://viewer.etisplus.net/ select collection: ETISplus-2005-Modelled highlight: Passenger open table: Road Impedances - Passenger		

Sub-theme 4: Rail Passenger Impedances

Access via	Collection	Group	Description
ETIS View	Observed Data	Passenger	Service Frequencies and Travel Times
2010	http://viewer.etisplus.net/ select collection: ETISplus-2010-Observed highlight: Passenger open table: Rail Impedances - Passenger Further estimated indicators are available in: select collection: ETISplus-2010-Modelled highlight: Passenger open table: Rail Impedances - Passenger		
2005	http://viewer.etisplus.net/ select collection: ETISplus-2005-Observed highlight: Passenger open table: Rail Impedances – Passenger Further estimated indicators are available in: select collection: ETISplus-2005-Modelled highlight: Passenger open table: Rail Impedances - Passenger		

Sub-theme 5: Freight Impedances (surface modes)

Access via	Collection	Group	Description
ETIS View	Modelled Data	Freight	Estimated distances and trip times by mode of transport per O/D.
2010	http://viewer.etisplus.net/ select collection: ETISplus-2010-Modelled highlight: Freight open tables: - Road Impedances – freight - Rail Impedances – freight - Inland Waterway Impedances – freight		
2005	http://viewer.etisplus.net/ select collection: ETISplus-2005-Modelled highlight: Freight open tables: - Road Impedances – freight - Rail Impedances – freight - Inland Waterway Impedances – freight		

Theme: Impacts of Transport

Access via	Collection	Group	Description
ETIS View	Modelled Data	Socio-economic	Estimated social impacts from transport (e.g. emissions and accidents)
2010	http://viewer.etisplus.net/ select collection: ETISplus-2010-Modelled highlight: Socio-economic open table: Impacts		
2005	http://viewer.etisplus.net/ select collection: ETISplus-2005-Modelled highlight: Socio-economic open table: Impacts		

Theme: Freight Demand

Sub-theme 1: Road Freight

Access via	Collection	Group	Description
ETIS View	Modelled Data	Freight	Road Freight Tonnages by NUTS3 O/D and NST2 Commodity
2010	http://viewer.etisplus.net/ select collection: ETISplus-2010-Modelled highlight: Freight open table: Road Freight by OD		
2005	http://viewer.etisplus.net/ select collection: ETISplus-2005-Modelled highlight: Freight open table: Road Freight by OD		

Sub-theme 2: Rail Freight

Access via	Collection	Group	Description
ETIS View	Modelled Data	Freight	Rail Freight Tonnages by NUTS3 O/D and NST2 Commodity
2010	http://viewer.etisplus.net/ select collection: ETISplus-2010-Modelled highlight: Freight open table: Disaggregated rail freight by OD		
2005	http://viewer.etisplus.net/ select collection: ETISplus-2005-Modelled highlight: Freight open table: Disaggregated rail freight by OD		

Sub-theme 3: Inland Waterway Freight

Access via	Collection	Group	Description
ETIS View	Modelled Data	Freight	Inland Waterway Freight Tonnages by NUTS3 O/D and NST2 Commodity
2010	http://viewer.etisplus.net/ select collection: ETISplus-2010-Modelled highlight: Freight open table: Disaggregated IWW Freight by OD		
2005	http://viewer.etisplus.net/ select collection: ETISplus-2005-Modelled highlight: Freight open table: Disaggregated IWW Freight by OD		

Sub-theme 4: Air Freight

Access via	Collection	Group	Description
ETIS View	Harmonised Data	Freight	Air Freight Tonnages by NUTS3 O/D (No Commodity) Additional data is available in Airport database (terminal theme)
2010	http://viewer.etisplus.net/ select collection: ETISplus-2010-Harmonised highlight: Freight open table: Air Freight by OD		
2005	http://viewer.etisplus.net/ select collection: ETISplus-2005-Harmonised highlight: Freight open table: Air Freight by OD		

Sub-theme 5: Maritime Freight

Access via	Collection	Group	Description
ETIS View	Modelled Data	Freight	Maritime Freight Tonnages by NUTS3 O/D and NST2 Commodity
2010	http://viewer.etisplus.net/ select collection: ETISplus-2010-Modelled highlight: Freight open table: Maritime freight by OD		
2005	http://viewer.etisplus.net/ select collection: ETISplus-2005-Modelled highlight: Freight open table: Maritime freight by OD		

Sub-theme 6: Input-Output Data

Access via	Collection	Group	Description
ETISplus Sharepoint	ETISplus Public Document Repository	Deliverables Data deliverables Freight	Input-Output Tables per economic sector , per EU country. XLS format.
2010	Not available		
2005	From www.etisplus.eu Click: <u>Deliverables</u> Tab, then <u>Data Deliverables</u> in sidebar, then <u>Freight</u> folder. Item: IOT_Europe2005 Or direct: http://www.etisplus.eu/deliverables/Data%20Deliverables/Freight/IOT_Europe2005.xls		

Sub-theme 7: Logistics

Access via	Collection	Group	Description
ETISplus Sharepoint	ETISplus Public Document Repository	Deliverables Data deliverables Freight	Regional socio-economic data related to Logistics Sectors, per NUTS2. MS-Access format
2010	Not available		
2005	<p>From www.etisplus.eu Click: <u>Deliverables</u> Tab, then <u>Data Deliverables</u> in sidebar, then <u>Freight</u> folder. Item: Logistieke data 2005</p> <p>Or direct: http://www.etisplus.eu/deliverables/Data%20Deliverables/Freight/Logistieke%20data%202005.zip</p>		

Sub-theme 8: Trade Data

Access via	Collection	Group	Description
ETIS View	Harmonised Data	Freight	Trade data by Country and NST2 Commodity
2010	http://viewer.etisplus.net/ select collection: ETISplus-2010-Harmonised highlight: Freight open table: Harmonised Trade		
2005	http://viewer.etisplus.net/ select collection: ETISplus-2005-Harmonised highlight: Freight open table: Harmonised Trade		

Sub-theme 9: Transport/Trade Chain Data

Access via	Collection	Group	Description
ETISplus Sharepoint	ETISplus Public Document Repository	Deliverables Data deliverables Freight	Transport Chain Data for 2010 by NUTSO and NST1 MS-Access Format
2010	<p>From www.etisplus.eu</p> <p>Click: <u>Deliverables</u> Tab, then <u>Data Deliverables</u> in sidebar, then <u>Freight</u> folder. Item: 2010_ETISplus_Transportchains_V21112_FINAL</p> <p>Or direct (MS-Access version):</p> <p>http://www.etisplus.eu/deliverables/Data%20Deliverables/Freight/2010_ETISplus_Transportchains_V21112_FINAL.zip</p> <p>Text Version:</p> <p>http://ftp.demis.nl/Outgoing/ETISplus/DataDeliverables/Additional/Freight-Miscellaneous.zip</p>		
2005	Not available.		

Theme: Passenger Demand

Sub-theme 1: Air Passenger Matrix

Access via	Collection	Group	Description
ETIS View	Modelled Data	Passenger	Air passengers by O/D and trip purpose. Flows by airport also available in airport database (see Airports, Ports, Terminals theme)
2010	<p>http://viewer.etisplus.net/</p> <p>select collection: ETISplus-2010-Modelled</p> <p>highlight: Passenger</p> <p>open table: Passenger transport by air at regional level</p>		
2005	<p>http://viewer.etisplus.net/</p> <p>select collection: ETISplus-2005-Modelled</p> <p>highlight: Passenger</p> <p>open table: Passenger transport by air at regional level</p>		

Sub-theme 2: Bus and Coach Passenger Matrix

Access via	Collection	Group	Description
ETIS View	Modelled Data	Passenger	Bus and Coach passengers by O/D and trip purpose. (Stored as separate modes – i.e. separate tables)
2010	http://viewer.etisplus.net/ select collection: ETISplus-2010-Modelled highlight: Passenger open tables: - Passenger transport by bus - Passenger trips by coach		
2005	http://viewer.etisplus.net/ select collection: ETISplus-2005-Modelled highlight: Passenger open tables: - Passenger transport by bus - Passenger trips by coach		

Sub-theme 3: Car Passenger Matrix

Access via	Collection	Group	Description
ETIS View	Modelled Data	Passenger	Car passengers by O/D and trip purpose. (Separate tables for intrazonal car trips are available separately)
2010	http://viewer.etisplus.net/ select collection: ETISplus-2010-Modelled highlight: Passenger open tables: - Passenger transport by car		
2005	http://viewer.etisplus.net/ select collection: ETISplus-2005-Modelled highlight: Passenger open tables: - Passenger transport by car		

Sub-theme 4: Rail Passenger Matrix

Access via	Collection	Group	Description
ETIS View	Modelled Data	Passenger	Rail passengers by O/D and trip purpose. (Separate tables for intrazonal car trips are available separately)
2010	http://viewer.etisplus.net/ select collection: ETISplus-2010-Modelled highlight: Passenger open tables: - Passenger transport by rail		
2005	http://viewer.etisplus.net/ select collection: ETISplus-2005-Modelled highlight: Passenger open tables: - Passenger transport by rail		

Sub-theme 5: Tram and Metro Passenger Matrix

Access via	Collection	Group	Description
ETIS View	Modelled Data	Passenger	Tram and metro passengers by O/D and trip purpose.
2010	http://viewer.etisplus.net/ select collection: ETISplus-2010-Modelled highlight: Passenger open tables: - Passenger trips by tram and metro		
2005	http://viewer.etisplus.net/ select collection: ETISplus-2005-Modelled highlight: Passenger open tables: - Passenger trips by tram and metro		

Sub-theme 6: Cycling and Walking Matrix

Access via	Collection	Group	Description
ETIS View	Modelled Data	Passenger	Cycling and walking trips by O/D and trip purpose.
2010	http://viewer.etisplus.net/ select collection: ETISplus-2010-Modelled highlight: Passenger open tables: - Passenger trips by cycling - Passenger trips by walking		
2005	http://viewer.etisplus.net/ select collection: ETISplus-2005-Modelled highlight: Passenger open tables: - Passenger trips by cycling - Passenger trips by walking		

4 Socio Economic Data

4.1 Scope of the Database

The present document describes the contents of the socio-economic data set for the ETISplus base year 2010. The scope of the socio-economic data set is illustrated by table Table 4-1.

Figure 4-1: Overview of main characteristics of the data set

Socio-economic data							
Data feature	Data specification					Remarks	
Base year	2010						
Scope of data	Link	Terminal	O/D relation	Region	Other		
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>		
GIS data	Yes	No					
	<input type="checkbox"/>	<input checked="" type="checkbox"/>					
Country coverage				Com-pletely	Par-tially		
	EU 27			<input type="checkbox"/>	<input checked="" type="checkbox"/>		
	Candidate countries & EFTA			<input type="checkbox"/>	<input checked="" type="checkbox"/>		
	Neighbouring countries			<input type="checkbox"/>	<input checked="" type="checkbox"/>		
	TRACECA			<input type="checkbox"/>	<input checked="" type="checkbox"/>		
	MEDA			<input type="checkbox"/>	<input checked="" type="checkbox"/>		
	Other countries			<input type="checkbox"/>	<input checked="" type="checkbox"/>		
	Total number of countries covered:			42			
Main data sources	EUROSTAT and national statistical offices						
Main type of data generation	Observed	<input checked="" type="checkbox"/>	Harmonised	<input checked="" type="checkbox"/>	Modelled	<input checked="" type="checkbox"/>	Parts of the socio-economic data set have been estimated.

4.1.1 Countries

In the socio-economic dataset European data is collected for the following countries, which can be subdivided into three groups:

- EU countries:
Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Greece, Germany, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, United Kingdom
- CC & EFTA countries:
Croatia, Island, Liechtenstein, Norway, Switzerland, Turkey
- Other countries:
Albania, Belarus, Bosnia and Herzegovina, Kosovo, Macedonia, Montenegro, Russia, Serbia, Ukraine

Regions

The socio-economic data set provides data for more than 1,600 European regions. The regions implemented in the socio-economic data set for EU and EFTA countries are in line with the regions defined by EUROSTAT. The lowest NUTS level available in the socio-economic data set is NUTS 3.

European Union and European Free Trade Association Countries

The NUTS classifications for the EU27 countries as well as for the Candidate and the EFTA countries are official classifications published by EUROSTAT. In case of the EU27 countries the NUTS classification used for the base year 2010 was published by EUROSTAT in 2006.

Other Countries

For the other countries an official NUTS classification is not available. Thus the segmentation applied within the socio-economic data set refers to an unofficial classification, which has been used in the WORLDNET project.

4.1.2 Indicators

The socio-economic data set presently contains the following indicators:

- GDP:
The indicator "GDP" contains the data for the Gross Domestic Product values in Euro.
- GDP in PPS:
"GDP in PPS" represents the GDP in Purchasing Power Standard. This indicator has a high force of expression, because it eliminates different price levels in different countries. The values were derived from national GDP figures in PPS, which were assigned to regions. PPS is the artificial currency of Purchasing Power Parities (PPP). PPP calculations are based on price surveys covering a basket of goods and service, which are both comparative and representative for the referring countries.
- Population, population by sex, population by age groups:

This indicator contains the number of inhabitants in total as well as differentiated by gender and by age classes. The age classes used are 5-years cohorts.

- **Area:**
The spatial extension of regions measured in square-kilometers is a basic information and precondition for calculating the population density and other area-related indicators.
- **GVA total, GVA by sectors:**
The indicators "GVA total" and "GVA by Sectors" contain the data for the Gross Value Added and the Gross Value Added by economic sectors.
- **Employed persons total, employed persons by sectors:**
These indicators comprise only persons in paid employment and refer to the population of working age (15-64 years). Total values and values by economic sectors are given for the employed persons.
- **Economically active population:**
In this dataset all economically active inhabitants (e.g. self-employed persons) of all ages are included.
- **Unemployment:**
For this indicator the rate of those persons is given, who belong to the population of working age (15-64 years) and who meet the following conditions simultaneously: Without work, currently available for work or seeking work.
- **Accommodation facilities:**
The tourism indicator "accommodation facilities" comprises the number of establishments in the region, differentiated by hotels and similar establishments, tourist campsites, holiday dwellings as well as other collective accommodation establishments.
- **Bedrooms in accommodation facilities:**
The tourism indicator "bedrooms in accommodation facilities" contains the number of bedrooms in the region.
- **Bed places in accommodation facilities:**
The tourism indicator "bed places in accommodation facilities" contains the number of bed places in the region, differentiated by bed-places in hotels and similar establishments, in tourist campsites, in holiday dwellings and in other collective accommodation establishments.
- **Households:**
The indicator "households" contains the number of households in total and differentiated by the number of persons living together within the same household.
- **Income of households:**
This indicator measures the net average income per household in the region in Euro.
- **R&D expenditures:**
Research and development expenditures include all funds in Euro used for the performance of R&D within the reporting unit. It includes current expenditures like employment costs, expenditures on materials, and capital expenditures on e.g. buildings or equipment. However, even the data of the countries belonging to the EU are not always comparable due to differences in interpreting the definitions, disparate survey methods and peculiarities of national R&D systems.

- **R&D personnel:**
The data for R&D personnel in EU countries includes all persons employed directly in research and development plus persons supplying direct services to R&D, such as managers, administrative staff and office staff.
- **Companies:**
The data provided for the indicator "companies" contains the number of companies differentiated by the sectors "mining and quarrying", "manufacturing", "electricity, gas and water supply", "construction", "wholesale and retail trade; repair of motor vehicles, motorcycles and personal and household goods", "hotels and restaurants", "transport, storage and communication", "real estate, renting and business activities"
- **Vehicle stock:**
The data sets provided for the indicator "vehicle stock" contain the numbers of different types of registered vehicles. The data sets are differentiated by "passenger cars", "buses", "goods road vehicles", "motorcycles", "special vehicles", "total utility vehicles", "road tractors" and "trailers and semitrailers" in the respective region.

Figure 4-2: Data structure of the socio-economic data set

Indicator	Description of indicator	Unit
GDPTotal	Gross Domestic Product at market prices in total	million Euro
GDPinPPS	Gross Domestic Product based on final consumption	Purchasing Power Standards
PopTotal	Number of total inhabitants in total	1000 persons
PopMale	Number of inhabitants by gender "male"	1000 persons
PopFemale	Number of inhabitants by gender "female"	1000 persons
PopAge0004	Number of inhabitants by age class "0-4"	persons
PopAge0509	Number of inhabitants by age class "5-9"	persons
PopAge1014	Number of inhabitants by age class "10-14"	persons
PopAge1519	Number of inhabitants by age class "15-19"	persons
PopAge2024	Number of inhabitants by age class "20-24"	persons
PopAge2529	Number of inhabitants by age class "25-29"	persons
PopAge3034	Number of inhabitants by age class "30-34"	persons
PopAge3539	Number of inhabitants by age class "35-39"	persons
PopAge4044	Number of inhabitants by age class "40-44"	persons
PopAge4549	Number of inhabitants by age class "45-49"	persons
PopAge5054	Number of inhabitants by age class "50-54"	persons
PopAge5559	Number of inhabitants by age class "55-59"	persons
PopAge6064	Number of inhabitants by age class "60-64"	persons
PopAge6569	Number of inhabitants by age class "65-69"	persons
PopAge70plus	Number of inhabitants by age class "70 or more years old"	persons
Area	Spatial extension	square-km
GVATotal	Gross Value Added at market prices in total	million Euro
GVASector1	Gross Value Added at market prices in sector 1: agriculture	million Euro
GVASector2	Gross Value Added at market prices in sector 2: industry	million Euro

Indicator	Description of indicator	Unit
GVASector3	Gross Value Added at market prices in sector 3: services	million Euro
EmpTotal	Employed persons in total	1000 persons
EmpSector1	Employed persons in sector 1: agriculture	1000 persons
EmpSector2	Employed persons in sector 2: industry	1000 persons
EmpSector3	Employed persons in sector 3: services	1000 persons
EconActivePop	Economically active population	1000 persons
Unemp	Unemployment rate	per cent
AccomFacHotels	Number of accommodation facilities by "hotels and similar establishments"	accommodation facilities
AccomFacTouCamp	Number of accommodation facilities by "tourist campsites"	accommodation facilities
AccomFacHolDwell	Number of accommodation facilities by "holiday dwellings"	accommodation facilities
AccomFacOtherColl	Number of accommodation facilities by "other collective accommodation establishments"	accommodation facilities
BedroomsHotels	Number of bedrooms in hotels	bedrooms
BedsHotels	Number of bedplaces "in hotels and similar establishments"	bedplaces
BedsTouCamp	Number of bedplaces in the region "in tourist campsites"	bedplaces
BedsHolDwell	Number of bedplaces in the region "in holiday dwellings"	bedplaces
BedsOtherColl	Number of bedplaces in the region "in other collective accommodation establishments"	bedplaces
Households1pers	Number of persons living together in "1-person-households"	persons
Households2pers	Number of persons living together in "2-person-households"	persons
Households3pers	Number of persons living together in "3-person-households"	persons
Households4pers	Number of persons living together in "4-person-households"	persons
Households5pers	Number of persons living together in "5-person-households"	persons
Households6persplus	Number of persons living together in "households with 6 or more persons"	persons
IncomeOfHouseholds	Net average income per household in the region	Euro
R&Dexpend	Expenditures for Research and Development	million Euro
R&Dpersonnel	Personnel employed in Research and Development	persons
CompaniesMining	Number of companies located in the region by sector "Mining and quarrying"	companies
CompaniesManufacturing	Number of companies located in the region by sector "Manufacturing"	companies
CompaniesElectrGasWater	Number of companies located in the region by sector "Electricity, gas and water supply"	companies
CompaniesConstruction	Number of companies located in the region by sector "Construction"	companies
CompaniesWholesaleRepair	Number of companies located in the region by sector "Wholesale and retail trade; repair of motor vehicles, motorcycles and personal and household goods"	companies
CompaniesHotelsRestaurants	Number of companies located in the region by sector "Hotels and restaurants"	companies
CompaniesTransportCommunication	Number of companies located in the region by sector "Transport, storage and communication"	companies
CompaniesRealEstateRenting	Number of companies located in the region by sector "Real estate, renting and business activities"	companies

Indicator	Description of indicator	Unit
VehicleStockPassCars	Number of registered vehicles by the application number of "passenger cars"	vehicles
VehicleStockBuses	Number of registered vehicles by the application number of "buses"	vehicles
VehicleStockGoodsRoadVeh	Number of registered vehicles by the application number of "goods road vehicles"	vehicles
VehicleStockMotocycles	Number of registered vehicles by the application number of "motorcycles"	vehicles
VehicleStockSpecVeh	Number of registered vehicles by the application number of "special vehicles"	vehicles
VehicleStockTotalUtilVeh	Number of registered vehicles by the application number of "total utility vehicles"	vehicles
VehicleStockRoadTractors	Number of registered vehicles by the application number of "road tractors"	vehicles
VehicleStockTrailers	Number of registered vehicles by the application number of "trailers" and "semitrailers"	vehicles

4.1.3 Basic Features of the Data

The socio-economic data set shows some basic features of all indicators used in the data sets.

Reference Year

The base year for the data collection has been 2010. However, not all data sets have been available at regional level for 2010. Especially data, which is the result from a census (e.g. number of households), refer to other years. Parts of the data are only available for the years 2005-2009 at EUROSTAT, the value for 2010 had to be estimated or modeled.

Currencies

Monetary values (e.g. GDP, GVA, income of households, R&D-expenditure) are given in Euro.

4.2 Methodology

The data sets published within the socio-economic data set are from EUROSTAT. Some data sets stem from national statistical offices. Often data sets of the socio-economic data set have been calculated.

4.2.1 Calculation of NUTS3 data for 2010 with available national data for 2010

Some data is not available at NUTS3 level for the base year 2010. Therefore, the regional distribution of this indicator, given by EUROSTAT, and national data for the year 2010 is utilized to estimate the NUTS3 values for the year 2010.

The distribution of the considered indicator for the different NUTS3 zones remains the same as in the latest by EUROSTAT given year (2005 – 2009). The national data is used to calculate a growth rate from the value of the latest given

year to the value of 2010. The total amount of all regions grows with this rate and the same growth rate can be used to estimate the values of the several regions.

- Calculation of growth rates between *year x* and *2010* for indicator *i*:

$$growth\ rate_{i,x,2010} = \frac{indicator_{i,2010}}{indicator_{i,x}}$$

$growth\ rate_{i,x,2010}$: Growth rate for indicator *i*, describing the variation between year *x* and 2010

$indicator_{i,2010}$: National value of indicator *i* for the year 2010

$indicator_{i,x}$: National value of indicator *i* for the year *x*

- Calculation of NUTS3 level values for the year 2010:

$$indicator_{i,2010,k}^* = growth\ rate_{i,x,2010} * indicator_{i,x,k}$$

$indicator_{i,2010,k}^*$: Estimated value of indicator *i* for the year 2010 and NUTS3 zone *k*

$indicator_{i,x,k}$: Value of indicator *i* for the year *x* and NUTS3 zone *k*

4.2.2 Estimation of NUTS3 level data with national or NUTS2 level data and population distribution

For some indicators, it is necessary to estimate the NUTS3 level values as there is no regional distribution given by EUROSTAT or other sources. The estimation process depends on whether there is NUTS2 level data for 2010 available, or only for previous years.

Estimation with available NUTS2 level data for 2010

Several indicators for some countries are only available at the level of NUTS2 or higher. Thus, these indicators had to be estimated at the level of NUTS3. For the estimation, the geographical distribution of the population was used to divide the given values into the corresponding NUTS3 regions. The following equation describes the applied approach:

$indicator_{i,2010,k}$: Estimated value of indicator *i* in NUTS3 region *k* for the year 2010

$indicator_{i,2010,c}$: Value of indicator *i* in NUTS2 region *C* for the year 2010

$c \in C$: All NUTS3 regions *c* in NUTS2 region *C*

pop_k : Number of inhabitants in the NUTS3 region *k*

$\sum_{c \in C} pop_c$: Number of total inhabitants in the NUTS2 region *C*

Estimation with NUTS2 level data of the years 2005-2009

If there is no NUTS2 level data available for the year 2010, the estimation has to be divided in two steps. In the first step, the NUTS2 level data for 2010 is estimated by a growth rate, using the national value for 2010 and the national value of the latest given year x (2005-2009) at the level of NUTS2:

- Calculation of growth rates between year x and 2010 for indicator i :

$$growth\ rate_{i,x,2010} = \frac{indicator_{i,2010}}{indicator_{i,x}}$$

$growth\ rate_{i,x,2010}$: Growth rate for indicator i , describing the variation between year x and 2010

$indicator_{i,2010}$: National value of indicator i for the year 2010

$indicator_{i,x}$: National value of indicator i for the year x

- Calculation of NUTS2 values for the year 2010:

$$indicator_{i,2010,C}^* = growth\ rate_{i,x,2010} * indicator_{i,x,C}$$

$indicator_{i,2010,C}^*$: Estimated value of indicator i for the year 2010 and NUTS2 zone C

$indicator_{i,x,C}$: Value of indicator i for the year x and NUTS2 zone C

In the second step, the NUTS3 level data for 2010 is estimated by the NUTS2 level data for 2010 and the geographical distribution of population:

$$indicator_{i,2010,k}^{*,\#} = \frac{pop_k}{\sum_{c \in C} pop_c} * indicator_{i,2010,C}^*$$

$indicator_{i,2010,k}^{*,\#}$: Estimated (2x) value of indicator i in NUTS3 region k for the year 2010

$indicator_{i,2010,C}^*$: Estimated value of indicator i in NUTS2 region C for the year 2010

$c \in C$: All NUTS3 regions c in NUTS2 region C

pop_k : Number of inhabitants in the NUTS3 region k

$\sum_{c \in C} pop_c$: Number of total inhabitants in the NUTS2 region C

Further estimations of NUTS2 and NUTS3 level data for 2010

For some indicators and countries, there is no data for 2010 available at all. In this case, the comment field in the ANNEX1 tables gives information about the applied method of calculating the values for 2010. If there is data at the required NUTS level available at EUROSTAT for the year 2008 or 2009, these values are used for the ETISplus dataset instead of the value for the year 2010. Older than

2008 data is not used, having regard to the global financial crisis beginning in the year 2007. If so, the comment goes as the following: "*value 2010 = value 2008*" respectively "*value 2010 = value 2009*".

Another applied method to calculate values for the year 2010 is to continue the growth rates of former periods:

- $value2010 = value2009 * \frac{value2009}{value2008}$
- $value2010 = value2008 * \left(\frac{value2008}{value2007}\right)^2$
- $value2010 = value2007 * \left(\frac{value2007}{value2006}\right)^3$
- ...

The correspondent comments in tables 3 – 44 are "*value2010 = value2009 * (value2009/value2008)*", "*value2010 = value2008 * (value2008/value2007)^2*", and so on.

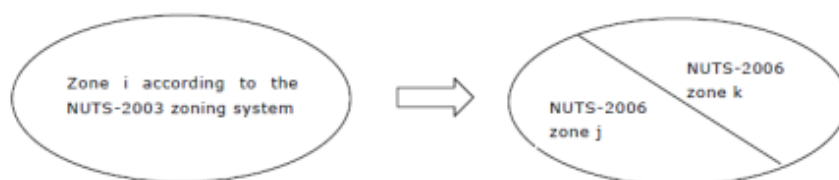
4.2.3 Calculation of values from NUTS-2003 zoning system to NUTS-2006 zoning system

In ETISplus base year 2010, the data is given in NUTS-2006 zoning system. If it was necessary to use data from base year 2005 to calculate values for the base year 2010 (compare 2.2.2), this data could be given in NUTS-2003 zoning system and has to be converted into NUTS-2006 zoning system.

Calculation of absolute values from NUTS-2003 zoning system to NUTS-2006 zoning system

Absolute values (e.g. population, area, GDP, vehicle stock) given in the NUTS-2003 zoning system had to be converted by dividing the NUTS3-2003 regions in two or more NUTS3-2006 regions, see Figure 4-3:

Figure 4-3: Calculation of indicators from NUTS-2003 to NUTS-2006 zoning system



The disaggregation follows the proportionate shares of population in the considered NUTS3-2006 region and is illustrated by the following formulas:

$$x_{i,2003} = x_{j,2006} + x_{k,2006}$$

$$x_{j,2006} = \left(\frac{pop_{j,2006}}{pop_{i,2003}} \right) * x_{i,2003}$$

$$x_{k,2006} = \left(\frac{pop_{k,2006}}{pop_{i,2003}} \right) * x_{i,2003}$$

$x_{i,2003}$:	Indicator value of the NUTS3-2003 region i
$x_{j,2006}$:	Indicator value of the NUTS3-2006 region j
$x_{k,2006}$:	Indicator value of the NUTS3-2006 region k
$pop_{i,2003}$:	Population of the NUTS3-2003 region i
$pop_{j,2006}$:	Population of the NUTS3-2006 region j
$pop_{k,2006}$:	Population of the NUTS3-2006 region k

Calculation of relative values from NUTS-2003 zoning system to NUTS-2006 zoning system

Another methodology is applied for the calculation of indicators with relative values. The only indicator in the ETISplus socio-economic data set, where such a calculation is necessary, is the indicator unemployment:

$$unemp_{i,2003} = \frac{empl_{j,2006} \cdot unemp_{j,2006} + empl_{k,2006} \cdot unemp_{k,2006}}{empl_{i,2003}}$$

$unemp_{i,2003}$:	Unemployment rate of NUTS 3-2003 region i
$unemp_{j,2006}$:	Unemployment rate of NUTS 3-2006 region j
$unemp_{k,2006}$:	Unemployment rate of NUTS 3-2006 region k
$empl_{i,2003}$:	Number of persons in paid employment of NUTS 3-2003 region i
$empl_{j,2006}$:	Number of persons in paid employment of NUTS 3-2006 region j
$empl_{k,2006}$:	Number of persons in paid employment of NUTS 3-2006 region k

4.2.4 Currency conversion

National data is often given in varying currencies, for the ETISplus database, these values have to be converted into Euro to ensure comparability between all countries. The used exchange rates for different years can be found at EUROSTAT:

<http://epp.eurostat.ec.europa.eu/tgm/table.do?tab=table&init=1&plugin=1&language=de&pcode=tec00033>

4.3 Data sources

This section is devoted to a description of data availability in the socio-economic data set for the ETISplus base year 2010.

4.3.1 Data Availability at Regional Level

By comparing the availability of data at regional level with the availability of data at national level, one can observe at least two main differences:

- Regional data are often less detailed than national data. The number of available features decreases with a lower level of aggregation. As an example, GVA values in Belgium are published for 60 economic sectors at national level, for 17 economic sectors at the level of NUTS2, but for only three economic sectors at the level of NUTS3. This scheme of publishing data for GVA by sectors is applied by most of the statistical offices in order to ensure confidentiality and to disable the user of the data to assign the values to a single company.
- In some cases regional data are less up-to-date than national data. Regional data, e.g. for the number of households by size, often stem from a census. Therefore data sets for these indicators refer to former years.
- The data availability at regional level for non-EU27 countries considered in the socio-economic data set is still very low.

4.3.2 Data Availability by Countries

When giving a summary of the data availability for all countries included in the socio-economic data set, now two aspects can be highlighted: The indicators for which data is available in the country and the extent of regional availability of this data. If there is no hint in the "Comment" column of the data availability tables in ANNEX1, all indicator values are from EUROSTAT.

All data sources for the socio-economic data set are given in detail in ANNEX1.

4.4 Results

Main results are stored in ETISplus via the ETIS-VIEW system.

Table 4-1: Key Results

Access via	Collection	Group	Description
ETIS-View	Observed Data	Socio-Economic	Indicators per EZ2006 -level3 region.
2010	http://viewer.etisplus.net/ select collection: ETISplus-2010-Observed highlight: Socio-economic		
2005	http://viewer.etisplus.net/ select collection: ETISplus-2005-Observed highlight: Socio-economic		

The ANNEX1 of this report contains tables for the availability of data for the ETISplus base year 2010 by countries. These country tables provide facts about which data sets are available in the socio-economic data set and how they were collected.

4.5 References

4.5.1 Eurostat sources

Applied tables as data sources for the ETISplus socio-economic database at EUROSTAT

(http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/search_database)

REG_E3GDP (for the indicator GDP)
REG_E3GDP (for the indicator GDP in PPS)
REG_D3AVG (for the indicator Population)
REG_D3AVG (for the indicator Population by sex)
REG_D2JAN (for the indicator Population by age groups)
REG_D3AREA (for the indicator Area)
REG_E3VABP95 (for the indicator GVA total)
REG_E3VABP95 (for the indicator GVA sectoral)
REG_E3EMPL95 (for the indicator Employed persons total)
REG_E3EMPL95 (for the indicator Employed persons sectoral)
REG_LFP3POP (for the indicator Economically active population)
REG_LFU3RT (for the indicator Unemployment)
TOUR_CAP_NUTS3 (for the indicator Accommodation facilities)
TOUR_CAP_NUTS3 (for the indicator Bedrooms in accommodation facilities)
TOUR_CAP_NUTS3 (for the indicator Bed places in accommodation facilities)
CENS_RHSIZE (for the indicator Households)
TRAN_VEHST (for the indicator vehicle stock)
REG_EHH2INC (for the indicator Income of households)
RD_E_GERDREG (for the indicator R&D expenditures)
RD_P_PERSREG (for the indicator R&D personnel)
SBS_R_NUTS03 (for the indicator Companies)

4.5.2 Other sources

Table 4-2: International and national sources

Country	Data source
International database	EUROSTAT http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/search_database International Monetary Fund http://www.imf.org/external/data.htm The World Factbook https://www.cia.gov/library/publications/the-world-factbook/index.html Indexmundi http://www.indexmundi.com
EU27	
Austria	National Statistical Office of Austria http://www.statistik.at/
Belgium	SPF Economie http://www.statbel.fgov.be/en/statistics/figures/ Federal Planning Bureau http://www.plan.be National Bank of Belgium http://www.nbb.be/
Bulgaria	National Statistical Office of Bulgaria http://www.nsi.bg/index_en.htm
Cyprus	Statistical Service of Cyprus http://www.mov.gov.cy Cyprus Tourism Organisation http://www.visitcyprus.com
Czech Republic	Estimation of NESTEAR National Statistical Office of the Czech Republic http://www.czso.cz/eng/redakce.nsf/i/home
Germany	National Statistical Office of Germany http://www.genesis.destatis.de Statistical Office of the State Saxony-Anhalt http://www.stala.sachsen-anhalt.de
Denmark	National Statistical Office of Denmark http://www.dst.dk/HomeUK.aspx
Estonia	National Statistical Office of Estonia http://www.stat.ee/
Spain	Instituto Nacional De Estadística (INE) – National Statistical Office of Spain http://www.ine.es/ Dirección General de Tráfico http://www.dgt.es
Finland	National Statistical Office of Finland http://www.tilastokeskus.fi/index_en.html Finnish Transport Safety Agency http://www.trafi.fi/en/
France	INSEE – National Institute of Statistics and Economic Studies http://www.insee.fr/en/default.asp SOeS, le service statistique du ministère de l'Écologie, du Développement durable, des Transports et du Logement http://www.statistiques.developpement-durable.gouv.fr
Greece	National Statistical Office of Greece http://www.statistics.gr/
Hungary	National Statistical Office of Hungary http://www.ksh.hu/?lang=en
Ireland	National Statistical Office of Ireland http://www.cso.ie Department of Transport, Tourism and Sport http://www.transport.ie
Italy	National Statistical Office of Italy – ISTAT http://www.demo.istat.it
Lithuania	National Statistical Office of Lithuania http://www.stat.gov.lt
Luxembourg	National Statistical Office of Luxembourg http://www.statistiques.public.lu

Country	Data source
Latvia	National Statistical Office of Latvia http://www.csb.gov.lv/
Malta	National Statistical Office of Malta http://www.nso.gov.mt/site/page.aspx
Netherlands	National Statistical Office of the Netherlands – CBS Statline http://www.cbs.nl/en-GB/menu/home/default.htm De Nederlandsche Bank (DNB) http://www.dnb.nl/
Poland	National Statistical Office of Poland http://stat.gov.pl
Portugal	National Statistical Office of Portugal – INE http://www.ine.pt
Romania	National Statistical Office of Romania http://www.insse.ro/cms/rw/pages/index.en.do
Sweden	National Statistical Office of Sweden http://scb.se
Slovenia	National Statistical Office of Slovenia http://www.stat.si/eng/index.asp
Slovakia	National Statistical Office of Slovakia http://statistics.sk
United Kingdom	National Statistical Office of the United Kingdom http://www.statistics.gov.uk
Non-EU27	
Switzerland	National Statistical Office of Switzerland http://www.bfs.admin.ch/bfs/portal/en/index.html
Croatia	National Statistical Office of Croatia http://www.dzs.hr/default_e.htm
Island	National Statistical Office of Island http://www.statice.is/
Liechtenstein	National Statistical Office of Liechtenstein http://www.as.liv.li/
Norway	National Statistical Office of Norway http://www.ssb.no/english/
Turkey	National Statistical Office of Turkey http://www.turkstat.gov.tr/Start.do
Albania	National Statistical Office of Albania http://www.instat.gov.al/
Bosnia and Herzegovina	National Statistical Office of Bosnia and Herzegovina http://www.bhas.ba/index.php?lang=en
Belarus	National Statistical Office of the Republic of Belarus http://belstat.gov.by/
Montenegro	National Statistical Office of Montenegro http://www.monstat.org/eng/index.php/
Macedonia	National Statistical Office of Macedonia http://www.stat.gov.mk/NSO_en.aspx
Serbia	National Statistical Office of Serbia http://webzrs.stat.gov.rs/
Russia	National Statistical Office of Russia http://www.gks.ru/wps/wcm/connect/rosstat/rosstatsite.eng/
Ukraine	National Statistical Office of Ukraine http://www.ukrstat.gov.ua/
Kosovo	National Statistical Office of Kosovo http://www.esk.rks-gov.net/eng/

5 Road Network

5.1 Scope

The road network represents a GIS database containing road links in Europe, Asia and the Northern part of Africa, which are of potential relevance for long-distance transport flows within European countries, as well as for transport flows between EU countries and neighbouring countries. The main characteristics of the road network database are summarised by Table 5-1, while their contents are listed by Table 5-2 and Table 5-3.

Table 5-1: Overview of main characteristics of the data set

Road network						
Data feature	Data specification					Remarks
Base year	2010					
Scope of data	Link	Terminal	O/D relation	Region	Other	
	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
GIS data	Yes	No				
	<input checked="" type="checkbox"/>	<input type="checkbox"/>				
Country coverage				Com-pletely	Par-tially	
				<input checked="" type="checkbox"/>	<input type="checkbox"/>	
	EU 27			<input checked="" type="checkbox"/>	<input type="checkbox"/>	
	Candidate countries & EFTA			<input checked="" type="checkbox"/>	<input type="checkbox"/>	
	Neighbouring countries			<input checked="" type="checkbox"/>	<input type="checkbox"/>	
	TRACECA			<input type="checkbox"/>	<input checked="" type="checkbox"/>	
	MEDA			<input type="checkbox"/>	<input checked="" type="checkbox"/>	
	Other countries			<input type="checkbox"/>	<input checked="" type="checkbox"/>	
	Total number of countries covered:			64		
Main data sources	Various international and national data sources exploited.					
Main type of data generation	Observed	<input checked="" type="checkbox"/>				Depending on the attribute, all types of data generation have been applied.
	Harmonised	<input checked="" type="checkbox"/>				
	Modelled	<input checked="" type="checkbox"/>				

Table 5-2: Data structure of the road network data set, part 1

Indicator	Description of indicator	Unit
ObjectID	Identifier used by ArcGIS	
ID	Unique identifier	
Shape	ArcGIS geometry	
FromNodeID	FromNode of the link	
ToNodeID	ToNode of the link	
Country	Country the link is located in	
CountryBorder	Indicates whether a link crosses a country border	
ZoneID	Zone the link is located in	
ZoneBorderCrossing	Indicates whether the link crosses a zone border or not	
NationalName	National name of the link	
EuroName	Euroname of the link	
Active	Indicates whether the link is active or not	
Deactivation	Year the link is put out of service, empty if unknown	
Activation	Year the link is put into service, empty if unknown	
Length	Length of link	km
LinkLength	Length of link	m
Shape_Length	ArcGIS link length	
OpenFor	Indicates whether link is open or not in the forward direction (FromNode to ToNode)	
OpenBack	Indicates whether link is open or not in the backward direction (ToNode to FromNode)	
FreeSpeedPass	Passenger car speed in an uncongested situation	km/h
FreeSpeedFreight	Truck speed in an uncongested situation	km/h
LanesFor	Number of lanes in forward direction	lanes
LanesBack	Number of lanes in backward direction	lanes
LinkTypeID	Link type of the link	
RoadClass	Link road class	
Urban	Indicates whether the link is located in urban areas or not	
LaneHCFFor	Lane hour capacity in forward direction	passenger cars/h per lane
LaneHCBack	Lane hour capacity in backward direction	passenger cars/h per lane
GenericTollCostPC	Generic toll cost for passenger cars	€
LinkSpecificTollCostPC	Link-specific toll cost for passenger cars	€
TollCostPC	Total toll cost for passenger cars	€
FuelCostPC	Fuel cost on the link for passenger cars	€
LinkSpecificTollCostTR	Link-specific toll cost for trucks	€
TollCostTR	Total toll cost for trucks	€
FuelCostTR	Fuel cost on the link for trucks	€
LinkCostPC	Total link cost for passenger cars	€
LinkCostTR	Total link cost for trucks	€

Table 5-3: Data structure of the road network data set, part 2

Indicator	Description of indicator	Unit
FerryFreq	Number of ferries per day	ferries/day
FerrySailingTime	Sailing time on the ferry link	min
FerryWaitingTime	Average waiting time on the ferry link	min
FerryCostPC	Ferry cost for passenger cars	€
FerryCostTR	Ferry cost for trucks	€
TrafficCountPass	Number of passengers per year	passengers/year
TrafficCountFreight	Number of tonnes carried per year	tonnes/year
AADT	Average Annual Daily Traffic	vehicles/day
AADTPassCars	Average Annual Daily Passenger Car Traffic	passenger cars/day
AADTTrucks	Average Annual Daily Truck Traffic	trucks/day
AADTCoaches	Average Annual Daily Coach Traffic	coaches/day
AADTUNECE	Average Annual Daily Traffic (UN/ECE)	vehicles/day
AADTTTv2	Average Annual Daily Traffic (TTv2)	vehicles/day
AADTCarsTTv2	Average Annual Daily Passenger Car Traffic (TTv2)	passenger cars/day
TrafficCountTTv2Source	Indicator of the TTv2 data source	
Enabled	Indicates whether a link is active (ArcGIS attribute)	

5.2 Methodology

5.2.1 General approach

The ETISplus road network model 2010 is based on the ETISplus road network model 2005 (see Szimba and Kraft 2012).

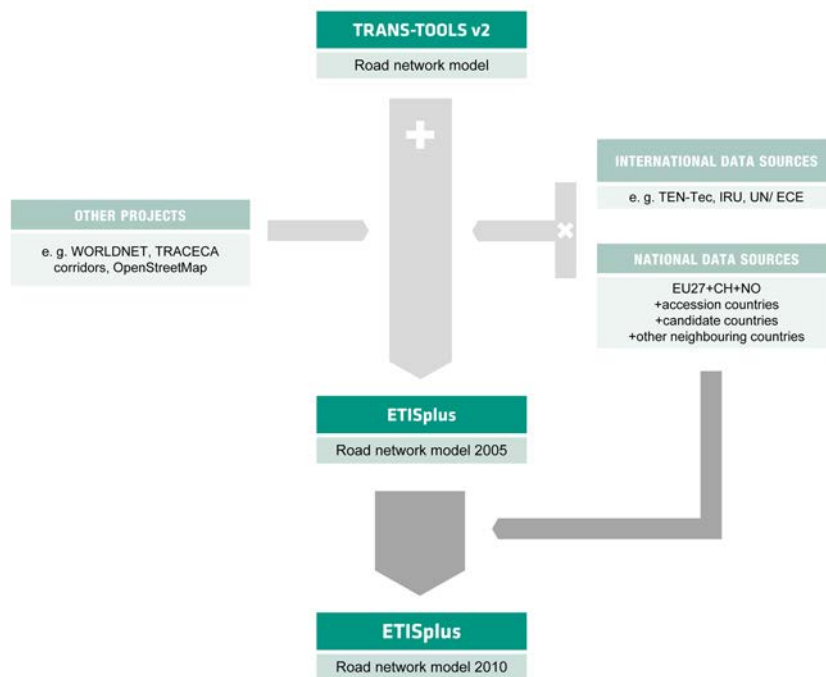
The ETISplus road network model 2005 relies on the TRANS-TOOLS v2 road network model which was published by the EU's Joint Research Centre (JRC), IPTS in Seville in autumn 2009. Key structural elements of this database have been maintained in ETISplus in order to keep consistency with TRANS-TOOLS.

Based on the ETISplus road network model 2005, various kinds of updates have been realised for the compilation of the road network 2010:

- Review and update of attributes (e.g. road type);
- Further update of alignment;
- Implementation of new data (e.g. traffic count data).

Update and implementation of data has been realised under application of a wide range of different data sources: international data sources (e.g. TENtec); national data sources; and information from OpenStreetMap. Figure 5-1 gives an overview of the data generation process for the development of the ETISplus road network 2010.

Figure 5-1: Overview of methodology to process the ETISplus road network models



5.2.2 Review and update of network topology

In many cases, the network topology has been adjusted – for instance by deletion of incorrectly connected links or the implementation of additional nodes. Furthermore, the link alignment has been improved significantly, which has been achieved under application of digital maps and OpenStreetMap data.

Figure 5-2 illustrates – as an example – improvements of network topology performed within ETISplus: the network nodes set in the pre-ETISplus network model represent overcrossings (without any physical connection between the motorway and the trunk road), while the existing driveway is not mapped. The map below shows the corrected network topology by ETISplus.

Figure 5-3 illustrates the improvement of network topology and alignment in a region in the Northern part of Portugal. Both maps show the link alignment of the road network model: while map (I) displays the link alignment in the pre-ETISplus road network model, map (II) shows the situation after the corrections and improvements made within ETISplus. The map shown in the background of Figure 5-3 is not part of ETISplus.

(I) Pre-ETISplus

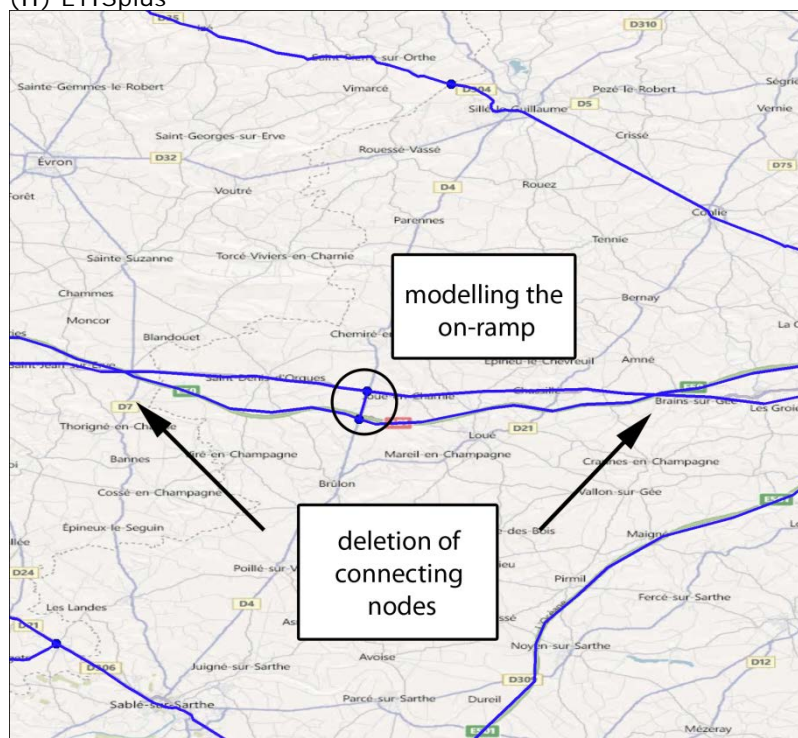
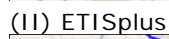
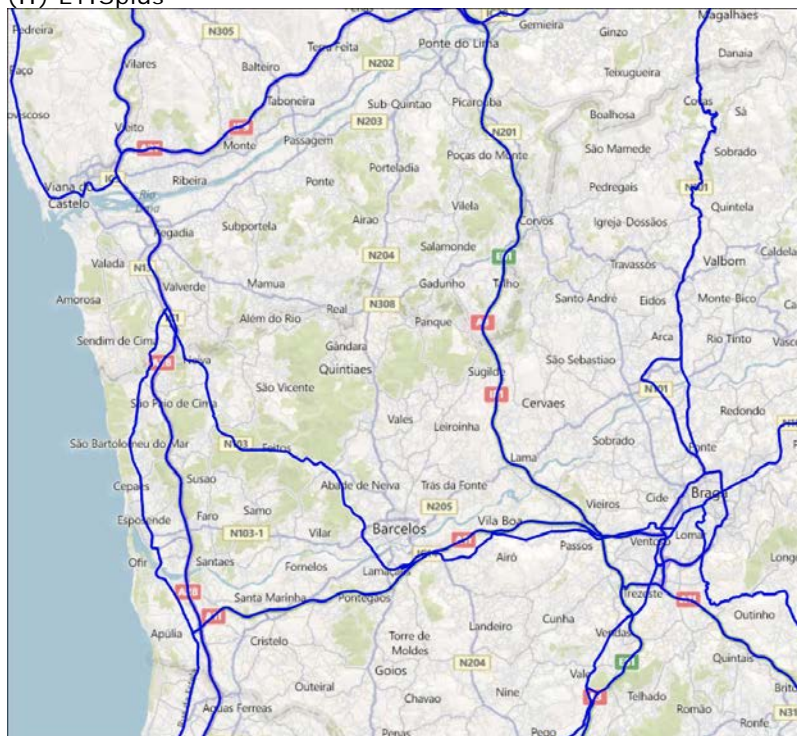


Figure 5-3: Example of improvement of network topology and alignment

(I) Pre-ETISplus



(II) ETISplus



5.2.3 Elementary link attributes

Network topology

The attributes "ObjectID", "Shape", "ID", "FromNodeID" and "ToNodeID" relate to the network topology. "FromNodeID" and "ToNodeID" refer to the node connecting two links. "ID" represents the network link's unique identifier, while "ObjectID" is the identifier used within ArcGIS. The topological location of a link is represented by the entry "Shape". The attributes "FromNodeID" and "ToNodeID" contain information on the unique identifier of the nodes a link is connected to. The entries of these data attributes have been generated via an automated process.

Administrative link information

Each link contains information on its administrative classification. "Country" refers to the country a link is located in, while "ZoneID" allocates a road link to a zone of the ETISplus zoning system (mainly NUTS-3 zone). "CountryBorder" and "ZoneBorderCrossing" contains information whether or not a link crosses a national border, or a zone respectively. This data has been computed automatically by merging the links of the network model with the ETISplus GIS layers of the applied zoning system.

The attributes "NationalName" and "EuroName" contain the route number of a road link according to the national and European road coding system. Information for the latter two attributes has been based on road labels in digital maps and road maps.

Basic link characteristics

The attribute "Active" informs on whether or not a road link is in operation in the base year 2005.

For reasons of keeping consistency with requirements of the TRANS-TOOLS model, three different attributes are contained in the database related to the length of a link: "Length" represents the length of a link in kilometres, whereas the attribute "LinkLength" represents the length in metres. "ShapeLength" refers to the length computed by ArcGIS. The unit of measurement depends on the projection (default: degrees).

The indicators "OpenFor" and "OpenBack" inform on whether a link is drivable in forward and backward direction. "FreeSpeedPass" and "FreeSpeedFreight" contain data on the maximum allowed speed for passenger vehicles and trucks. For some countries proxy values had to be assumed due to non-availability of data from the International Road Union (IRU) and other sources. The entries represent country-specific speed limits on certain road types, without the consideration of 'local' speed limits.

In urban areas, the maximum allowed speed is often reduced for various reasons such as noise protection or the requirement to maximise capacity. Therefore, on

all road links which are located in urban areas the maximum speed values have been reduced. The assumed free-flow speeds are displayed by Table 5-4, Table 5-5, Table 5-6 and Table 5-7.

“QueueSpeed” is a TRANS-TOOLS specific attribute, which in ETISplus is set “-1”, indicating that a speed flow function can be used for impedance calculation and assignment¹.

Table 5-4: Maximum speed of passenger cars, part 1

NO	Country	In built-up areas (urban=1)			Outside built-up areas (urban=0)			Proxy
		all-purpose roads [km/h]	4-lane roads (express- ways or dual carriage- ways) [km/h]	motor-ways [km/h]	all-purpose roads [km/h]	4-lane roads (express- ways or dual carriage- ways) [km/h]	motor-ways [km/h]	
	EU27							
AT	Austria	50	80	100	100	100	130	
BE	Belgium	50	80	100	90	90	120	
BG	Bulgaria	50	80	100	90	90	120	
CY	Cyprus	50	80	100	65	80	100	
CZ	Czech Republic	50	80	100	80	90	130	
DK	Denmark	50	80	100	80	80	130	
EE	Estonia	50	80	90	90	90	90	
FI	Finland	50	80	100	80	80	120	
FR	France	50	80	100	90	110	130	
DE	Germany	50	80	100	100	130	130	
GR	Greece	50	80	100	90	100	120	
HU	Hungary	50	80	100	90	110	130	
IE	Ireland	50	80	100	80	100	120	
IT	Italy	50	80	100	90	110	130	
LV	Latvia	50	80	100	90	90	110	
LT	Lithuania	50	80	100	90	100	110	
LU	Luxembourg	50	80	100	90	110	130	
MT	Malta	50	80	80	80	80	80	
NL	Netherlands	50	80	100	80	100	120	
PL	Poland	50	80	100	90	100	130	
PT	Portugal	50	80	100	90	100	120	
RO	Romania	50	80	100	90	100	130	
SK	Slovakia	50	80	100	90	90	130	
SI	Slovenia	50	80	100	90	100	130	
ES	Spain	50	80	100	90	100	120	
SE	Sweden	50	80	100	80	110	110	
UK	United Kingdom	48	80	96	96	112	112	
	Candidate countries & EFTA							
HR	Croatia	50	80	100	80	100	130	
IS	Iceland	50	80	90	80	90	90	
LI	Liechtenstein	50	80	100	80	100	120	CH
MK	FYR Macedonia	50	80	100	80	100	120	
ME	Montenegro	50	80	80	80	80	80	
NO	Norway	50	80	80	80	80	80	
RS	Serbia	60	80	100	80	100	120	
CH	Switzerland	50	80	100	80	100	120	

¹ See <http://www.trafficanalyst.dk/transtools/DataModel/index.htm>

NO	Country	In built-up areas (urban=1)			Outside built-up areas (urban=0)			Proxy
		all-purpose roads [km/h]	4-lane roads (express- ways or dual carriage- ways) [km/h]	motor-ways [km/h]	all-purpose roads [km/h]	4-lane roads (express- ways or dual carriage- ways) [km/h]	motor-ways [km/h]	
TR	Turkey	50	80	100	90	90	120	

Table 5-5: Maximum speed of passenger cars, part 2

NO	Country	In built-up areas (urban=1)			Outside built-up areas (urban=0)			Proxy
		all-purpose roads [km/h]	4-lane roads (express- ways or dual carriage- ways) [km/h]	motor-ways [km/h]	all-purpose roads [km/h]	4-lane roads (express- ways or dual carriage- ways) [km/h]	motor-ways [km/h]	
	Neighbouring countries							
AL	Albania	40	80	90	90	90	90	ES
AD	Andorra	50	80	100	90	100	120	
BY	Belarus	60	80	100	90	90	110	
BA	Bosnia and Herzegovina	50	80	100	80	100	100	RS
XK	Kosovo	60	80	100	80	100	120	
MD	Moldova	60	80	90	90	90	90	
RU	Russia	60	80	100	90	90	110	IT
SM	San Marino	50	80	100	90	110	130	
UA	Ukraine	60	70	90	70	70	90	
	TRACECA							
AM	Armenia	60	80	90	90	90	90	*)
AZ	Azerbaijan	60	80	100	90	90	110	
GE	Georgia	60	70	90	70	70	90	
KZ	Kazakhstan	60	80	90	90	90	90	KZ
KG	Kyrgyzstan	60	80	90	90	90	90	
TJ	Tajikistan	60	80	90	90	90	90	
TM	Turkmenistan	60	80	100	90	90	120	*)
UZ	Uzbekistan	60	70	90	70	70	90	
	MEDA							
DZ	Algeria	50	80	100	70	100	100	LB
EG	Egypt	50	80	100	70	100	100	
IL	Israel	50	80	100	80	90	110	
JO	Jordan	50	80	100	70	100	100	LB
LB	Lebanon	50	80	100	70	100	100	
MA	Morocco	50	80	100	70	100	100	
PS	Palestine	50	80	100	70	100	100	LB
SY	Syria	50	80	100	70	100	100	
TN	Tunisia	50	80	100	70	100	100	
	Other countries							
AF	Afghanistan	50	80	100	70	90	110	IR
CN	China	40	80	100	70	100	120	
IR	Iran	50	80	100	70	90	110	
IQ	Iraq	50	80	100	70	90	110	IR
LY	Libya	50	80	100	70	100	100	
MN	Mongolia	40	70	70	70	70	70	

*) Freight speeds are used as proxy

Table 5-6: Maximum speed of trucks, part 1

NO	Country	In built-up areas (urban=1)			Outside built-up areas (urban=0)			Proxy
		all-purpose roads [km/h]	4-lane roads (express-ways or dual carriage-ways) [km/h]	motor-ways [km/h]	all-purpose roads [km/h]	4-lane roads (express-ways or dual carriage-ways) [km/h]	motor-ways [km/h]	
	EU27							
AT	Austria	50	60	60	70	70	80	
BE	Belgium	50	60	60	60	90	90	
BG	Bulgaria	50	60	60	80	80	100	
CY	Cyprus	50	60	60	65	80	100	
CZ	Czech Republic	50	60	60	80	80	80	
DK	Denmark	50	60	60	70	70	80	
EE	Estonia	50	60	60	90	90	90	
FI	Finland	50	60	60	80	80	80	
FR	France	50	60	60	80	90	90	
DE	Germany	50	60	60	60	60	80	
GR	Greece	50	60	60	80	80	85	
HU	Hungary	50	60	60	70	70	80	
IE	Ireland	50	60	60	80	80	80	
IT	Italy	50	60	60	80	80	100	
LV	Latvia	50	60	60	80	80	80	
LT	Lithuania	50	60	60	70	80	90	
LU	Luxembourg	50	60	60	80	90	90	
MT	Malta	50	60	60	80	80	80	
NL	Netherlands	50	60	60	80	80	80	
PL	Poland	50	60	60	70	80	80	
PT	Portugal	50	60	60	80	80	90	
RO	Romania	50	60	60	80	90	110	
SK	Slovakia	50	60	60	90	90	90	
SI	Slovenia	50	60	60	70	70	70	
ES	Spain	50	60	60	70	80	90	
SE	Sweden	50	60	60	70	80	90	
UK	United Kingdom	48	64	64	64	80	96	
	Candidate countries & EFTA							
HR	Croatia	50	60	60	70	70	70	
IS	Iceland	50	60	60	80	80	80	
LI	Liechtenstein	50	60	60	80	80	80	CH
MK	FYR Macedonia	50	60	60	70	70	70	
ME	Montenegro	50	60	60	80	80	80	
NO	Norway	50	60	60	80	80	80	
RS	Serbia	60	60	60	70	70	70	
CH	Switzerland	50	60	60	80	80	80	
TR	Turkey	50	60	60	50	80	90	

Table 5-7: Maximum speed of trucks, part 2

NO	Country	In built-up areas (urban=1)			Outside built-up areas (urban=0)			Proxy
		all-purpose roads [km/h]	4-lane roads (express-ways or dual carriage-ways) [km/h]	motor-ways [km/h]	all-purpose roads [km/h]	4-lane roads (express-ways or dual carriage-ways) [km/h]	motor-ways [km/h]	
	Neighbouring countries							
AL	Albania	40	60	60	90	90	90	
AD	Andorra	50	60	60	70	80	90	ES
BY	Belarus	60	60	60	70	70	90	
BA	Bosnia and Herzegovina	50	60	60	80	100	100	
XK	Kosovo	60	60	60	70	70	70	RS
MD	Moldova	60	60	60	70	70	70	
RU	Russia	60	60	60	70	70	90	
SM	San Marino	50	60	60	80	80	100	IT
UA	Ukraine	60	60	60	70	70	90	
	TRACECA							
AM	Armenia	60	60	60	90	90	90	
AZ	Azerbaijan	60	60	60	70	70	90	
GE	Georgia	60	60	60	70	70	90	
KZ	Kazakhstan	60	60	60	90	90	90	
KG	Kyrgyzstan	60	60	60	90	90	90	KZ
TJ	Tajikistan	60	60	60	90	90	90	KZ
TM	Turkmenistan	60	60	60	90	90	90	
UZ	Uzbekistan	60	60	60	70	70	90	
	MEDA							
DZ	Algeria	50	60	60	70	100	100	LB
EG	Egypt	50	60	60	70	100	100	LB
IL	Israel	50	60	60	80	80	80	
JO	Jordan	50	60	60	70	100	100	LB
LB	Lebanon	50	60	60	70	100	100	
MA	Morocco	50	60	60	70	100	100	LB
PS	Palestine	50	60	60	70	100	100	LB
SY	Syria	50	60	60	70	100	100	LB
TN	Tunisia	50	60	60	70	100	100	LB
	Other countries							
AF	Afghanistan	50	60	60	70	90	110	IR
CN	China	40	60	60	70	70	70	
IR	Iran	50	60	60	70	90	110	
IQ	Iraq	50	60	60	70	90	110	IR
LY	Libya	50	60	60	70	100	100	LB
MN	Mongolia	40	60	60	70	70	70	CN

"LinkTypeID" and "RoadClass" represent the road type according to two different types of categorisation:

"LinkTypeID" distinguishes between

- motorway (LinkTypeID=1),
- (rural) road with separate directions (LinkTypeID=5),
- (rural) two-lane road (LinkTypeID=6),
- urban road (LinkTypeID=9),
- and ferry (LinkTypeID=90).
-

"RoadClass" differentiates by

- motorway (RoadClass="M" or "ME"),
- dual carriageway (RoadClass="D" or "DE"),
- express road (RoadClass="E" or "EE"),
- urban road (RoadClass="U"),
- and ferry (RoadClass="F").

Both categories of link type classification correspond with each other. A (rural) road with separate directions in most cases corresponds to a dual carriageway road (2x2), but may also represent a 2x1 or 1x1 express road. Thus, the information provided by the attributes "LinkTypeID" and "RoadClass" is recommended to be interpreted in combination with information on number of lanes per direction ("LanesFor" and "LanesBack"). Urban roads are characterised by a high number of intersections. However, in several cases the distinction whether a certain road link in a built-up area represents a motorway, a road link with separate directions, a two-lane road, or an urban road link, is ambiguous. Therefore, the label LinkTypeID=9 has to be handled with care. Further information regarding location of a road link in urban areas is provided by the attribute "Urban".

"LanesFor" and "LanesBack" indicate the number of lanes per forward and backward direction.

Information on "LinkTypeID", "RoadClass", "LanesFor" and "LanesBack" has been gathered from various sources, mainly road maps in digital and print version.

The attributes "LaneHCF" and "LaneHCBack" refer to the hourly link capacity per lane in forward and backward direction, respectively. In the applied approach, the values represent the transition points from free-flow condition to reduced speed due to high traffic volumes, according to speed/ flow equations elaborated for the economic assessment of road transport evaluation (EWS, 1997).

Table 5-8 displays the applied values per link type and number of lanes per direction.

It has to be noted however, that capacity may vary among different European countries, for instance due to different infrastructure quality, speed limits or driving styles. Country-specific variations are not considered due to a lack of consistent data sources at national level.

Table 5-8: Capacity per lane by number of lanes and road type

Road type (LinkTypeID)	Number of lanes per direction	Capacity per lane [passenger cars per hour]
1: motorway	1	1800
1: motorway	2	1950
1: motorway	3	1867
1: motorway	4	1875
1: motorway	5	1875
1: motorway	6	1875
5: (rural) road with separate directions	1	1800
5: (rural) road with separate directions	2	1950
5: (rural) road with separate directions	3	1867
5: (rural) road with separate directions	4	1875
6: (rural) two-lane road	1	1700
6: (rural) two-lane road	2	1750
6: (rural) two-lane road	3	1800

Allocation of links to urban areas

The attribute “urban” indicates whether or not a road link is located within an urban area. The values for this attribute have been generated in a semi-automated way by following procedure.

The main input data were as follows:

- GIS data with cities with population greater than 50,000 inhabitants;
- Land Cover from CORINE datasets; *Continuous Urban Fabric* and *Discontinuous Urban Fabric Polygon Layers* (Land Cover Dataset 2006) (EEA 2011).

Thus, three spatial layers are used that represent urban areas: a point layer representing cities with more than 50,000 inhabitants, and two polygon layers representing continuous and discontinuous urban fabric for countries in Europe (excluding Switzerland and the UK). A combination of buffers is applied to these layers to create a single urban areas layer, which was subsequently used to locate road links that fall completely within these urban areas.

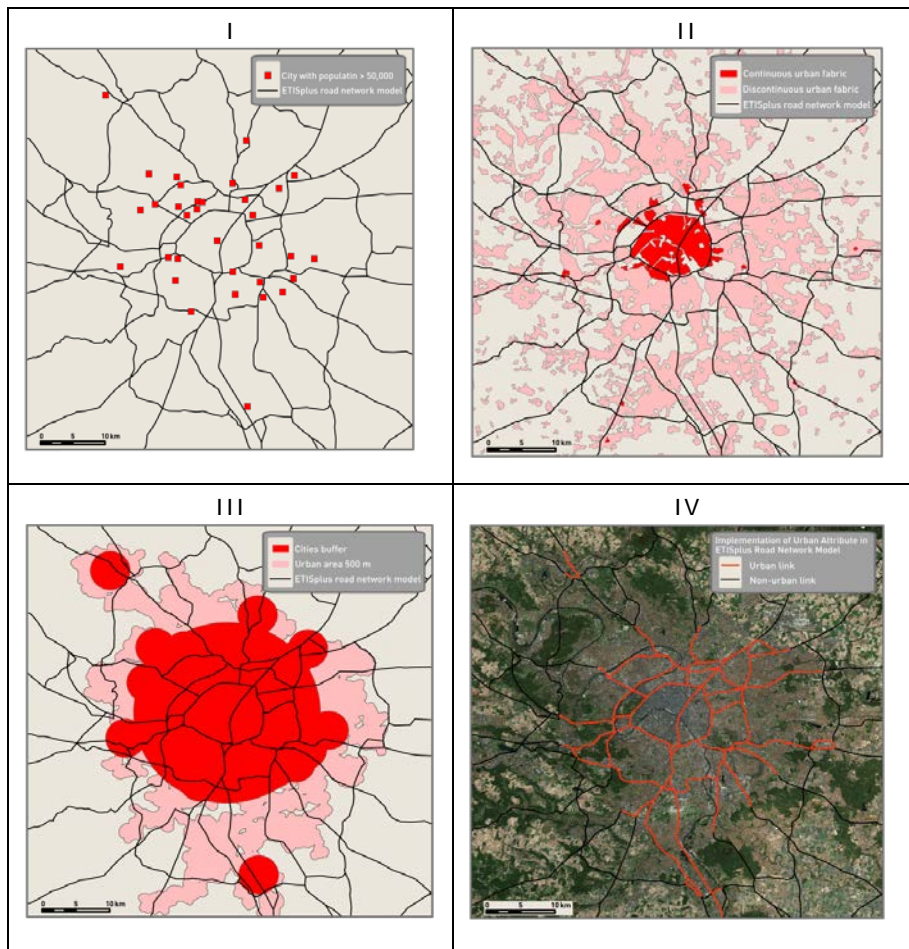
The initial step was to create a series of buffers on a point layer of the cities with more than 50,000 inhabitants, which is derived based on the number of inhabitants. The largest buffer obtained was 14 km and was applied to cities with populations greater than two million, whereas the smallest is three kilometres for cities with population less than 250,000. With these buffers, a query by intersection was performed to extract the continuous and discontinuous urban fabric polygons. From the query, a layer was created that represents urban areas around larger agglomerations in Europe, and excludes smaller towns and villages that were originally included in the CORINE Land Cover Data. To reduce the number of sliver polygons in the urban fabric layers, the cities buffers and the urban fabric layers were combined, and subsequently, an additional buffer of 500 meters was applied. This resulted in complete polygons in all urban areas surrounding cities with population greater than 50,000.

A query of road links that fall completely within the newly created Urban Areas Polygon was performed to fill the “urban” attribute. The results of this query excluded some links that should have been attributed as “urban” and so an additional buffer of 250 meters to the Urban Areas was applied to identify possible urban links. The result was a selection of approximately 600 links that were manually checked for validity. This final check allowed for review of the initial query of road links that fall within the 500 meter buffer of urban areas, and in few cases non-urban and urban attributes were corrected to represent the true character of the road links.

The methodology involves the pattern that only those road links are labelled “urban” which are in the spatial context of a city with more than 50,000 inhabitants.

Figure 5-4 illustrates the methodology at the example of Paris and surroundings: Map (I) displays all cities with more than 50,000 inhabitants, whereas map (II) illustrates the CORINE layers Continuous Urban Fabric and Discontinuous Urban Fabric. By merging buffers around the selected cities and buffers around urban areas, the spatial extensions of urban areas are modelled (III). After merging the buffered urban areas with the links of the ETISplus road network model, the set of ‘urban links’ is identified (IV).

Figure 5-4: Process of the identification of ‘urban’ road links



5.2.4 User cost data

The user cost data implemented in the road network model comprise two cost components as follows:

- Road charges (passenger car and trucks)
 - Generic road tolls for passenger cars (PC)
 - Link-specific toll costs for passenger cars (PC) and trucks (TR)
- Fuel costs for passenger cars (PC) and trucks (TR)

The methodology to derive these cost components are explained in the following paragraphs.

The main dependencies between the user cost components are as follows. The toll costs are the sum of generic toll costs and link-specific toll costs:

$$\begin{aligned} \text{TollCostPC} &= \text{GenericTollCostPC} + \text{LinkSpecificTollCostPC} \\ \text{TollCostTR} &= \text{LinkSpecificTollCostTR} \end{aligned}$$

The overall user costs per link are determined by toll costs, fuel costs, and – where applicable – ferry costs:

$$\begin{aligned} \text{LinkCostPC} &= \text{TollCostsPC} + \text{FuelCostsPC} + \text{FerryCostPC} \\ \text{LinkCostTR} &= \text{TollCostsTR} + \text{FuelCostsTR} + \text{FerryCostTR} \end{aligned}$$

5.2.5 Road charges

The data elements associated with road charges differentiate by ‘generic tolls’ and ‘link-specific tolls’: Generic tolls (“GenericTollCostPC”) reflect a vignette system which is applied to certain parts of a road network and which allows for the usage of the charged network within a defined period of time, independently of the frequency of usage (e.g. motorway vignette in Austria or Switzerland)¹. In contrast, link-specific tolls (“LinkSpecificTollCostPC” and “LinkSpecificTollCostTR”) are applied for the usage of a certain road section and accrue each time the charged road section is used (e.g. motorway toll system in France or Italy; Arlberg tunnel in Austria; Øresund bridge between Copenhagen and Malmö).

For collecting road charges for trucks, a ‘reference truck’ with following features has been assumed: two axles, gross vehicle weight: 12 tonnes, EURO-3 emission standard.

For the computation of link-specific road charges, the costs per link have been derived as follows: In the first stage, data on road charges have been collected from a large number of different data sources (see Table 5-19, Table 5-20 and Table 5-21). The road charges on ‘isolated’ charged links, e.g. tolls on tunnels,

¹ Since the spatial scope of freight transport movements is significantly more international than the spatial scope of road passenger transport, tolls resulting from vignette systems for trucks have not been assigned to the network level.

bridges or mountain passes have been assigned directly to the referring network links of the road network model. The scope of these links is shown by Table 5-9 and Table 5-10.

Table 5-9: Link-specific toll costs implemented on 'isolated' charged links, part 1¹

Nuts0	Country	Link	LinkSpecificTollCostPC	LinkSpecificTollCostTR
AT	Austria	A9, Bosrucktunnel	4.50 €	4.84 €
AT	Austria	A9, Gleinalmtunnel	7.50 €	11.47 €
AT	Austria	A10, Tauernautobahn	10.00 €	16.42 €
AT	Austria	A13 Brenner; Gesamtstrecke	8.00 €	27.94 €
AT	Austria	Felbertauernstrasse	9.80 €	29.30 €
AT	Austria	Großglockner-Hochalpenstraße	30.00 €	93.00 €
AT	Austria	S16, Arlberg Straßentunnel	8.50 €	10.49 €
AT/SI	Austria/ Slovenia	A11, Karawankentunnel	6.50 €	10.85 €
BE	Belgium	Liefkenhoehtunnel	5.40 €	17.60 €
CH/IT	Switzerland/ Italy	Tunnel du Grand-Saint-Bernard	20.55 €	56.05 €
DE	Germany	Herrentunnel	1.30 €	2.30 €
DK	Denmark	Storebaelt-Bridge	28.90 €	87.30 €
DK/SE	Denmark/ Sweden	Oresund-Bridge	39.00 €	111.70 €
FR	France	Mont Blanc-Tunnel	37.30 €	135.30 €
FR/IT	France/ Italy	Fréjus Road Tunnel	36.00 €	130.80 €
ME	Montenegro	Sozina Bridge	2.40 €	7.80 €
NO	Norway	Atlantshavstunnelen, Møre og Romsdal, FV64	10.90 €	50.00 €
NO	Norway	Bolstad (Voss), Hordaland, E16	5.00 €	10.00 €
NO	Norway	Farsund/Lyngdal, Listerpakken, Vest-Agder, RV43	3.10 €	6.20 €
NO	Norway	Fatlatunnelen, Sogn og Fjordane, RV43	3.50 €	7.00 €
NO	Norway	Gardermoen-Moelv, Akershus, Hovinmoen – Dal, E6	1.60 €	4.50 €
NO	Norway	Gardermoen-Moelv, Akershus, Skaberud – Kolomoen, E6	2.00 €	4.00 €
NO	Norway	Gausdalsvegen, Oppland, FV255	2.20 €	4.50 €
NO	Norway	Gjesdal, Rogaland, FV45	6.00 €	10.60 €
NO	Norway	Godøystraumen-Tverrlandet, FV17	2.50 €	5.00 €
NO	Norway	Hækni, Setesdal, Aust-Agder, RV9	3.70 €	7.50 €
NO	Norway	Handeland, Listerpakken, Vest-Agder, E39	3.10 €	6.20 €
NO	Norway	Inntjore, Aust-Agder, E18	3.70 €	7.50 €
NO	Norway	Kåfjord-Honningsvåg, Finnmark, E69	18.10 €	57.50 €
NO	Norway	Kjepse, Hordaland, FV7	5.00 €	10.00 €
NO	Norway	Kløfta-Nybak, Akershus, RV2	2.50 €	5.00 €
NO	Norway	Kristiansund fastlandsforbindelse (Krifast), Møre og Romsdal, E39/RV70	8.70 €	30.00 €

¹ The road charges for trucks on 'isolated' links on Austrian motorways are part of the generic HGV charge in Austria and, hence, are set zero.

Table 5-10: Link-specific toll costs implemented on 'isolated' charged links, part 2

Nuts0	Country	Link	LinkSpecificTollCostPC	LinkSpecificTollCostTR
NO	Norway	Langåker-Bommestad, Larvik/Sandefjord, E18	1.20 €	2.50 €
NO	Norway	Ødegården, Vestfoldpakka, Vestfold, RV313	2.70 €	5.50 €
NO	Norway	Oslofjordtunnelen, Akershus/Buskerud, RV23	7.50 €	16.20 €
NO	Norway	Østerholtheia, Aust-Agder (Nord), E18	1.90 €	3.70 €
NO	Norway	Østfoldpakka, Østfold, E18	3.10 €	6.20 €
NO	Norway	Øysand - Thamshamn, Sør-Trøndelag, E39	2.50 €	5.00 €
NO	Norway	Raukerød, Østfoldpakka, Østfold, E6	2.50 €	5.00 €
NO	Norway	Reinsvoll - Hunndalen, Grønndalen, Oppland, RV4	1.90 €	3.70 €
NO	Norway	Rullestadjuvet (Åkrafjorden), Hordaland, E134	5.00 €	10.00 €
NO	Norway	Sande, E18 Vestfold Nord, Vestfold	3.70 €	7.50 €
NO	Norway	Steinsdalen (Kvam), Hordaland, FV7	5.00 €	10.00 €
NO	Norway	Svelgane (Voss), Hordaland, RV13	5.00 €	10.00 €
NO	Norway	Trondheim-Stjørdal, Sør-Trøndelag, E6	3.70 €	5.00 €
NO/SE	Norway/ Sweden	Svinesund Bridge	2.50 €	12.60 €
PL	Poland	Konin-Nowy Tomyśl, A2	7.40 €	n/a
PL	Poland	Kraków-Katowice, A4	3.00 €	n/a
PT	Portugal	25 de Abril Bridge	1.40 €	3.30 €
PT	Portugal	Vasco da Gama Bridge	2.30 €	5.50 €
UK	United Kingdom	Dartford-Tunnel	1.30 €	1.70 €
UK	United Kingdom	Humber Bridge	3.00 €	12.20 €
UK	United Kingdom	M6Toll (Birmingham North Relief Road)	5.20 €	10.60 €

For other links, where charges are raised for the usage of a certain sub-network (e.g. French or Italian motorway charging system), data on road charges has been collected for each section, and weighted according to link lengths. Thus, for country c , the average road charge per kilometre has been estimated as follows:

$$AverageToll(c) = \frac{\sum_i p_i^c \cdot l_i^c}{\sum_i l_i^c}$$

where

p_i^c road charge of road link i in country c ($i=1, \dots, n$)
 l_i^c length of charged road link i in country c ($i=1, \dots, n$)

The average road charge obtained from this estimation has been allocated to each network link of a country which belongs to the road type subject to a charge.

Table 5-11 and Table 5-12 give an overview of the average level of link-specific road charge per country.

Table 5-11: Average level of link-specific road charge per country and vehicle-km

NUTSO	Country	Motorway Passenger Car Toll €-Cent/km	Motorway Truck Toll €-Cent/km
AT	Austria	n/a	17.80
CH	Switzerland	n/a	23.87
CZ	Czech Republic	n/a	10.87
DE	Germany	n/a	19.00
ES	Spain	9.95	15.87
FR	France	9.98	15.85
GR	Greece	4.10	7.02
HR	Croatia	6.15	8.79
IE	Ireland	3.07	7.01
IT	Italy	8.20	7.44
MK	Macedonia	2.90	n/a
PL	Poland	n/a	11.72
PT	Portugal	8.20	13.58
RS	Serbia	3.42	7.66
SI	Slovenia	n/a	19.82
SK	Slovakia	n/a	18.30
TR	Turkey	1.40	1.65

The user costs associated with generic road charges have been derived as follows: under assumption of average distances covered on the road type subject to a generic toll, the cost for the vignette has been apportioned to one vehicle-kilometre, and lastly, been assigned to the network links. The average level of generic road charges is summarised by Table 5-12.

Table 5-12: Average level of generic road charge per country and vehicle-km

NUTSO	Country	Vignette €-Cent/km
AT	Austria	1.12
BG	Bulgaria	1.62
CH	Switzerland	1.34
CZ	Czech Republic	2.66
HU	Hungary	2.67
ME	Montenegro	0.12
RO	Romania	0.97
SI	Slovenia	2.14
SK	Slovak Republic	1.40

Fuel costs

Fuel costs – represented by the attributes “FuelCostsPC” and “FuelCostsTR” – depend on the level of fuel prices, the fuel consumption of the fleet, as well as the share of gasoline/ diesel vehicles. As far as data availability allowed, country-specific circumstances were taken into account for the quantification of fuel costs. Input data on average fuel consumption and the share of gasoline/ diesel vehicles has been applied from TREMOVE for EU27 countries, Croatia, Switzerland, Norway and Turkey. For all other countries, the values relating to Croatia had to be used as proxy values. For fuel costs, data by the German

Association for International Cooperation (GTZ) and the Automobile Club ADAC have been used (references see Table 5-18), without the requirement of applying proxy values (see Table 5-13). Table 5-14 and Table 5-15 display the average fuel prices assumed for the year 2010.

Table 5-13: Proxy values applied for variables relevant for the estimation of fuel costs of passenger road transport

Country/ Variable	Average fuel consumption value/ proxy	Share of fuel (gasoline/ diesel) value/ proxy	Fuel costs
EU-27 + Croatia+ Switzerland + Norway + Turkey	Values from TREMOVE	Values from TREMOVE	German Association for International Cooperation (GTZ); German Automobile Club (ADAC)
All other countries	Proxy value of Croatia	Proxy value of Croatia	German Association for International Cooperation (GTZ); German Automobile Club (ADAC)

Average fuel costs on a network link l , p_l^F were calculated according to following principle:

$$p_l^F = \frac{1}{100} \cdot l^c \cdot (FC_d^c \cdot FP_d^c \cdot S_d^c + FC_g^c \cdot FP_g^c \cdot S_g^c)$$

where

p_l^F Fuel costs for road network link l

l^c Length of road network link located in country C

FC_d^c Average consumption of the diesel engine passenger car in country C per 100 km

FP_d^c Fuel price (diesel) in country C

S_d^c Share of diesel engines in country C

FC_g^c Average consumption of the gasoline engine passenger car in country C per 100 km

FP_g^c Fuel price (gasoline) in country C

S_g^c Share of gasoline engines in country C

Table 5-14: Average fuel prices in the year 2010, part 1

NUTSO	Country	Diesel [€/l]	Gasoline [€/l]	Proxy
	EU27			
AT	Austria	1.14	1.20	
BE	Belgium	1.19	1.38	
BG	Bulgaria	1.16	1.11	
CY	Cyprus	1.08	1.08	
CZ	Czech Republic	1.24	1.29	
DK	Denmark	1.32	1.47	
EE	Estonia	1.16	1.13	
FI	Finland	1.18	1.43	
FR	France	1.27	1.46	
DE	Germany	1.24	1.40	
GR	Greece	1.31	1.51	
HU	Hungary	1.19	1.23	
IE	Ireland	1.24	1.31	
IT	Italy	1.24	1.38	
LV	Latvia	1.10	1.09	
LT	Lithuania	1.05	1.17	
LU	Luxembourg	1.00	1.14	
MT	Malta	1.22	1.20	
NL	Netherlands	1.26	1.57	
PL	Poland	1.10	1.16	
PT	Portugal	1.10	1.16	
RO	Romania	1.16	1.36	
SK	Slovakia	1.09	1.10	
SI	Slovenia	1.13	1.25	
ES	Spain	1.08	1.15	
SE	Sweden	1.34	1.38	
UK	United Kingdom	1.46	1.41	
	Candidate countries & EFTA			
HR	Croatia	1.10	1.17	
IS	Iceland	1.26	1.26	
LI	Liechtenstein	1.30	1.22	
MK	FYR Macedonia	0.94	1.12	
ME	Montenegro	1.10	1.19	
NO	Norway	1.48	1.56	
RS	Serbia	0.53	0.62	
CH	Switzerland	1.30	1.22	
TR	Turkey	1.49	1.86	

Table 5-15: Average fuel prices in the year 2010, part 2

NUTS0	Country	Diesel [€/l]	Gasoline [€/l]	Proxy
	Neighbouring countries			
AL	Albania	1.03	1.08	
AD	Andorra	0.97	1.10	
BY	Belarus	0.63	0.80	
BA	Bosnia and Herzegovina	1.05	1.05	
XK	Kosovo	1.18	1.20	
MD	Moldova	0.80	0.89	
RU	Russia	1.08	1.08	
SM	San Marino	1.24	1.38	Italy
UA	Ukraine	0.68	0.74	
	TRACECA			
AM	Armenia	0.73	0.80	
AZ	Azerbaijan	0.41	0.55	
GE	Georgia	0.83	0.83	
KG	Kyrgyzstan	0.58	0.63	
KZ	Kazakhstan	0.38	0.52	
TJ	Tajikistan	0.67	0.75	
TM	Turkmenistan	0.15	0.16	
UZ	Uzbekistan	0.61	0.68	
	MEDA			
DZ	Algeria	0.14	0.24	
EG	Egypt	0.24	0.35	
IL	Israel	1.38	1.36	
JO	Jordan	0.54	0.77	
LB	Lebanon	0.57	0.83	
MA	Morocco	0.65	0.91	
PS	Palestine	1.13	1.26	
SY	Syria	0.33	0.71	
TN	Tunisia	0.60	0.69	
	Other countries			
AF	Afghanistan	0.74	0.85	
CN	China	0.77	0.82	
IR	Iran	0.01	0.07	
IQ	Iraq	0.41	0.57	
LY	Libya	0.10	0.13	
MN	Mongolia	0.77	0.82	

5.2.6 Ferry attributes

The road network model contains around 350 ferry links. To ensure consistency with TRANS-TOOLS, following ferry attributes are part of the ETISplus network model: "FerryFreq", "FerrySailingTime", "FerryWaitingTime", "FerryCostPC" and "FerryCostTR". The attribute "FerryFreq" contains the number of ferry connections per day: a return journey is counted as one connection. "FerrySailingTime" informs on the duration of the ferry journey, and "FerryCostPC" and "FerryCostTR" on the costs per passenger car (passenger car and two persons) and per truck.

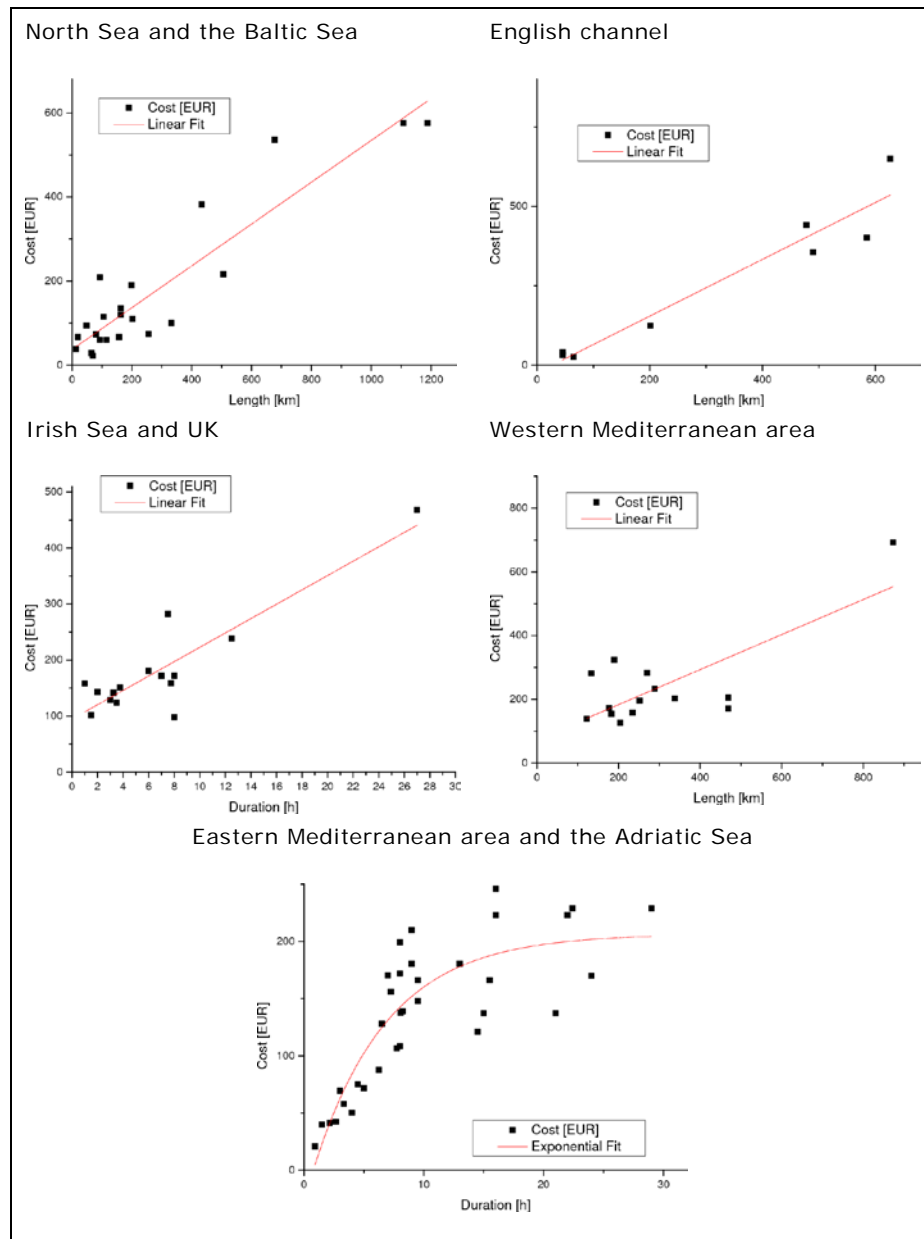
The TRANS-TOOLS v2 road network model contains several ferry links which were closed down in 2005 (e.g. Degeberga-Gdansk, Rostock-Riga or Rønne-Gdansk). Therefore, all ferry links have been checked whether or not they were in operation in 2005. The alignment has been adjusted and, where required, ferry links have been split at intermediate stops. Ferry level-of-service data for the attributes "FerryFreq" have been compiled under application of various sources, including existing data in the TRANS-TOOLS v2 road network model. Following the methodology by TRANS-TOOLS v2, "FerrySailingTime" has been estimated on the basis of link length and under the assumption of an average speed value. Empirical analysis on more than 400 ferry lines has revealed an average speed of 22 km/h; this has been the basis for the calculation of values for "FerrySailingTime".

Since the accessibility of data on user cost for ferry links is limited in scope, the following modelling approach has been applied: user cost data has been collected for as many ferry links as possible, resulting in a set of around 100 lines. Since the availability of tariff data for trucks is significantly more restricted than for passenger cars, the collection has focused on user costs for passenger cars (medium-class passenger cars and two persons). Analysing the relations between tariffs and ferry distances and times, results to the approach to define four different tariff clusters as follows:

- Ferry links in the North Sea and the Baltic Sea;
- Ferry links between the European continent and UK and Ireland (English channel);
- Ferry links within/ between UK and Ireland (Irish Sea);
- Ferry links in the Western Mediterranean area;
- Ferry links in the Eastern Mediterranean area and the Adriatic.

For each tariff cluster, regression functions have been derived, which compute the tariff (passenger car) per ferry link depending on the sailing time or the sailing distance, which results to the entries of the attribute "FerryCostPC". Figure 5-5 shows the regression functions used for the ferry tariffs in the different seas.

Figure 5-5: Applied regression functions for the computation of user costs for ferries (passenger cars)



Due to very limited availability of data on ferry costs for trucks, the TRANS-TOOLS v2 approach has been applied to compute "FerryCostTR":

$$FerryCostTR = 2 \cdot FerryCostPC$$

FerryCostTR=-1 indicates that a ferry does not allow the transportation of trucks.¹

In line with TRANS-TOOLS, the waiting time (in minutes) is computed according to following formula:

$$FerryWaitingTime = \max \left\{ 4 \cdot \left(\frac{24 \cdot 60}{FerryFreq} \right); 30 \right\}$$

Service patterns of ferry links, particularly frequencies, may depend on the season. The Level-of-Service determinants have been collected consistently to the month September.

5.2.7 Traffic count data

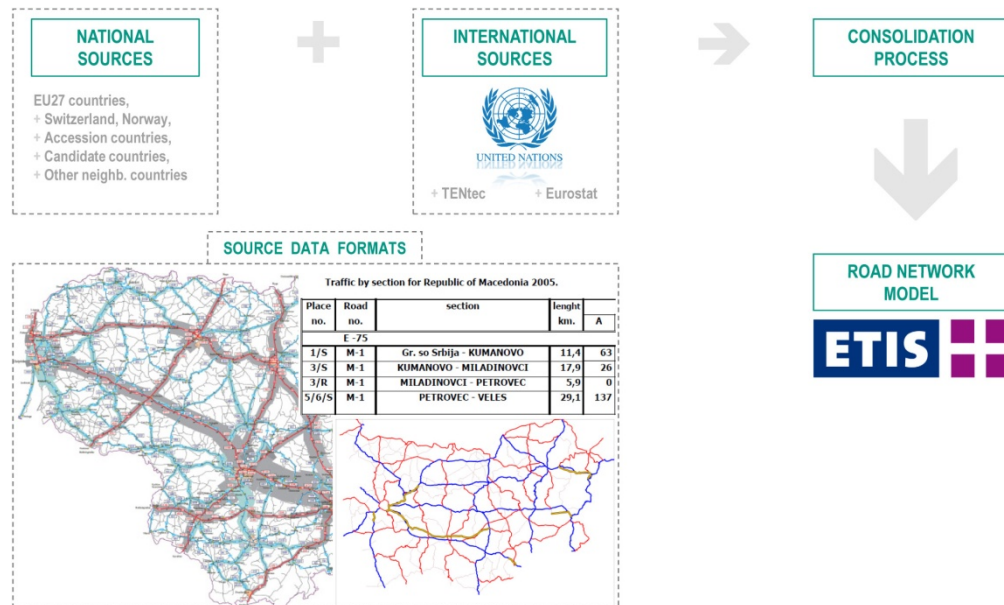
Traffic count data is represented in the ETISplus road network model by following five attributes: "AADT", "AADTPassCars", "AADTTrucks", "AADTCoaches" and "AADTUNECE". "AADT" – Average Annual Daily Traffic – relates to the all vehicles which have been counted on a specific road section. "AADTPassCars", "AADTTrucks" and "AADTCoaches" refers to the vehicle categories passenger cars, trucks and coaches. Additionally, the following three attributes were added from TRANS-TOOLS v2 network model: "AADTTTv2", "AADTCarsTTv2" and "TrafficCountTTv2Source". They refer to traffic count data from 2005 compiled within the TRANS-TOOLS v2 project.

The attribute "AADTUNECE" has not been filled in the 2010 road network model, since more detailed data from national sources has been applied.

Traffic count data has been implemented into the ETISplus network model by exploiting a considerable number of different data sources (see Figure 5-6). Depending on the country, data has been available in different formats, i.e. in form of GIS data, tables or thematic maps.

¹ Information on availability of ferry services by vehicle categories is only partially available. Therefore, a setting FerryCostTR>0 does not necessarily allow the conclusion that a ferry link allows the transportation of trucks.

Figure 5-6: Overall approach of the implementation of traffic count data into the ETISplus road network model



There are two types of data sources that have been used to implement traffic count data into the ETISplus network model:

- Data from national sources (see Table 5-22 and Table 5-23).
- TENtec (EC 2010).

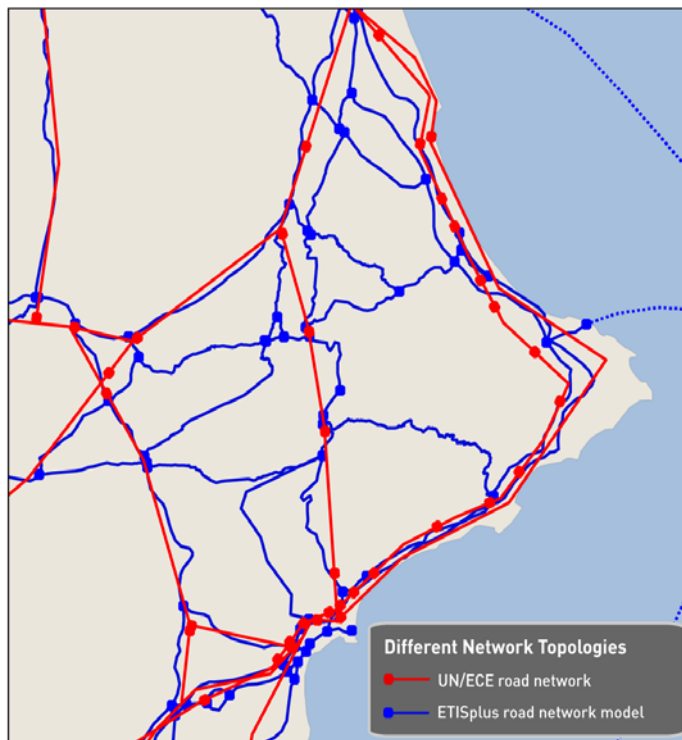
UN/ECE traffic count data has not been implemented in the ETISplus road network model for 2010 since the data was only available in a less detailed way compared to the national sources for the base year 2010.

In most cases, the implementation of traffic count data has been carried out manually. The network topology of the ETISplus road network model has always been different from the network topology of the traffic count data sources (see Figure 5-7 as an example). In order to assign traffic count data from a source network to the ETISplus road network model, three methods have been applied:

- (1) Link-wise implementation of values of the source network to the ETISplus network model;
- (2) Adjustment of the ETISplus road network model to the topology of the source data;
- (3) Implementation of averaged values of the sources to the ETISplus network model.

Alternative (1) could only be applied in a few cases, in which the topology of source data and ETISplus were similar. Alternative (2) has been applied in those cases in which the network topology was not adjusted – mainly by implementing an additional network node and splitting links – would have resulted to a significant loss of information. Alternative (3) has been the most frequently applied method to accommodate the source data as realistically as possible in the ETISplus network model.

Figure 5-7: Example of different network topologies: ETISplus road network model vs. network model with source data



For various reasons the traffic count data of the attribute "AADTUNECE" may differ from the traffic count data based on the exploitation of other sources.

In addition, the following three attributes were added from TRANS-TOOLS v2 network models: "AADTTTv2", "AADTCarsTTv2" and "TrafficCountTTv2Source". "AADTTTv2" contains the total number of vehicles per day, "AADTCarsTTv2" the number of passenger cars, and "TrafficCountTTv2Source" contains a source code for the data provided by "AADTTTv2" and/ or "AADTCarsTTv2". As of October 2012, detailed documentation for the traffic count data related to TRANS-TOOLS v2 has not become available.

All traffic count data from TRANS-TOOLS v2 refer to the base year 2005.

5.3 Data sources

A wide range of supra-national and national data sources have been exploited in order to develop the ETISplus road network model. The current section gives an overview of the main data sources applied for

- maximum speeds;
- fuel costs;
- toll costs;
- ferry services;
- and traffic count data.

5.3.1 Maximum speeds

Information on the maximum speed of passenger cars and trucks per road class are based on a limited number of international sources (see Table 5-16 and Table 5-17). The assumed maximum speed limits inside built-up areas are estimations made within ETISplus.

Table 5-16: Data sources for maximum speeds of passenger cars

Country	Data source
International database	http://www.iru.org/ http://www.europe.org/speedlimits.html http://wikitravel.org/ http://en.wikipedia.org/wiki/Speed_limits_by_country

Table 5-17: Data sources for maximum speeds of freight vehicles

Country	Data source
International database	http://www.iru.org/ http://www.europe.org/speedlimits.html

5.3.2 Fuel costs

The prices underlying the computation of fuel costs are based on three sources by the German Association for International Cooperation (GTZ) and the German Automobile Association (ACAD), as summarised by Table 5-18.

Table 5-18: Data sources for fuel prices

Country	Data source
International database	http://www.giz.de/Themen/en/dokumente/giz-en-IFP2010.pdf http://www.gtz.de/de/dokumente/gtz2009-en-ifp-full-version.pdf http://www.adac.de/infotestrat/tanken-kraftstoffe-und-antrieb/kraftstoffpreise/default.aspx

5.3.3 Toll costs

In order to compile data on toll costs, a large number of international and – particularly – national data sources have been applied. Table 5-19, Table 5-20 and Table 5-21 give an overview of the relevant data sources. In several countries, information on road charges is not available from a common source, but is rather distributed on the websites of infrastructure operators. Road charges in countries which are not listed in Table 5-19, Table 5-20 and Table 5-21 have not been in the main scope of ETISplus.

Table 5-19: Data sources for road tolls, part 1

Country	Data source
International database	http://portal.wko.at/wk/format_detail.wk?angid=1&stid=240298&dstid=7164&opennavid=31614 http://www.theaa.com/allaboutcars/overseas/european_tolls_select.jsp http://www.tolltickets.com/country/europe/europe.aspx?lang=de-DE http://www.adac.de/
EU27	
Austria	http://www.asfinag.at/ http://www.asfinag.at/index.php?idtopic=52 http://www.asfinag.at/index.php?idtopic=31 http://www.felbertauernstrasse.at/de/tickets-tarife/tarife.html http://www.grossglockner.at/preise/
Belgium	http://www.liefkenshoeektunnel.be/Nieuws/2982/liefkenshoeektunnel
Bulgaria	http://www.aebtri.com/Default_en.aspx?Layout=Layouts/InsideEN&Page=EPageCE#A
Czech Republic	http://tollcz.ptv.de/premid/ti/index.jsf?locale=de_DE http://www.uamk.cz/ http://portal.wko.at/wk/format_detail.wk?angid=1&stid=240298&dstid=7164&opennavid=31614
Denmark	http://www.storebaelt.dk/deutsch http://www.oresundsbron.com/
France	http://www.autoroutes.fr/
Germany	http://www.herrentunnel.de/index.php/article/detail/1025
Greece	http://www.teo.org.gr/ http://portal.wko.at/wk/format_detail.wk?angid=1&stid=240298&dstid=7164&opennavid=31614 http://en.aodos.gr/default.asp?catid=21574 http://en.gefyra.gr/
Hungary	http://www.autobahn.hu/
Ireland	http://www.nra.ie/GeneralTollingInformation/TollCharges/
Italy	http://autostrade.it/autostrade/percorso.do http://autostrade.it/la-nostra-rete/ http://www.autostradesiciliane.it/ http://www.tunnelmb.net/v3.0/de/tarifde.asp#tarifit http://www.sftrf.fr/doc/commerciales/tariftunnelnew.pdf http://www.letunnel.com/tariffe.asp?id=37&l=4
Lithuania	http://www.nerija.lt/en/fag/ http://www.lra.lt/en.php/vignettes/vignette_tariffs/3100
Netherlands	http://portal.wko.at/wk/format_detail.wk?angid=1&stid=240298&dstid=7164&opennavid=31614
Poland	http://www.adac.de/ReiseService/routenplaner/Maut_Infos/Polen/default.asp?ComponentID=3466&SourcePageID=8049 http://www.autostrada-a2.pl/en/ http://www.autostrada-a4.pl/

Table 5-20: Data sources for road tolls, part 2

Country	Data source
Portugal	http://www.lusoponte.pt/uk/pvg_tarifas.asp http://www.aeatlantico.pt/index.asp http://www.viaverde.pt/ http://www.brisa.pt/PresentationLayer/taxasPortagem.aspx?menuid=122&exmenuid=121
Romania	http://www.cnadnr.ro/pagina.php?idg=52
Slovakia	http://www.ndsas.sk/vignettes/13284s
Slovenia	http://www.dars.si/
Spain	http://www.acega.es/Tarifas.html http://www.ap1europistas.es/pdf/tarifasap1.pdf http://www.ap68.es/ http://www.aseta.es/ http://www.aucalsa.com/autopista/conjunto_autopista.htm http://www.audasa.es/Tarifas_E.htm http://www.audenasa.es/ http://www.autema.com/tarifas-i-descomptes/tarifas/ http://www.autoestradas.com/ http://www.autopistamadridlevante.es/ http://www.autopistas.com/cast/tarifas/1_tarifas.php http://www.bidelan.com/ESP/tarifas.htm http://www.ejeaeropuerto.com/tarifas.htm http://www.iberpistas.es/peajes.php http://www.iberpistas.es/peajes_resultado.php http://www.radial2.com/cms/index.php?idcat=14 http://www.radial3.com/tarifas/tarifasr3.html http://www.radial4.com/ http://www.radial5.com/tarifas/tarifasr5.html http://www.tunelesdeartxanda.com/tarifas.htm http://www.tunelsdevallvidrera.com/ca/tarifas/tarifas
Sweden	http://www.svinesundsforbindelsen.no/
United Kingdom	http://www.m6toll.co.uk/ http://www.theaa.com/allaboutcars/overseas/european_tolls_results.jsp?country=Great%20Britain http://portal.wko.at/wk/format_detail.wk?angid=1&stid=240298&dstid=7164&opennavid=31614
Candidate countries & EFTA	
Croatia	http://www.arz.hr/ http://www.bina-istra.com/Default.aspx?sid=1889 http://www.azm.hr/?en/static/page/cjenik# http://www.hac.hr/
FYR Macedonia	http://portal.wko.at/wk/format_detail.wk?angid=1&stid=240298&dstid=7164&opennavid=31614
Montenegro	http://portal.wko.at/wk/format_detail.wk?angid=1&stid=240298&dstid=7164&opennavid=31614
Norway	http://www.autopass.no/ http://www.adac.de/ReiseService/routenplaner/Maut_Infos/Norwegen/default.asp?ComponentID=3449&SourcePageID=8049
Serbia	http://www.putevi-srbije.rs/index.php?lang=en
Switzerland	http://www.ezv.admin.ch/zollinfo_privat/informationen/02262/index.html?lang=de http://www.ezv.admin.ch/zollinfo_privat/informationen/00421/index.html?lang=de http://www.engadin-strom.ch/Tarife.45.0.html?&L=0 http://www.letunnel.com/tariffe.asp?id=37&l=4
Turkey	http://www.kgm.gov.tr/Sayfalar/KGM/SiteEng/Root/MainPageEnglish.aspx

Table 5-21: Data sources for road tolls, part 3

Country	Data source
Neighbouring countries	
Belarus	http://www.arboe.at/services-reisen/reisen/mautgebuehren/polen-und-weissrussland/
Bosnia and Herzegovina	http://portal.wko.at/wk/format_detail.wk?angid=1&stid=240298&dstid=7164&opennavid=31614

5.3.4 Traffic count data

The main international references for road traffic count data has been TENtec (EC 2010).

National sources for road traffic count data are displayed by Table 5-22 and Table 5-23.

Table 5-22: National data sources for road traffic count data, part 1

Country	Data source(s)
EU 27 countries	
Austria	Bundesministerium für Verkehr, Innovation und Technologie: Straßenverkehrszählung 2010. + ASFiNAG: Dauerzählstellen 2010.
Belgium	Federale Overheidsdienst Mobiliteit en Vervoer: Verkeerstellingen 2009.
Bulgaria	Central Roads And Bridges Laboratory, Institute of Transport and Communications: Road traffic counts 2010.
Czech Republic	Ředitelství silnic a dálnic ČR: Celostátní sčítání dopravy 2010.
Denmark	Vejdirektoratet: Årsdøgnstrafikken (ÅDT) på det rutenummererede vejnet i 2010.
Estonia	Maanteeamet: Aastaraamat 2010. + Teede Tehnokeskus AS: Liiklusloenduse tulemused 2010 aastal.
Finland	Liikennevirasto: Liikennemääräkartta 2010.
France	Sétra: Recensement de la circulation sur les routes nationales et autoroutes. Données de l'année 2010.
Germany	Bundesanstalt für Straßenwesen (BAST): Manuelle Straßenverkehrszählung 2010.
Hungary	Magyar Közút: Az országos közutak 2010. Évre vonatkozó keresztmetszeti forgalma. + Közlekedésfejlesztési Koordinációs Központ: ÚtAdat v1.2.
Latvia	Latvijas Valsts celi: Valsts autocelu gadagrāmata 2010. + Latvijas Valsts celi: Satiksmes intensitāte 2010.
Lithuania	Ministry of Transport and Communications, Lithuanian Road Administration: Total traffic and heavy vehicles traffic volumes in 2010.
Luxembourg	Administration des ponts et chaussées Grand-Duché de Luxembourg: Comptage du trafic 2010.
Netherlands	Rijkswaterstaat, Ministerie van Infrastructuur en Milieu, 2010.
Poland	SISKOM: Generalny Pomiar Ruchu (GPR) 2010.
Portugal	Instituto de Infra-Estruturas Rodoviárias IP: Relatório de tráfego na rede nacional de auto-estradas 2010.
Slovakia	Slovenská správa ciest: Celoštátné sčítanie dopravy v roku 2010.
Slovenia	Direkcija republike slovenije za ceste: Prometne obremenitve 2010. + Direkcija republike slovenije za ceste: Karta prometnih obremenitev 2010.

Country	Data source(s)
EU 27 countries	
Spain	Ministerio de Fomento: Mapa de Trafico 2010, CD-ROM.
United Kingdom	Department for Transport: Traffic counts 2010.

Table 5-23: National data sources for road traffic count data, part 2

Country	Data source(s)
Candidate countries & EFTA	
Croatia	Hrvatske Ceste d.o.o.: Brojenje prometa na cestama Republike Hrvatske godine 2010.
FYR Macedonia	Republic of Macedonia, State Statistical Office: 2010 E-Road Census of Motor Traffic on Main International Traffic Arteries in Europe (E-Road Census).
Serbia	J.P. "Putevi Srbije": Prosečan godišnji dnevni saobraćaj – PGDS u 2010. Godini.
Switzerland	Bundesamt für Strassen (ASTRA): Schweizerische automatische Strassenverkehrszählung (SASVZ) 2010. + Bundesamt für Strassen (ASTRA): Verkehrsmonitoring.
Turkey	Karayollari Genel Müdürlüğü: 2010 Trafik ve ulaşım bilgileri. Otayollar ve devlet yollarının trafik dilimlerine göre. Yıllık ortalama günlük trafik değerleri ve ulaşım bilgileri. + 2010 Yılı Trafik Hacim Haritası.
Neighbouring countries	
Albania	Institute of Transport (Instituti i Transportit), Information Transport Sector: Road traffic counts 2010.
Bosnia & Herzegovina	J.P. Ceste Federacije BiH: BROJANJE saobraćaja na magistralnim cestama Federacije BiH u 2010. godini. + J.P. "Putevi Republike Srpske": Brojanje vozila na mreži puteva u republici srpskoj 2009. godina.

5.3.5 Data on ferry services

Data on ferries links have been collected by exploiting several websites as displayed by Table 5-24.

Table 5-24: Data sources for Level-of-Service for ferries

Scope	Data source
General	http://www.ferrytravel.de/N_Europe/n_europe.html
	http://www.ukstudentlife.com/Travel/Transport/Ferry.htm
	http://www.travelchoice.org/ferry.asp
	http://www.worldtravellers.net/seatravel/ferry.html
	http://www.aferry.com/
Single operator	Thomas Cook Publishing: European Rail Timetable, Summer 2005, Petersborough PE3 8SE, United Kingdom.
	Frewin Poffley: Greek Island Hopping 2010, Thomas Cook Publishers.
	http://www.anek.gr
	http://www.balearia.com
	http://www.bluestarferries.com
	http://www.calmac.co.uk/
	http://www.colorline.de
	http://www.corsicaferries.com/

Scope	Data source
	http://www.dfdseaways.de http://www.endeavor-lines.com/ http://www.finnlines.com http://www.fjordline.de http://www.grieksegids.nl/minoan/ http://www.irishferries.com http://www.ldlines.de http://www.marmaralines.com http://www.minoan.gr/de http://www.mobylines.de http://www.montenegrolines.net http://www.nel.gr http://www.nordic-ferry.com http://www.norfolkline.de http://www.northlinkferries.co.uk http://www.poferries.de http://www.scandlines.de http://www.seafrance.com http://www.sncm.fr http://www.stenaline.de http://www.superfast.com http://www.tirrenia.it http://www.trasmediterranea.es http://www.ttline.com/de http://www.ventouris.gr http://www.vikingline.fi/timetables/timetables/timetables/mar_kap-alf.asp

5.4 Results

The current section intends to give a rough overview of the scope and selected contents of the ETISplus road network model.

Data can be obtained via the following online links.

Table 5-25: Key Results: Full Network in SHP Format

Access via	Location	Folder	Description
ETIS Bulk Download	Data Bulk Downloads ETIS Data	Additional data Resources	Road network as SHP file
2010	http://www.etisplus.eu/data/Public/Downloads.aspx Additional data resources: Land_networks_2005_2010.zip File: ETISplus_road_network_2_1_final_2010.mdb (Access/SHP)		
2005	http://www.etisplus.eu/data/Public/Downloads.aspx Additional data resources: Land_networks_2005_2010.zip File: ETISplus_road_network_model_2005_v_3_1.mdb (Access/SHP)		

Table 5-26: Key Results: Editable Online Network

Access via	Location	Toolbar	Description
ETIS NETTER	http://netter.etisplus.net/	Network - Link - Road	2010 Road network as Editable GIS layer.

Figure 5-8 highlights the geographical scope of the ETISplus road network model, labelling three different road categories: motorways, dual carriageway roads, other links and ferries.

Table 5-27, Table 5-28 inform on the availability of traffic count data, which have been collected and implemented within ETISplus. Table 5-27 gives a country-wise overview of data sources that have been used to implement traffic count data, whereas Table 5-28 illustrates which traffic count data attributes are available per country.

Figure 5-9 displays the links of the road network model which contain traffic count data (at least one of following attributes are filled with data: "AADT", "AADTPassCars", "AADTTrucks", "AADTCoaches", "AADTUNECE", "AADTTTv2" or "AADTCarsTTv2 (the latter relating to data from 2005)). Figure 5-10 highlights the links for which traffic count data have been compiled within ETISplus, while Figure 5-11 displays traffic count data for 2005 from TRANS-TOOLS v2 (TT v2).

As an example of results of the developed methodology to identify "urban" links, Figure 5-12 highlights the set of "urban" links in the south-western part of the Netherlands: the red-marked road links display those road links which are labelled "urban" links (urban=1). Figure 5-13 highlights the same indicator for the whole of Europe.

Figure 5-8: Scope of the ETISplus road network model

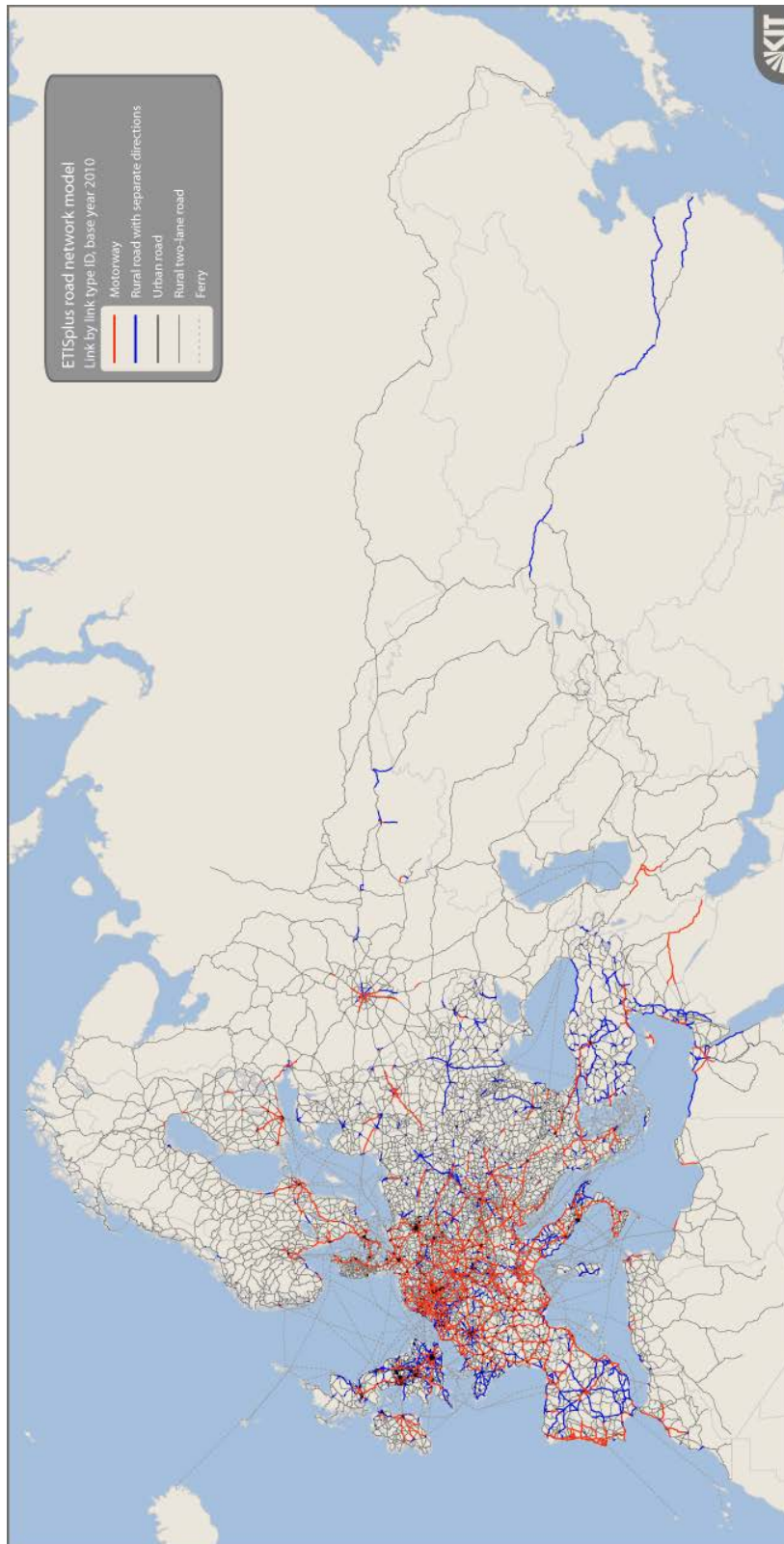


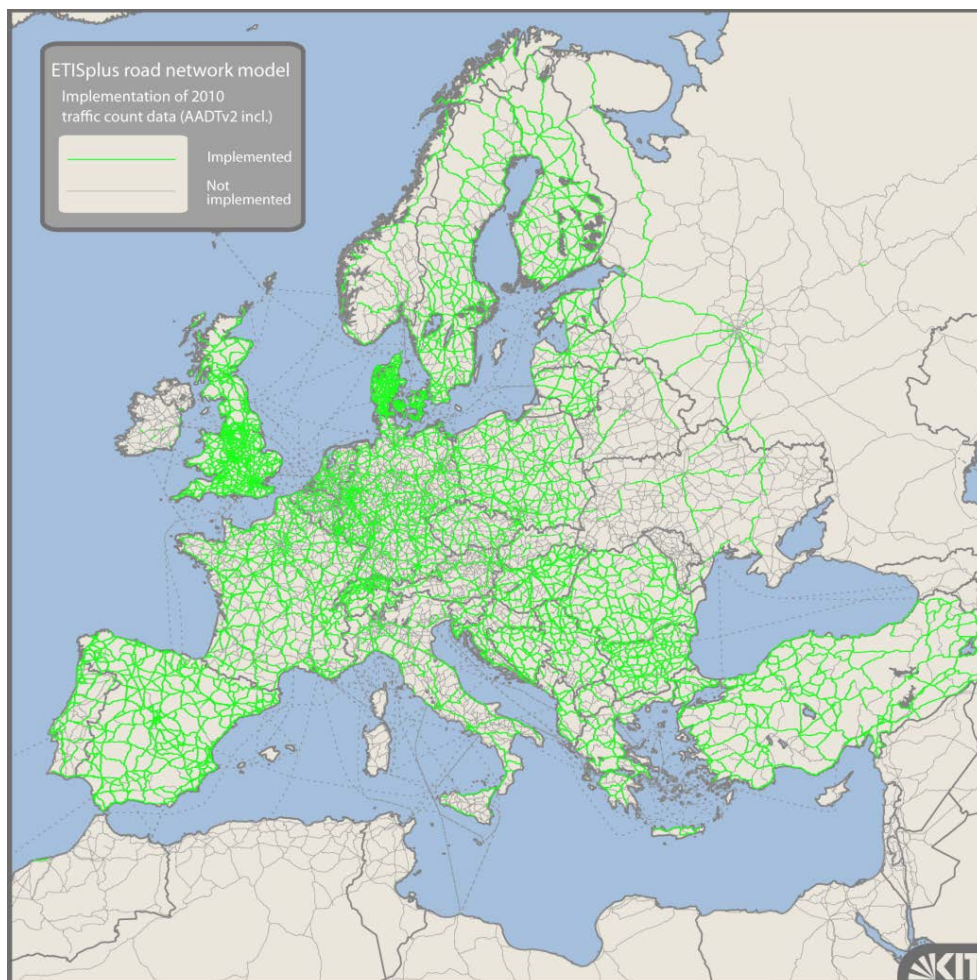
Table 5-27: Overview of types of implemented traffic count data per country

Country	National sources	TENtec	UN/ECE
EU 27 countries			
Austria	X		
Belgium	X		
Bulgaria	X		
Czech Republic	X		
Denmark	X		
Estonia	X		
Finland	X		
France	X		
Germany	X		
Greece		X	
Hungary	X		
Italy		X	
Latvia	X		
Lithuania	X		
Luxembourg	X		
Netherlands	X		
Poland	X		
Portugal	X		
Romania		X	
Slovakia	X		
Slovenia	X		
Spain	X		
Sweden		X	
United Kingdom	X		
Candidate countries & EFTA			
Croatia	X		
FYR Macedonia	X		
Serbia	X		
Switzerland	X		
Turkey	X		
Neighbouring countries			
Albania	X		
Bosnia & Herzegovina	X		

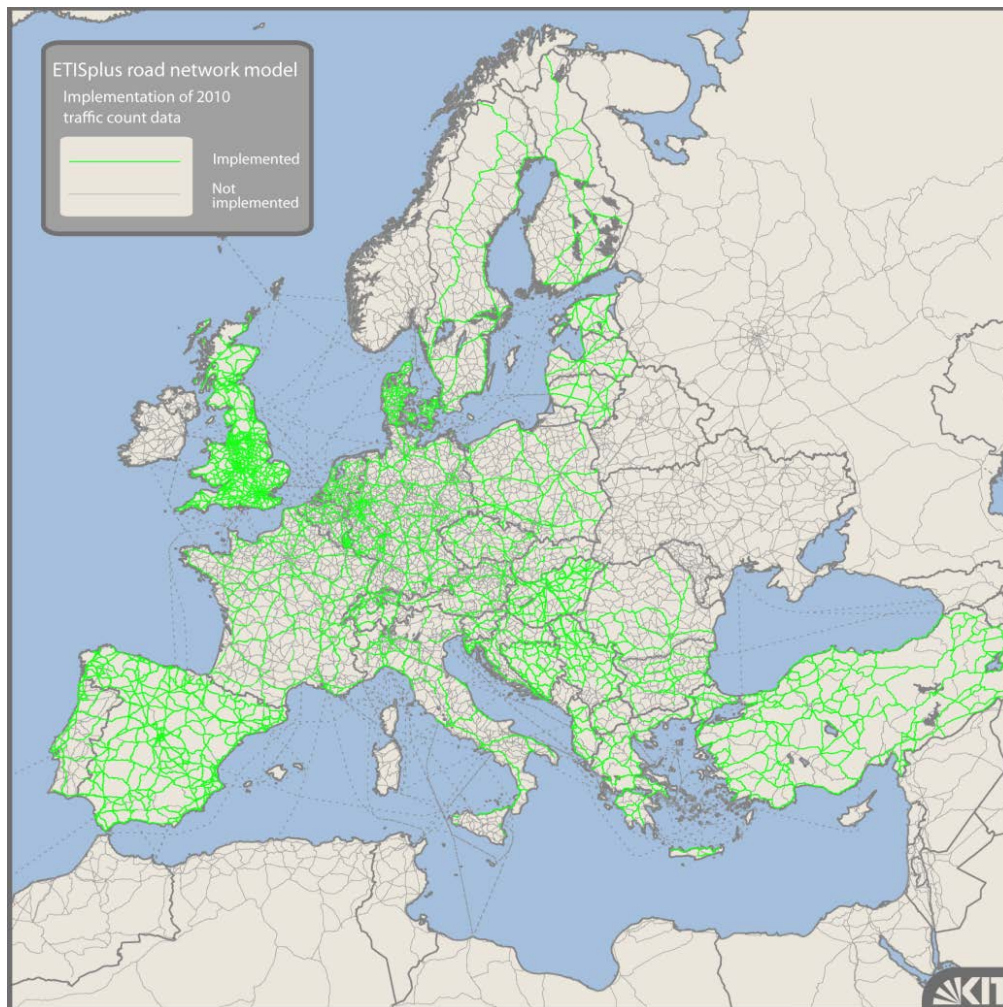
Table 5-28: Overview of implemented traffic count data attributes per country

Country	AADT	AADTCoaches	AADTTrucks	AADTPassCars
EU 27 countries				
Austria	NAT		NAT +	NAT #
Belgium	NAT			
Bulgaria	NAT	NAT	NAT	NAT
Czech Republic	NAT		NAT	NAT *
Denmark	NAT		NAT +	NAT
Estonia	NAT			
Finland	NAT		NAT +	NAT
France	NAT			
Germany	NAT		NAT +	NAT #
Greece			TENtec ^	TENtec ^
Hungary	NAT	NAT	NAT	NAT
Italy			TENtec ^	TENtec ^
Latvia	NAT		NAT +	NAT
Lithuania	NAT	NAT	NAT	NAT ‡
Luxembourg	NAT		NAT	NAT
Netherlands	NAT			
Poland	NAT	NAT	NAT	NAT
Portugal	NAT			
Romania			TENtec ^	TENtec ^
Slovakia	NAT		NAT	NAT *
Slovenia	NAT	NAT	NAT	NAT ‡
Spain	NAT		NAT +	NAT *
Sweden			TENtec ^	TENtec ^
United Kingdom	NAT	NAT	NAT	NAT ‡
Candidate countries & EFTA				
Croatia	NAT			
FYR Macedonia	NAT			
Serbia	NAT		NAT +	NAT
Switzerland	NAT	NAT	NAT	NAT ‡
Turkey	NAT		NAT +	NAT #
Neighbouring Countries				
Albania	NAT			
Bosnia & Herzegovina	NAT			
NOTES				
+ ... includes coaches		‡ ... includes pass. cars, motorcycles & light vehicles		
* ... includes motorcycles		^ ... volumes translated into vehicles		
# ... includes passenger cars & light vehicles				

**Figure 5-9: Scope of traffic count data in the ETISplus road network model
(including traffic count data from TTv2)**



**Figure 5-10: Scope of traffic count data in the ETISplus road network model
(traffic count data collected and implemented within ETISplus)**



**Figure 5-11: Scope of traffic count data in the ETISplus road network model
(traffic count data implemented from TTv2)**

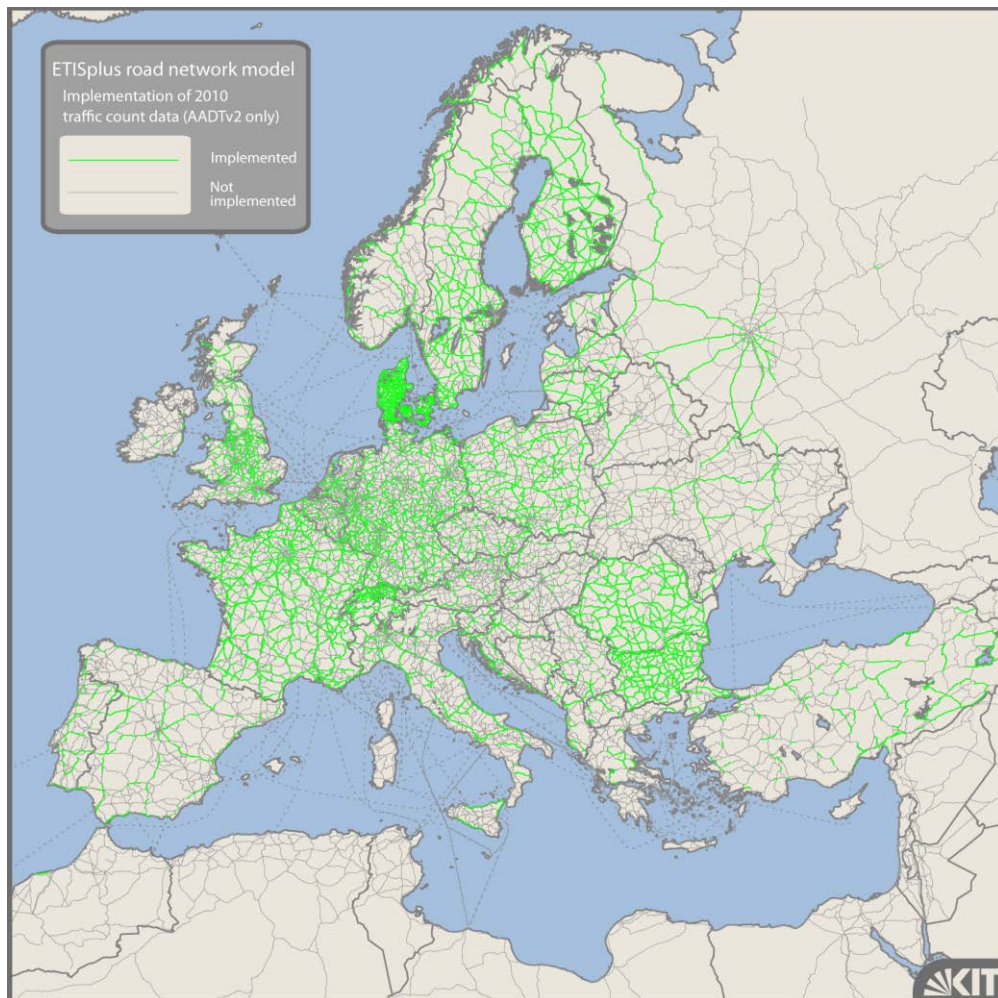


Figure 5-12: Illustration of the scope of the attribute “urban”

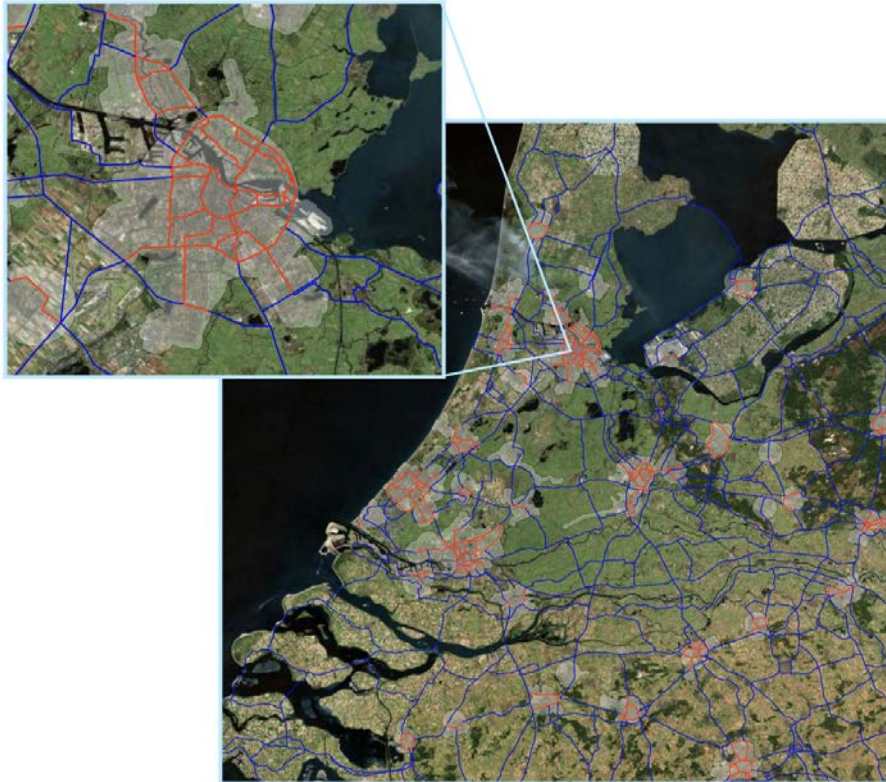
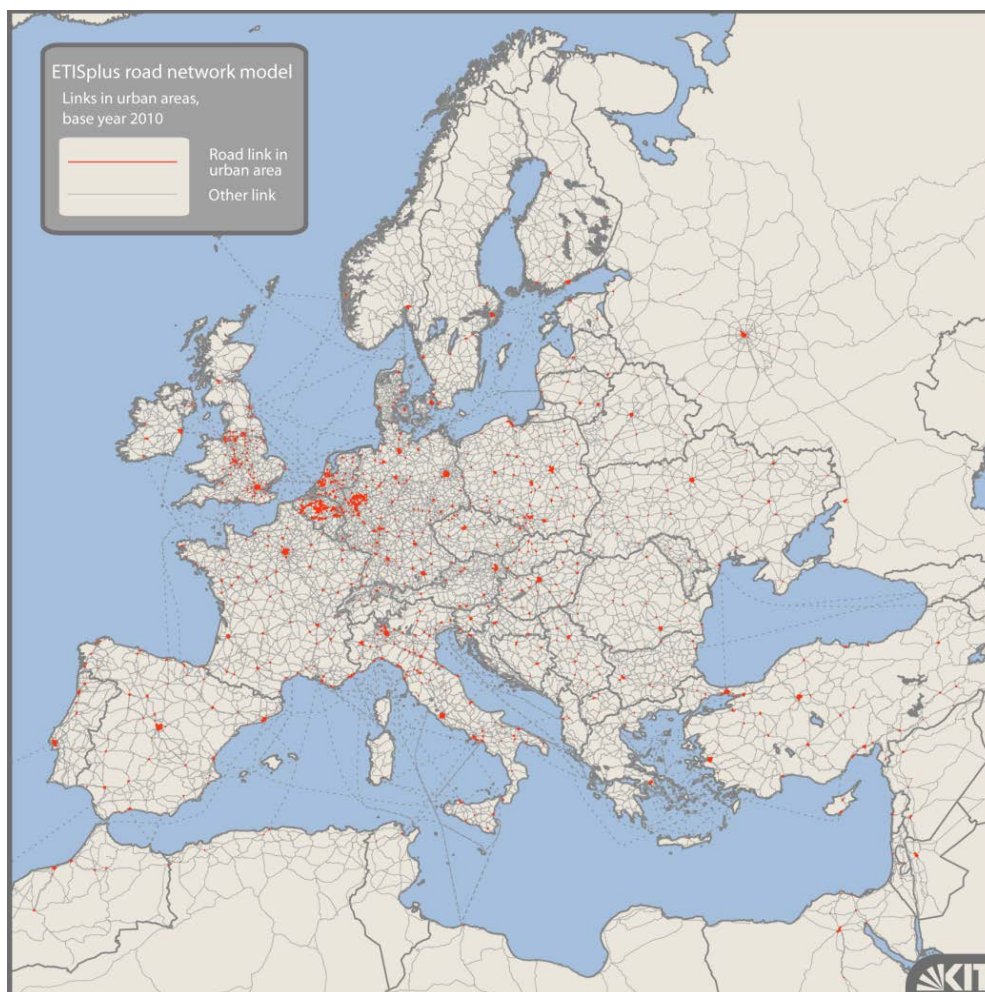


Figure 5-13: Road links in urban areas



5.5 References

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<http://www.eea.europa.eu/data-and-maps/data/corine-land-cover-2006-raster-1>

Documentation of the TRANS-TOOLS model version v1:
<http://www.trafficanalyst.dk/transtools/DataModel/index.htm>

EWS (1997): Forschungsgesellschaft für Strassen- und Verkehrswesen, Arbeitsgruppe Verkehrsplanung (1997): Empfehlungen für Wirtschaftlichkeitsuntersuchungen an Straßen, EWS, Aktualisierung der RAS-W 86, Köln: Forschungsgesellschaft für Strassen- und Verkehrswesen.

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<http://www.openstreetmap.org>

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6 Rail Network

6.1 Scope of database

The rail network is represented in a GIS database containing rail links and rail nodes. The main characteristics of the rail network database are summarised by Table 6-1, while their contents are listed by Table 6-2.

The main focus of the network model developments in ETISplus has been the EU-27 countries, Candidate countries, EFTA countries and some of neighbouring countries.

Table 6-1: Overview of main characteristics of the data set

Rail network						
Data feature	Data specification					Remarks
Base year	2010					
Scope of data	Link	Terminal	O/D relation	Region	Other	
	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
GIS data	Yes	No				
	<input checked="" type="checkbox"/>	<input type="checkbox"/>				
Country coverage				Com-pletely	Par-tially	
	EU 27			<input checked="" type="checkbox"/>	<input type="checkbox"/>	
	Candidate countries & EFTA			<input checked="" type="checkbox"/>	<input type="checkbox"/>	
	Neighbouring countries			<input checked="" type="checkbox"/>	<input type="checkbox"/>	
	TRACECA			<input type="checkbox"/>	<input checked="" type="checkbox"/>	
	MEDA			<input type="checkbox"/>	<input checked="" type="checkbox"/>	
	Other countries			<input type="checkbox"/>	<input checked="" type="checkbox"/>	
	Total number of countries covered:			58		
Main data sources	Various international and national data sources exploited.					
Main type of data generation	Observed	<input checked="" type="checkbox"/>				Depending on the attribute, all types of data generation have been applied.
	Harmonised	<input checked="" type="checkbox"/>				
	Modelled	<input checked="" type="checkbox"/>				

Table 6-2: Data structure of the rail network data set

Indicator	Description of indicator	Unit
ObjectID	Identifier used by ArcGIS	
ID	Unique identifier	
Shape	ArcGIS geometry	
FromNodeID	FromNode of the link	
ToNodeID	ToNode of the link	
Country	Country the link is located in	
ZoneID	Zone the link is located in	
CountryBorder	Indicates whether the link crosses a country border or not	
ZoneBorder	Indicates whether the link crosses a zone border or not	
Active	Indicates whether the link is active or not	
Deactivation	Year the link is put out of service (period of time 2005-2010)	
Activation	Year the link is put into service (period of time 2005-2010)	
Length	Length of link	km
LinkLength	Length of link	m
Shape_Length	ArcGIS link length	
OpenFor	Indicates whether link is open or not in the forward direction (FromNode to ToNode)	
OpenBack	Indicates whether link is open or not in the backward direction (ToNode to FromNode)	
HighSpeed	Indicates whether the rail link represents high-speed infrastructure or not	
FreeSpeedPass	Maximum operating speed on the link for passenger trains	km/h
FreeSpeedFreight	Maximum operating speed on the link for freight trains	km/h
Tracks	Total number of tracks	tracks
Electrified	Indicates whether a link is electrified	
Gauge	Link gauge	
LinkTypeID	Link type	
Class	Link class in terms of infrastructure category	
PassFreight	Link class in terms of operation	
LongDistancePassengerTrain	Indicates whether the link is operated by a long-distance passenger train	
PriorityFreightLink	Indicates whether the link is a rail section on which priority is given to freight transport	
FerryTime	Sailing time on ferry links	min
FerryLength	Length of ferry links	m
TrafficCountPass	Number of passengers per year	passengers/year
TrafficCountFreight	Number of tonnes carried per year	tonnes/year
TrafficCountPassVeh	Number of passenger trains per year	passenger trains/year
TrafficCountFreightVeh	Number of freight trains per year	freight trains/year
TrafficCountVeh	Number of trains per year	trains/year
TrafficCountUNECE	Number of trains per year	trains/year
Enabled	Indicates whether a link is active (ArcGIS attribute)	

6.2 Methodology

6.2.1 General approach

The ETISplus rail network model 2010 is based on the ETISplus rail network model 2005 (see Szimba and Kraft 2012).

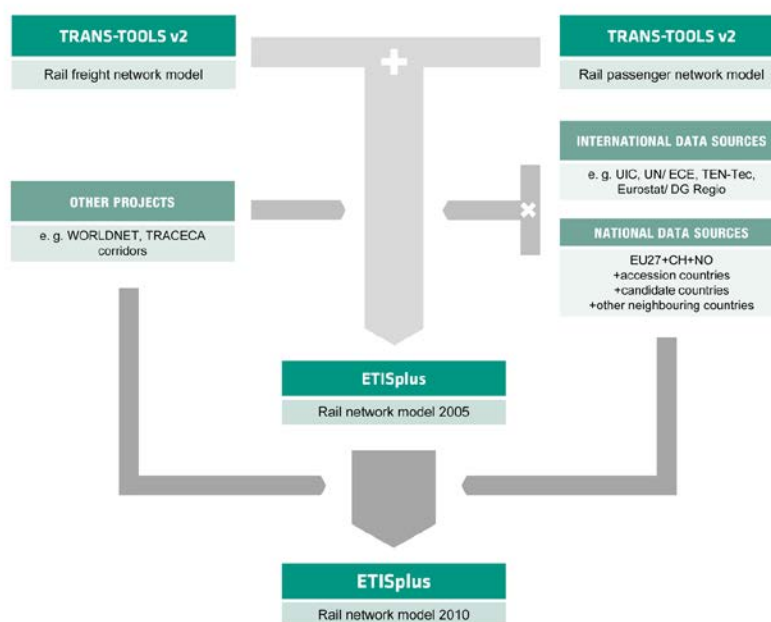
The ETISplus rail network model 2005 relies on the TRANS-TOOLS v2 rail network models which were published by the EU's Joint Research Centre (JRC), IPTS in Seville in autumn 2009. To overcome the disadvantages of separate freight and passenger rail network models, the separate rail network models by TRANS-TOOLS have been merged into integrated ETISplus network models, covering both passenger and freight.

Based on the ETISplus rail network model 2005, various kinds of updates have been realised for the compilation of the rail network 2010:

- Implementation of new high-speed lines;
- Review and update of attributes (e.g. speed);
- Further update of alignment;
- Implementation of new data (e.g. traffic count data).

Update and implementation of data has been realised under application of a wide range of different data sources: international data sources; national data sources; and information from OpenStreetMap. Table 6-1 gives an overview of the data generation process for the development of the ETISplus rail network 2010.

Figure 6-1: Overview of methodology to process the ETISplus rail network model



6.2.2 Review and update of network topology and alignment

In many cases, the network topology has been adjusted – for instance by deletion of incorrectly connected links or the implementation of additional nodes. Furthermore, the link alignment has been improved significantly, which has been achieved under application of digital maps and OpenStreetMap data (see example of improvement in Figure 6-2).

Furthermore, in some cases the network connectivity has been improved and has been adjusted to real-world conditions: For instance, in the pre-ETISplus rail network model, the long-distance passenger rail stations in Paris were not connected to each other by the metro and regional train system (see upper map in Figure 6-3). Within ETISplus, the long-distance rail stations have been connected by metro/ RER lines via the centrally located station Châtelet Les Halles (see lower map in Figure 6-3).

Figure 6-2: Example of improvement of link alignment

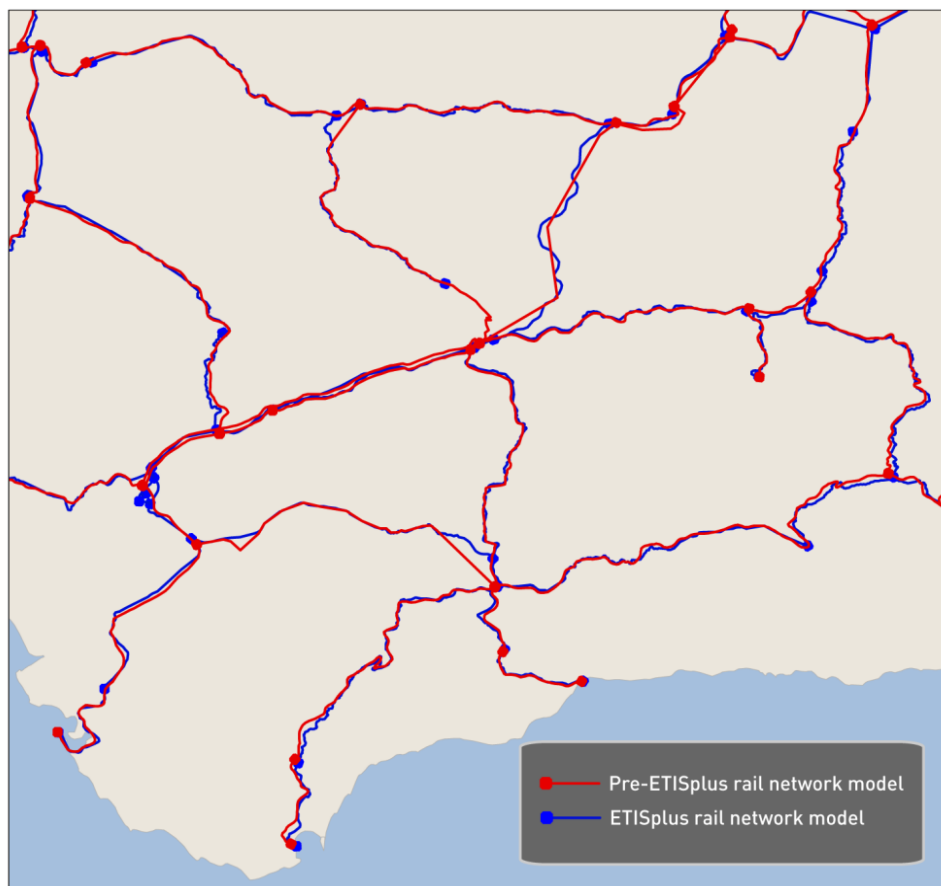


Figure 6-3: Example for improvement of network connectivity

Pre-ETISplus



ETISplus



6.2.3 Elementary link attributes

Network topology

The attributes "ObjectID", "Shape", "ID", "FromNodeID" and "ToNodeID" represent important elements of the network topology. "FromNodeID" and "ToNodeID" refer to the node connecting two links. "ID" represents the network link's unique identifier, while "ObjectID" is the identifier used within ArcGIS. The topological location of a link is represented by the entry "Shape". The attributes "FromNodeID" and "ToNodeID" contain information on the unique identifier of the nodes a link is connected to. The data for these attributes have been generated via an automated process.

Administrative link information

Each link contains information concerning its administrative classification. "Country" refers to the country in which the link is located, while "ZoneID" allocates a road link to a zone of the ETISplus zoning system (mainly NUTS-3 zones). "CountryBorder" and "ZoneBorder" contain information whether or not a link crosses a national border or a zone respectively. This data has been computed automatically by merging the links of the network model with the ETISplus GIS layers of the applied zoning system.

Basic link characteristics

The attribute "Active" informs on whether or not a rail link is in operation in the base year 2005. Two attributes inform on newly opened or abandoned infrastructure within the period of time 2005-2010: "Activation" informs on the year the infrastructure link has been taken into operation, whereas "Deactivation" displays the year in which the links has been abandoned. The attribute contains a year only in case the infrastructure was added or removed in the period of time 2005-2010.

For reasons of keeping consistency with requirements of the TRANS-TOOLS model, three different attributes are contained in the database, which are related to the length of a link: "Length" represents the length of a link in kilometres, whereas the attribute "LinkLength" represents the length in metres. "ShapeLength" refers to the length computed by ArcGIS. The unit of measurement depends on the projection (default: degrees).

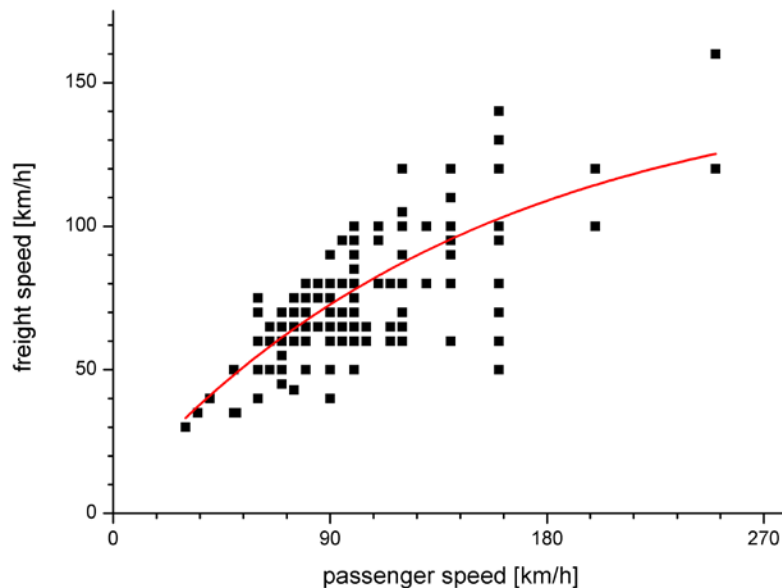
The indicators "OpenFor" and "OpenBack" inform on whether a link is drivable in forward and backward direction. All rail links are assumed to have been operational in both directions.

"HighSpeed" contains information whether the link has the characteristics of a high-speed line (design speed at least 250 kph). "FreeSpeedPass" and "FreeSpeedFreight" contain data on the maximum allowed speed for passenger and freight trains. Information for the speed indicators has often been available from network statements of railway companies. Also, data from TENtec (EC 2010) has been applied – particularly in case where more disaggregated data is

not available. However, in several cases, information on maximum speeds has only been available in the form of intervals. Particularly the lower speed categories have been pooled in the available data sources by large intervals (e.g. maximum link speed < 100 kph), which reduces the degree of data accuracy. In several cases the design speed had to be used as proxy for the value relating to the attribute “FreeSpeedPass”.

In general, data availability for maximum speed allowed for freight trains has been inferior to data availability for maximum speed allowed for passenger trains. In order to bridge this data gap, the values for maximum speed allowed for freight trains have been computed as a function of the maximum speed allowed for passenger trains based on empirical data. In order to capture country-specific differences, this approach has been applied for three country groups. Figure 6-4 displays the relationship between maximum passenger train operating speed and maximum freight train operating speed for one of the three applied country groups, as well as the applied regression function. The resulting values for maximum operating speed of freight trains have been rounded to integer values divisible by five.

Figure 6-4: Relationship between maximum allowed rail speeds for passenger and freight trains



In most cases, the speed values implemented into the ETISplus rail network model neither factor speed restrictions due to capacity restrictions, nor local constraints caused for instance by track switches, level grade crossings or the capability of the rolling stock. Since, in addition, intermediate stops (e.g. at stations or country borders) are not captured by the network model, the travel times computed on the basis of the implemented speeds may differ significantly from real-world travel times.

"Tracks" informs on the number of tracks a link consists of, and "Electrified" informs on whether or not a link is electrified. The value of the attribute "Gauge" differentiates between standard gauge (1435mm), broad gauge (>1435 mm), narrow gauge (< 1435mm) and mixed gauge (standard/ broad). For these attributes the rail network maps by B ker¹ have been a rich and useful data source. However, certain data availability gaps are related to the number of tracks per link: the information provided by B ker differentiates between "single track" and "two tracks or more". Therefore, the provided information on number of tracks has to be dealt with caution.

"Class" indicates the type of rail link and differentiates between following categories:

"New lines", which mainly correspond to high-speed lines; "upgraded lines", featuring high quality railway sections (maximum operating speed > 160 kph), whose design speed is below the high-speed label; "conventional lines", representing all other link types; and ferries.

The attribute "PassFreight" informs on whether a rail link is opened for passenger trains, freight trains, or both types of trains. Also for this attribute, the rail network maps by B ker² have been the main reference.

"LongDistancePassengerTrain" indicates whether or not a link is operated by a long-distance passenger train. Table 6-3 informs on the types of long-distance trains per country represented by the value of the attribute "LongDistancePassengerTrain".

¹ <http://www.bueker.net/trainspotting/maps.php>

² dto.

Table 6-3: Overview of long-distance trains per country

Country	Long distance trains
EU27 countries	
Austria	<i>ICE, RJ, ÖIC, ÖEC, IC, EC, EN, CNL, D, E, SPR</i>
Belgium	<i>ICE, Thalys, IC, EC, IR</i>
Bulgaria	<i>Express, Fast train</i>
Czech Republic	<i>IC, EC, SuperCity, Express, Fast train</i>
Denmark	<i>ICE, IC, EC, Lyn</i>
Estonia	<i>Fast train</i>
Finland	<i>S220, IC, Express, Fast train</i>
France	<i>TGV, Thalys, Eurostar, ICE, EC, Talgo, Intercités, Téo, Corail</i>
Germany	<i>ICE, Thalys, TGV, RJ, IC, EC, NZ, CNL, EN, IR, D</i>
Greece	<i>ICE, IC, IR</i>
Hungary	<i>RJ, IC, EC, EN, Fast train</i>
Ireland	<i>IC, Fast train</i>
Italy	<i>Eurostar Italia, IC, EC, ICN, EN, IR, D, E</i>
Latvia	<i>Fast train</i>
Lithuania	<i>Fast train</i>
Luxembourg	<i>TGV, IC, EC, Fast train</i>
Netherlands	<i>ICE, Thalys, IC, D</i>
Poland	<i>IC, EC, Express, TLK, IR</i>
Portugal	<i>Alfa Pendular, IC, IN, IR</i>
Romania	<i>IC, Rapid, Accelerat</i>
Slovakia	<i>IC, EC, Express, IR</i>
Slovenia	<i>ICS, IC, EC, D</i>
Spain	<i>AVE, Alvia, Avant, Alaris, Euromed, Arco, Altaria, Talgo, Estrella, Trenhotel, D</i>
Sweden	<i>X2000, IC, Fast train</i>
United Kingdom	<i>Eurostar, Fast train</i>
Candidate countries & EFTA	
Croatia	<i>IC, EC, Fast train</i>
FYR Macedonia	<i>Fast train</i>
Norway	<i>IC, Fast train</i>
Serbia	<i>Fast train</i>
Switzerland	<i>ICE, TGV, RJ, RJ, IC, EC, ICN, EN, CNL, IR</i>
Turkey	<i>YHT, Fast train</i>
Neighbouring countries	
Belarus	<i>Fast train</i>
Bosnia and Herzegovina	<i>IC, Fast train</i>
Moldova	<i>Fast train</i>
Russia	<i>Sapsan, Fast train</i>
Ukraine	<i>Fast train</i>

6.2.4 Priority freight links

The attribute "PriorityFreightLink" informs whether a link is a rail section on which priority is given to freight transport.

The definition of 'priority freight link' has been based on different considerations and network approaches (NESTEAR 2011):

1. "physical description" and geo-coding of the network;
2. "performances of rail operations" with in particular, inclusion of nodal intermodal points (ports and inland terminals as well as major hubs): the network is associated with a database of intermodal services;
3. "corridor approach" for which monitoring, planning of investments, coordination of slots allocation and maintenance are expected from EIM and public administrations. In addition, the proposed network includes ERTMS corridors;
4. "European coverage" of the network from which a priority "core network" can be extracted, to comply with definition of priorities set for selection of projects in the new TEN-T guidelines.

These considerations result in two types of dedicated rail freight links: links belonging to the main priority network and links of the priority network (see Figure 6-5). In the ETISplus rail network model, the links allocated to the "main priority network" are labelled in the attribute "PriorityFreightLink".

Figure 6-5: Priority rail freight links



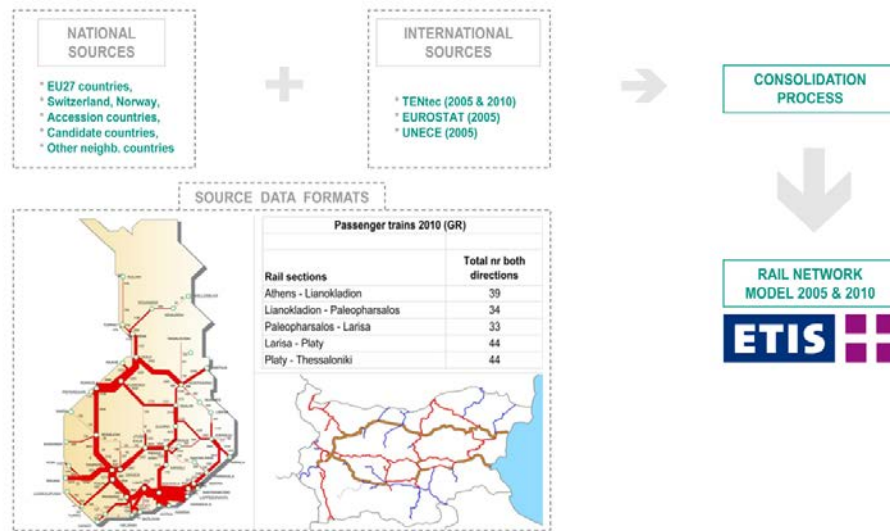
6.2.5 Traffic count data

Traffic count data is represented in the ETISplus rail network model by following six attributes: "TrafficCountPass", "TrafficCountFreight", "TrafficCountPassVeh", "TrafficCountFreightVeh", "TrafficCountVeh", and "TrafficCountUNECE".

"TrafficCountPass" refers to the annual passenger transport volume (number of passengers p.a.), while "TrafficCountFreight" refers to the freight transport volume (number of tons carried p.a.). "TrafficCountPassVeh" and "TrafficCountFreightVeh" contain data on the number of passenger and freight trains, whereas "TrafficCountVeh" represents the total number of trains using a certain rail link.

Traffic count data has been implemented into the ETISplus rail network model under application of several data sources. Depending on the country, data has been available in different formats, i.e. in form of GIS data, tables and thematic maps.

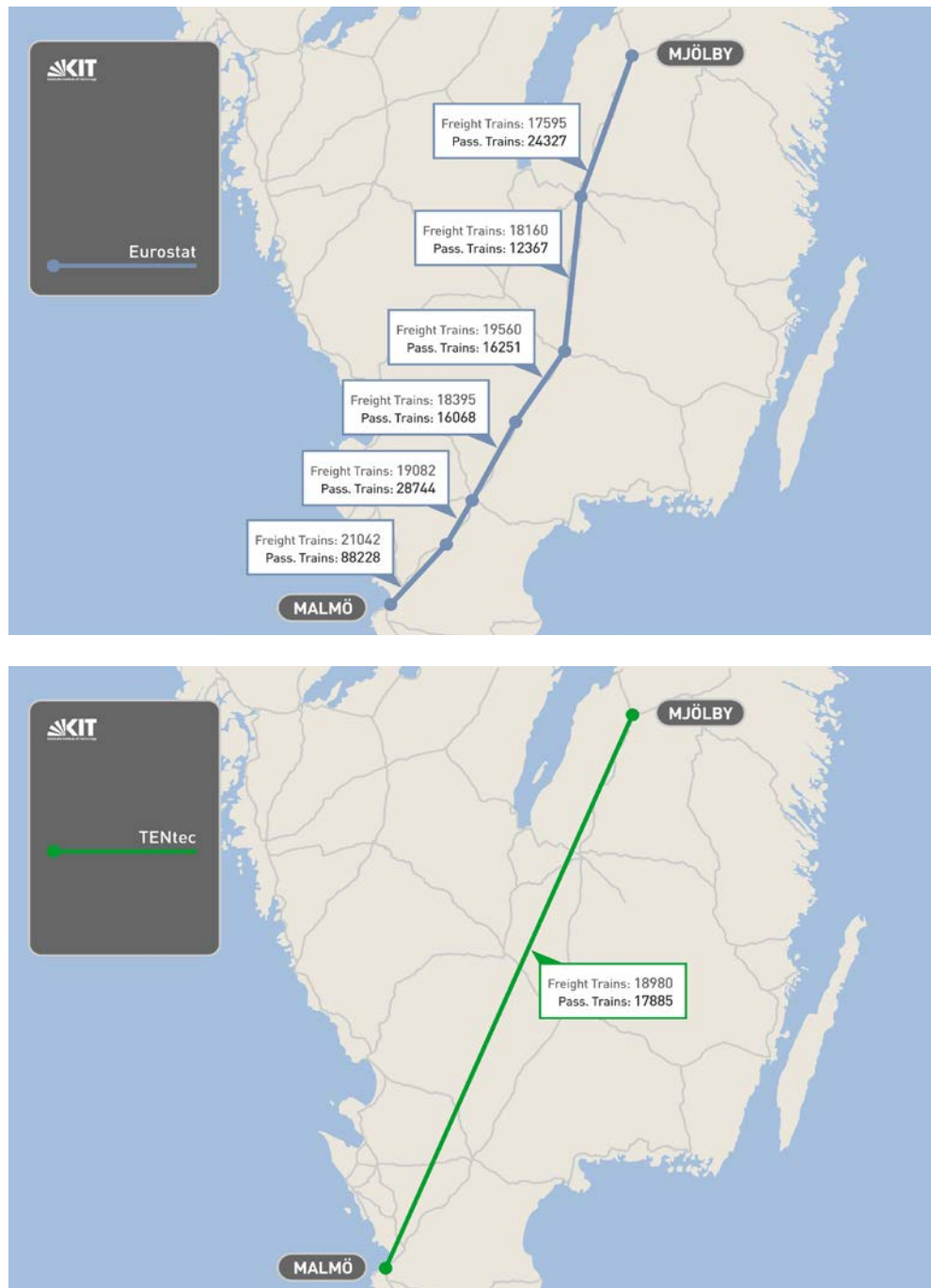
Figure 6-6: Overall approach of the implementation of traffic count data into the ETISplus rail network model



In contrast to the situation for 2005, the availability of rail traffic count data from international sources has been rather limited for 2010. The only available source has been TENtec (EC 2012), whose traffic counts were implemented for nine countries. Rail traffic count data for 2010 were neither available from UN/ ECE nor from Eurostat/ DG Regio.

The data contents of different data sources are often ambiguous – partly due to the fact that the traffic count data relate to different network links. As an example, Figure 6-7 (source: Szimba 2012) illustrates the availability of traffic count data from different sources for the railway section between Malmö and Mjölby in the southern part of Sweden (year 2005). In the Eurostat database, the link between Malmö and Mjölby is split into six sections, whereas only one traffic load value from the TENtec network has been available to ETISplus.

Figure 6-7: Illustration of different formats of availability of traffic count data



As a general rule, the most detailed traffic count data available in terms of refinement of networks and train differentiation (passenger/ freight differentiation) has been implemented into the ETISplus network model. In most cases, the most detailed data has been available from national sources, which, however, has not been available for all countries.

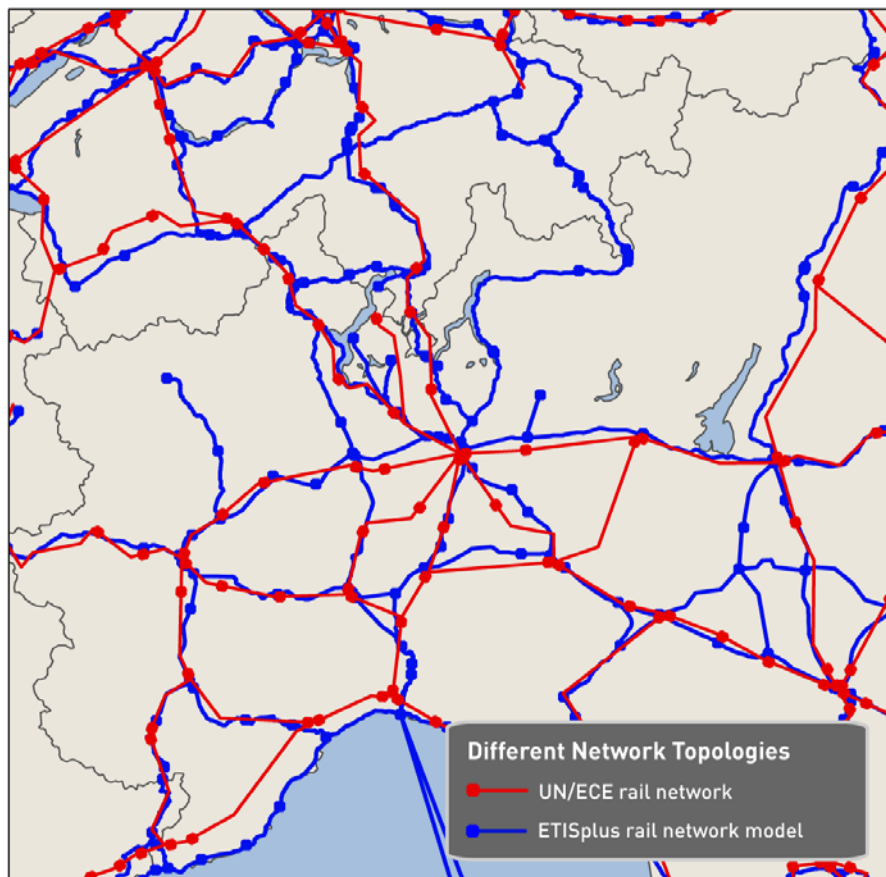
In most cases, the implementation of traffic count data has been carried out manually. However, the network topology of the ETISplus rail network model has always been different from the network topology of the sources of traffic count

data (see Figure 6-8 as an example, relating to data for 2005). In order to assign traffic count data from a source network to the ETISplus rail network model, three methods have been applied:

- (1) Link-wise implementation of values of the source network to the ETISplus network model;
- (2) Adjustment of the ETISplus rail network model to the topology of the source data;
- (3) Implementation of averaged values of the sources to the ETISplus network model.

Alternative (1) could only be applied in a few cases, in which the topology of source data and ETISplus are similar. Alternative (2) has been applied in those cases in which not adjusting the network topology - mainly by implementing an additional network node and splitting links – would have resulted to a significant loss of information. Alternative (3) has been the most frequently applied method to accommodate the source data as realistically as possible in the ETISplus network model.

Figure 6-8: Example of differences in network topologies (ETISplus vs. UN/ECE rail network model)



6.3 Data sources

The current chapter gives an overview of the most relevant data sources applied for the compilation of the ETISplus rail network model.

6.3.1 Elementary link attributes

Data sources on elementary link attributes embrace a large number of different providers, as displayed by Table 6-4, Table 6-5, and Table 6-6. Apart from the specific data sources listed in this table, TENtec data has also been used.

Table 6-4: Data sources applied for elementary link attributes, part 1

Country	Data source
EU27 countries	
Austria	http://www.bmvit.gv.at/verkehr/gesamtverkehr/statistik/downloads/viz07gesamt.pdf (page 156 f.) http://www.oebb.at/infrastruktur/de/ p 3 0 fuer Kunden Partner/3 3 Schieneninfrastruktur/index.jsp http://de.wikipedia.org/wiki/Westbahn_%28%C3%96sterreich%29
Belgium	http://hari.b-holding.be/Hafas/folders/20091213/G/1st.htm http://hari.b-holding.be/Hafas/folders/map_nl.htm http://en.wikipedia.org/wiki/High-speed_rail_in_Belgium http://upload.wikimedia.org/wikipedia/commons/9/9f/High_Speed_Railroad_Map_Europe_2009.gif
Bulgaria	http://www.andrewgrantham.co.uk/bulgarian-narrow-gauge/ http://www.bueker.net/trainspotting/maps/bulgaria/bulgaria.gif http://760net.heimat.eu/international.html http://razpisanie.bdz.bg/site/search.jsp http://bdz.creato.biz/bg/ext_razp http://www.europetrainsguide.com/200907154/Countries/Bulgaria/Bulgaria-BDZ.html http://760net.heimat.eu/international.html http://en.wikipedia.org/wiki/BDZ
Czech Republic	http://www.bueker.net/trainspotting/map.php?file=maps/czechia/czechia.gif
Denmark	http://www.bane.dk http://www.bueker.net/trainspotting/maps_scandinavian-peninsulas.php
Finland	http://www.vr.fi/en/index.html http://www.bueker.net/trainspotting/map.php?file=maps/finland/finland.gif Finnish Transport Agency: Network Statement 2012
France	Network statement of SNCF (2004) http://fr.wikipedia.org/wiki/Ligne_Strasbourg-Ville_-_Saint-Louis_%28B%C3%A2le%29 http://de.wikipedia.org/wiki/LGV_Est_europ%C3%A9enne
Germany	Statistisches Bundesamt, Verkehr, Anhang zur Fachserie 8, R 2.1, Eisenbahnverkehr, Betriebsdaten des Schienenverkehrs 2005: Statistik der Verkehrsströme im Eisenbahnnetz http://de.wikipedia.org/wiki/Schnellfahrstrecke_N%C3%BCrnberg%E2%80%93Ingolstadt%E2%80%93M%C3%BCnchen
Greece	http://www.bueker.net/trainspotting/maps/greece/greece.gif http://www.ose.gr/en/Home/NetworkStatement.aspx http://www.trainose.gr/el/travel/nea-dromologia-apo-19-06-2011 http://www.europetrainsguide.com/Countries/Greece/Greece-OSE.html
Hungary	http://www.vpe.hu/takt/vonal_lista.php
Ireland	Network statement

Table 6-5: Data sources applied for elementary link attributes, part 2

Country	Data source
EU27 countries (continued)	
Italy	http://www.bueker.net/trainspotting/map.php?file=maps/italy/italy.gif http://www.trail.unioncamere.it/ricerca_infrastrutture.asp?idtipo=infrastrutture&idcategoria=2 http://de.wikipedia.org/wiki/Schnellfahrstrecke_Torino%E2%80%93Milano http://de.wikipedia.org/wiki/Schnellfahrstrecke_Roma%E2%80%93Napoli http://de.wikipedia.org/wiki/Schnellfahrstrecke_Napoli%E2%80%93Salerno http://de.wikipedia.org/wiki/Schnellfahrstrecke_Milano%E2%80%93Bologna http://de.wikipedia.org/wiki/Schnellfahrstrecke_Bologna%E2%80%93Firenze
Lithuania	Network statement Lithuanian Railways, PASSENGER TRANSPORTATION STRATEGY OF SC “LITHUANIAN RAILWAYS” http://upload.wikimedia.org/wikipedia/commons/b/b1/Baanvaksnelheden.png http://en.wikipedia.org/wiki/List_of_railway_lines_in_the_Netherlands
Poland	http://www.bueker.net/trainspotting/maps_poland.php
Portugal	http://en.wikipedia.org/wiki/Alfa_Pendular http://en.wikipedia.org/wiki/High-speed_rail_in_Portugal
Romania	http://testcfr.infofer.ro/index.php?option=com_content&task=view&id=22&Itemid=55&limit=1&limitstart=1
Slovakia	http://www.bueker.net/trainspotting/maps_slovakia.php
Slovenia	http://www.stat.si/pxweb/Database/Economy/22_transport/03_22215_railway_transport/22218_goods_transport/22218_goods_transport.asp
Spain	http://www.adif.es/en_US/conoceradif/doc/CA_DRedEn_Completo.pdf http://en.wikipedia.org/wiki/High-speed_rail_in_Spain http://en.wikipedia.org/wiki/File:AVE.png http://en.wikipedia.org/wiki/Madrid%E2%80%93Barcelona_high-speed_rail_line http://en.wikipedia.org/wiki/Madrid%E2%80%93Seville_high-speed_rail_line http://en.wikipedia.org/wiki/Madrid%E2%80%93Valladolid_high-speed_rail_line http://en.wikipedia.org/wiki/C%C3%B3rdoba%E2%80%93M%C3%A1laga_high-speed_rail_line http://en.wikipedia.org/wiki/LGV_Perpignan%E2%80%93Figueres http://en.wikipedia.org/wiki/Madrid%E2%80%93Levante_high-speed_rail_line
Sweden	http://de.wikipedia.org/wiki/Schienenverkehr_in_Schweden http://en.wikipedia.org/wiki/Rail_transport_in_Sweden http://sv.wikipedia.org/wiki/J%C3%A4rnv%C3%A4g_i_Sverige http://www.bueker.net/trainspotting/map.php?file=maps/scandinavian-peninsulas-network/scandinavian-peninsulas.gif http://www.sj.se/ http://www.sj.se/start/startpage/index.form?l=en Network statement 2012
United Kingdom	http://www.bueker.net/trainspotting/maps.php http://www.networkrail.co.uk/aspx/4451.aspx
Candidate countries & EFTA	
Croatia	Network statement
FYR Macedonia	http://www.bueker.net/trainspotting/map.php?file=maps/albania---macedonia/albania---macedonia.gif
Montenegro	http://www.bueker.net/trainspotting/map.php?file=maps/serbia---montenegro/serbia---montenegro.gif
Norway	http://sv.wikipedia.org/wiki/J%C3%A4rnv%C3%A4g_i_Norge http://www.nsb.no/forside/ http://www.bueker.net/trainspotting/map.php?file=maps/scandinavian-peninsulas-network/scandinavian-peninsulas.gif
Serbia	Jernbarnestatistikk 2008 http://www.bueker.net/trainspotting/map.php?file=maps/serbia---montenegro/serbia---montenegro.gif
Switzerland	http://www.are.admin.ch/themen/verkehr/00256/00498/index.html?lang=de http://www.are.admin.ch/themen/verkehr/00258/00514/index.html?lang=de

Country	Data source
Candidate countries & EFTA (continued)	
Serbia	http://www.bueker.net/trainspotting/map.php?file=maps/serbia---montenegro/serbia---montenegro.gif
Switzerland	http://www.are.admin.ch/themen/verkehr/00256/00498/index.html?lang=de http://www.are.admin.ch/themen/verkehr/00258/00514/index.html?lang=de
Turkey	http://www.tcdd.gov.tr/yolcu/trenler.htm http://www.euromedaviation.org/fileadmin/images/MapsAndData/Infrastructure/RAIL_Turkey.pdf http://www.tcdd.gov.tr/tcdding/istatistik2005.zip http://www.tcdd.gov.tr/home/detail/?id=599 http://www.seat61.com/Turkey2.htm http://www.trainsofturkey.com/w/pmwiki.php/Maps/Maps http://www.bueker.net/trainspotting/maps/turkey/turkey.gif http://www.turkeytravelplanner.com/trans/Train/trains_by_name.html http://en.wikipedia.org/wiki/Turkish_State_Railways http://www.europetrainsguide.com/Countries/Turkey/Turkey-TCDD.html http://de.wikipedia.org/wiki/Hochgeschwindigkeitsstrecke_Ankara%E2%80%93Istanbul
Neighbouring countries	
Albania	http://www.bueker.net/trainspotting/maps/albania---macedonia/albania---macedonia.gif http://www.europetrainsguide.com/Countries/Albania/Albania-HSH.html http://www.matinic.us/albania/HSH.pdf http://www.mpptt.gov.al/transportet/orari.php http://www.hsh.com.al/historiku.htm http://www.angelfire.com/ak/hekurudha/
Belarus	http://www.bueker.net/trainspotting/map.php?file=maps/belarus/belarus.gif http://www.parovoz.com/maps/supermap/index-e.html
Bosnia and Herzegovina	http://www.bueker.net/trainspotting/maps_croatia---slovenia---bosnia-hercegovina.php
Moldavia	http://www.bueker.net/trainspotting/map.php?file=maps/ukraine/ukraine.gif http://www.parovoz.com/maps/supermap/index-e.html
Russia	http://www.parovoz.com/maps/supermap/index-e.html
Ukraine	http://www.bueker.net/trainspotting/map.php?file=maps/ukraine/ukraine.gif http://www.parovoz.com/maps/supermap/index-e.html

Apart from traffic count data from international sources (i.e. UN/ECE, TENtec and Eurostat/ DG Regio), a number of national sources have been utilised for implementation into the ETISplus rail network model. Table 6-7 gives an overview of the national sources used.

Table 6-7: Data sources for rail traffic count data

Country	Data source
EU27 countries	
Austria	TENtec
Bulgaria	National railway infrastructure company http://www.rail-infra.bg/cms/opencms/menu/en/
Czech Republic	TENtec (Base Year: 2009)
Denmark	TENtec
Estonia	Statistics Estonia
Finland	Finnish Railway Statistics 2011
Greece	Timetable data http://tickets.trainose.gr/dromologia/
Hungary	TENtec
Ireland	TENtec
Italy	TENtec (Base Year: 2009)
Latvia	TENtec
Lithuania	TENtec (Base Year: 2009)
Luxembourg	TENtec
Netherlands	CBS-EUROSTAT, Den Haag
Poland	PKP POLSKIE LINIE KOLEJOWE S.A.
Portugal	Rede Ferrovijria Portuguesa (REFER)
Romania	Timetable Data: http://www.mersultrenurilororcf.ro/
Slovakia	TENtec (Base Year: 2009)
Slovenia	TENtec (Base Year: 2009)
Sweden	Trafikverket (Swedish Transport Administration) www.trafikverket.se (Base Year: 2009); UN/ECE
Candidate countries & EFTA	
Croatia	Timetable data: http://www.hznet.hr/default.aspx
FYR Macedonia	Timetable data (Base Year: 2011)
Serbia	Timetable data: JP Železnice Srbije (Serbian railways) http://www.zeleznicesrbije.com/active/en/home.html
Neighbouring countries	
Moldova	Timetable Data: http://www.railway.md/en/schedule/

6.4 Results

The current section intends to give a rough overview of the scope and selected contents of the ETISplus rail network model.

Data can be obtained via the following online links.

Table 6-8: Key Results: Full Network in SHP Format

Access via	Location	Folder	Description
ETIS Bulk Download	Data Bulk Downloads ETIS Data	Additional data Resources	Rail network as SHP file
2010	http://www.etisplus.eu/data/Public/Downloads.aspx Additional data resources: Land_networks_2005_2010.zip ETISplus_rail_network_2_1_final_2010.mdb		
2005	http://www.etisplus.eu/data/Public/Downloads.aspx Additional data resources: Land_networks_2005_2010.zip ETISplus_rail_netw_2005_fin.mdb		

Table 6-9: Key Results: Editable Online Network

Access via	Location	Toolbar	Description
ETIS NETTER	http://netter.etisplus.net/	Network - Link - Rail	2010 Rail network as Editable GIS layer.

Figure 6-9 gives an overview of the geographical scope of the network model and highlights the high-speed rail links (maximum operating speed of at least 250 kph), as well as upgraded links (maximum operating speed > 160 kph).

All links which contain traffic count data for at least one of the considered attributes related to traffic counts, are flagged by Figure 6-10. Table 6-10 informs on the type of traffic count data implemented per country, while Table 6-11 gives an overview of the scope of traffic count indicators which are available in the ETISplus rail network model.

Figure 6-11 represents a thematic map of the gauge size (standard gauge/ broad gauge/ narrow gauge/ mixed gauges).

Figure 6-12 displays the implemented maximum operating speed for passenger trains by four speed categories.

Finally, Figure 6-13 informs on the scope of the rail network which is operated by long-distance passenger trains.

Figure 6-9: ETISplus rail network model

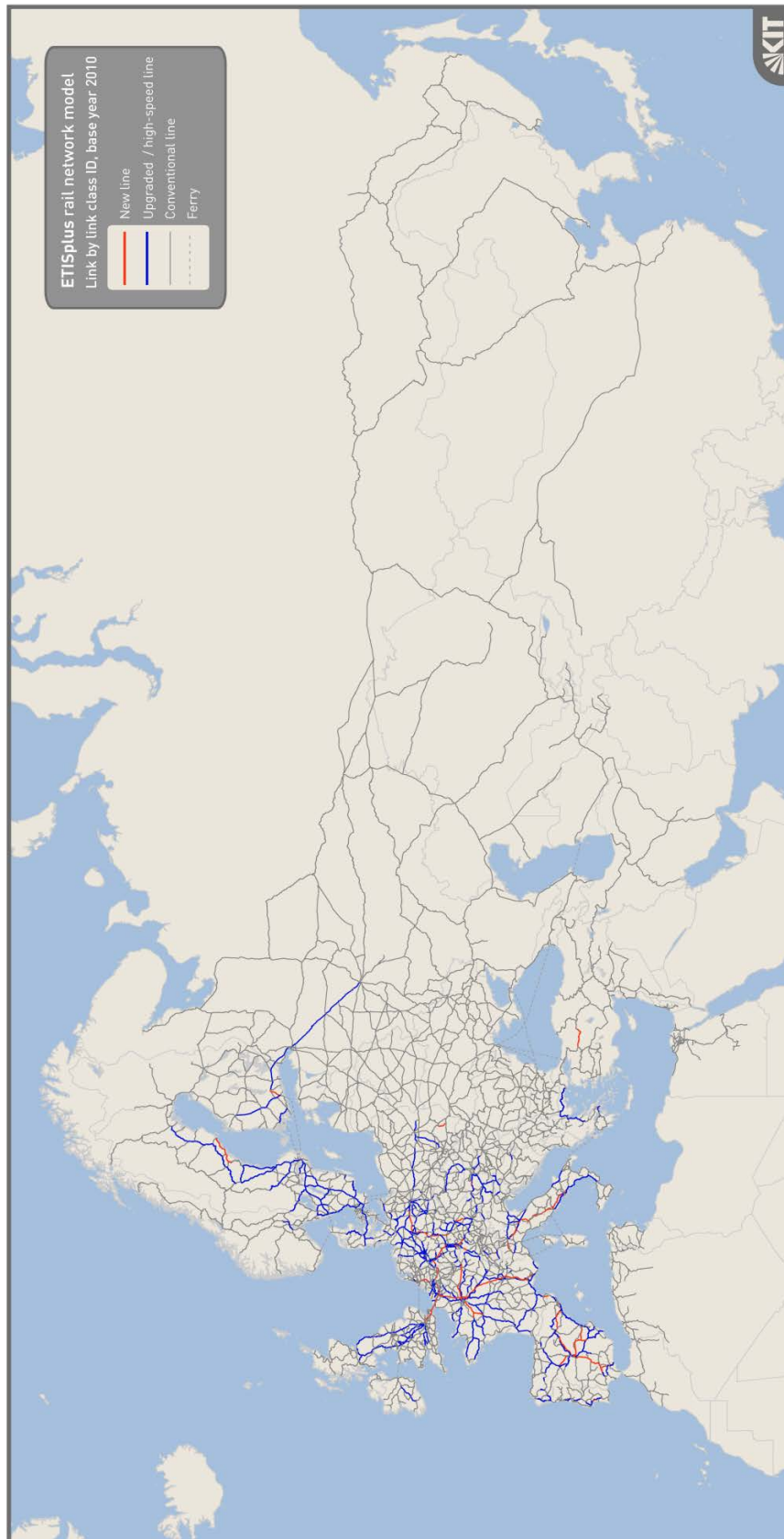


Figure 6-10: ETISplus rail network model – availability of traffic count data



Table 6-10: Traffic count data – type of data sources used

Country	Data sources implemented			Notes
	National Sources	Timetable	TENtec	
EU27 countries				
Austria			x	
Bulgaria	x			
Czech Republic			x	base year 2009
Denmark			x	freight traffic only
Estonia	x			
Finland	x			
Greece		x		passenger traffic only
Hungary			x	
Ireland			x	
Italy			x	base year 2009
Latvia				
Lithuania				base year 2009
Luxembourg			x	passenger traffic only
Netherlands	x			
Poland	x			
Portugal	x			
Romania		x		passenger traffic only
Slovakia			x	base year 2009
Slovenia			x	base year 2009
Sweden	x			base year 2009
Candidate countries & EFTA				
Croatia		x		passenger traffic only
FYR Macedonia		x		passenger traffic only, base year 2011
Serbia		x		passenger traffic only
Neighbouring countries				
Moldavia		x		passenger traffic only

Table 6-11: Traffic count data – implemented indicators by country

	Pass	Freight	PassVeh	FreightVeh
EU27 countries				
Austria			x	x
Bulgaria			x	
Czech Republic	x	x	x	x
Denmark		x		
Estonia			x	x
Finland	x	x		
Greece			x	
Hungary	x	x	x	
Ireland	x	x		
Italy	x	x	x	x
Latvia	x	x	x	x
Lithuania	x	x	x	x
Luxembourg	x			
Netherlands			x	x
Poland			x	x
Portugal			x	x
Romania			x	
Slovakia			x	x
Slovenia	x	x	x	x
Spain				
Sweden			x	x
Candidate countries & EFTA				
Croatia			x	
FYR Macedonia			x	
Serbia			x	
Neighbouring countries				
Moldavia			x	

Figure 6-11: ETISplus rail network model – gauges

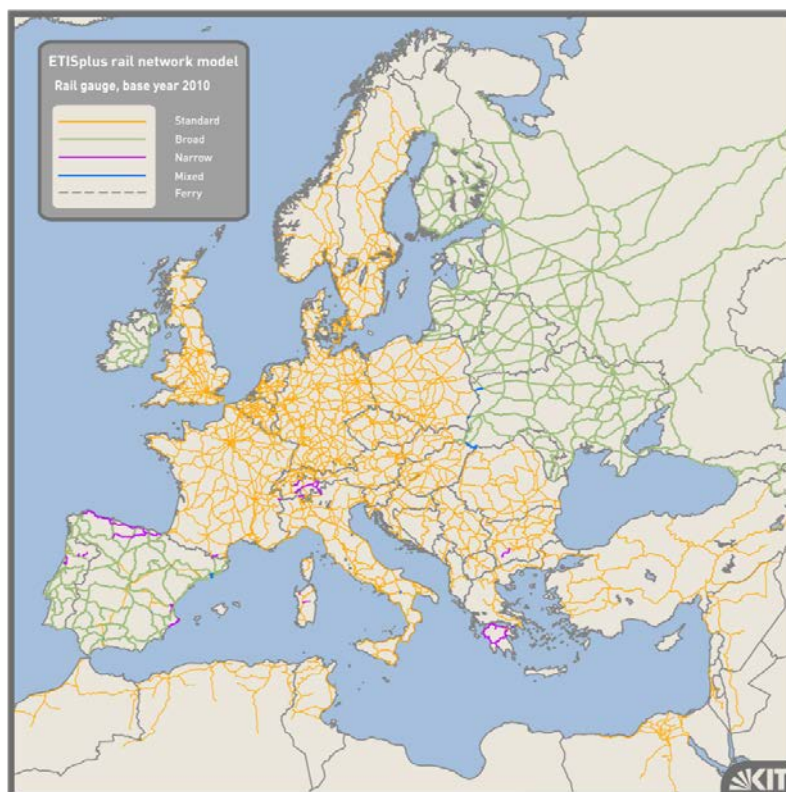


Figure 6-12: ETISplus rail network model – maximum speeds (passenger trains)

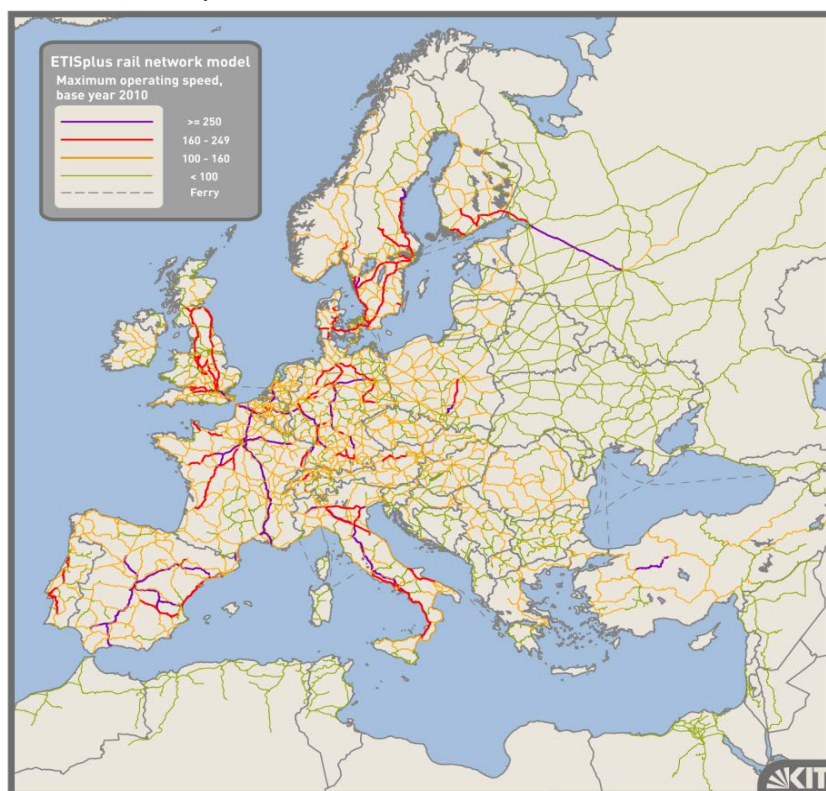


Figure 6-13: ETISplus rail network model – scope of links with long-distance train services



6.5 References

European Commission (2010): Implementation Report on the TEN-T Guidelines, OMC-exercise: Glossary - FINAL 1, DG MOVE, Directorate B - Trans-European transport networks & Smart transport, Brussels.

EEA (2011): CORINE Land Cover Data, version 15 (08/ 2011), owned by the European Environment Agency (EEA), processed by the European Topic Centre on Land Use and Spatial Information.

<http://www.eea.europa.eu/data-and-maps/data/corine-land-cover-2006-raster-1>

Documentation of the TRANS-TOOLS model version v1:
<http://www.trafficanalyst.dk/transtools/DataModel/index.htm>

EWS (1997): Forschungsgesellschaft für Strassen- und Verkehrswesen, Arbeitsgruppe Verkehrsplanung (1997): Empfehlungen für Wirtschaftlichkeitsuntersuchungen an Straßen, EWS, Aktualisierung der RAS-W 86, Köln: Forschungsgesellschaft für Strassen- und Verkehrswesen.

Openstreetmap (2010, 2011, 2012): Data available on following website:
<http://www.openstreetmap.org>

Szimba, E. and Kraft, M. (2012): Road network, base year 2005, Annex report B1, ETISplus D6 Database Manual: Networks, determinants and indicator database construction (WP 7), June 2012, Karlsruhe.

7 Waterway Network

In this section we describe the inputs, outputs and methodology for the construction of the ETISplus inland waterway network.

7.1 Scope of the Database

The waterway network includes the main navigable waterways in Europe, categorised by their CEMT classes, indicating the size and configuration of vessel that can use any given link. It includes regions such as the UK which were not included in previous TRANS-TOOLS networks.

Table 7-1: Overview of main characteristics of the data set

Waterway network							
Data feature	Data specification					Remarks	
Base year	2010					Differences between base year 2005 and base year 2010 concern cosmetic improvements (alignments)	
Scope of data	Link	Terminal	O/D relation	Region	Other		
	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
GIS data	Yes	No					
	<input checked="" type="checkbox"/>	<input type="checkbox"/>					
Country coverage					Com-pletely	Par-tially	Breakdown of the 24 covered countries: 18 countries of EU27, 1 of EFTA, 3 of Candidate countries and potential candidates, 2 of TRACECA countries
	EU 27				<input checked="" type="checkbox"/>	<input type="checkbox"/>	
	Candidate countries & EFTA				<input checked="" type="checkbox"/>	<input type="checkbox"/>	
	Neighbouring countries				<input checked="" type="checkbox"/>	<input type="checkbox"/>	
	TRACECA				<input type="checkbox"/>	<input checked="" type="checkbox"/>	
	MEDA				<input type="checkbox"/>	<input type="checkbox"/>	
	Other countries				<input type="checkbox"/>	<input type="checkbox"/>	
	Total number of countries covered:				24		
Main data sources	GIS: ETIS inland waterways network JPEG: European waterways map (Promotie Binnenvaart Vlaanderen) JPEG: Wasserstrassenkarte Donau (Via Donau)					Sources for national detail are mentioned in chapter 2	
Main type of data generation	Observed	<input checked="" type="checkbox"/>				Location and characteristics per link are observed data. For link counts, observed data if link load statistics are/were available; estimated/modelled if only counts at locks were available (applicable for NL, part of DE and BE).	
	Harmonised	<input checked="" type="checkbox"/>					
	Modelled	<input checked="" type="checkbox"/>					

The structure of the network attributes is shown below.

Table 7-2: Data structure of the waterway network

Indicator	Description of indicator	Unit	Not Applicable
ID	A unique identifier for each link		
FREESPEEDFREIGHT	Average free-flow speed	Km/Hour	
ACTIVE	Indicates whether the link is included in the calculations or not (1=active, 0=inactive)		
LENGTH	Length of link (Km)	Km	
CLASS	Ship type (CEMT class multiplied with 10 i.e. 10-60)	See below	
COUNTRY	The country which the link is located in		
TrafficCountFreightTonnes	Number of tonnes carried per year	Tonnes	
TrafficCountFreightVessels	Number of freight vessels per year	Vessels	

Coding for the CEMT classes is shown in the following table.

Table 7-3: CEMT Class Codes in ETISplus waterway network.

10=CEMT Class 1
20=CEMT Class 2
30=CEMT Class 3
40=CEMT Class 4
50=CEMT Class 5a or 5b
60=CEMT Class 6a,6b,6c
70=CEMT Class 7
0 = Unknown or Not applicable

The objective has been to build a new network suitable for either a GIS system or for a model, rather than modifying the waterway network from TRANSTOOLS v1 or v2. Therefore the following fields which are conventionally included in TRANSTOOLS were dropped. The reasons are given. All links can be treated as bi-directional.

Table 7-4: TRANSTOOLS attributes excluded from waterway network.

Indicator	Description of indicator	Unit
A	From node for the link	Auto-generated field
B	To node for the link	Auto-generated field
OPENFOR	Indicates whether the link is open or not in the forward direction (from node to node) (0=closed, 1=open)	Not relevant
OPENBACK	Indicates whether the link is open or not in the backward direction (to node to from node) (0=closed, 1=open)	Not relevant
QUEUESPEED	-1, not applicable	Not relevant
LANESFOR	1, not applicable	Not relevant
LANESBACK	1, not applicable	Not relevant
LANEHCFOR	-1, not applicable	Not relevant
LANEHCBACK	-1, not applicable	Not relevant

Indicator	Description of indicator	Unit
LINKTYPEID	1, only one link type used	Not needed
LINKTIME		Duplication
COSTSPEED	Speed on the link (km/Hour)	Km/hour
SHAPE_LENGTH		Auto-generated

7.2 Data Sources

This section gives an overview of all available and used data for the revision of the inland waterway network. Two main types of information were collected:

- Location of the inland waterway links and their characteristics
- Tonnes per link

To refine the shape of the waterway links and to add the missing links, two images and one GIS database were used. The “sources” refer to the inputs listed in section 7.2.1.

- European waterways map [source 1],
- Wasserstrassenkarte [source 2] and,
- GIS data from PLATINA project¹.

The European Waterways map gives a view of inland waterways with CEMT class information. For the Danube stretch the Wasserstrassenkarte presents a detailed map with CEMT class information. Especially for the Serbian waterways (Danube-Tisa-Danube hydro system), this map gives more detail than the European Waterways map. The GIS data from PLATINA is used for adding waterways in Finland, Sweden and Portugal.

For data on link level such as the length of the links used for freight transport, national statistical information has been collected. These are described underneath:

UK Department for Transport data gives detailed information about waterway characteristics (

- Table 7-5) in “2007 benchmark data” [source 3].
- For Italy the website of AIPO (Agenzia Interregionale per il fiume Po - Interregional Agency for the Po River) gives distance and CEMT class information per stretch. The list per waterway section is given in Table 7-6.
- Portugal has one stretch of inland waterway, the Douro river, 210km in length, which flows out at Porto [source 13].
- Distance information on two Moldovan rivers are given in a publication “Transportation” of MIEPO (Moldovan Investment and Export Promotion Organisation) [14]. The river Prut, which connects to the Danube and the Dniestr, which connects to the Black Sea through Ukraine, are considered.

¹ PLATINA: Platform for the implementation of NAIADES – WP5 Infrastructure

- Belgian [source 15] and Finnish [source 16] information are used for validation.

For the link counts information, the results from the PLATINA project are used. On behalf of PLATINA, data on link level were collected and processed by:

- Via Donau (Danube)
- VNF (French Waterways)
- Promotie Binnenvaart Vlaanderen (Belgian Waterways)
- NEA (Dutch Waterways)

PLATINA gives detailed traffic volume data in shipped tonnes per waterway link as the sum of both directions in GIS format. Currently (September 2011), the numbers of freight vessels are not included.

Table 7-5: UK waterways information

<i>Indicator</i>	<i>Description</i>
Navigation	
From	Name of the city/ lock / quay
To	Name of the city/ lock / quay
Authority	Navigation authority
Ownership	Type of authority
Distance (km)	Length of particular waterway section (km)
Length (m)	Maximum length of craft accepted (metres - nominal)
Beam (m)	Maximum beam of craft accepted (metres - nominal)
Draft (m)	Maximum draft of craft accepted (metres - nominal)
Air Draft (m)	Maximum airdraft of craft accepted (metres - nominal)
Type	Whether tidal, estuarial or locked
ECMT Classification	CEMT classification
MDS Classification	MDS Transmodal classification
Freight Use	Yes/No
Km In Use	Length of the particular section in freight-carrying use (km)
Government Office Region	

Source: DfT, *Waterway Inventory*, 2007

Table 7-6: Italian waterways information

<i>Section</i>	<i>km</i>	<i>CEMT</i>	<i>Source</i>
1. Po da Casal Monferrato a foce Ticino	65	-	[5]
2. Po da foce Ticino a mare	389	-	
3. fiume Ticino da Pavia alla confluenza con ilPo	7	-	
4. fiume Mincio da Mantova alla confluenza con ilPo	21	IV	[6]
5. Canale Po - Brondolo (Chioggia)	19	IV	[7]
6. Idrovia Fissero – Tartaro – Bianco - Po di Levante	135	Va	[8]
7. Idrovia Litoranea Veneta: da Portegrandi a foce Isonzo	130	II	[9]
8. Canale Milano - Cremona	66.5	V	[10]
9. Idrovia Ferrara - Ravenna (Idrovia Ferrarese estesa)	87	IV	[11]
10. Canale Padova - Venezia	28	IVa and Va	[12]

7.2.1 Links to Data sources

Maps:

¹ http://binnenvaart.be/nl/waterwegen/kaart_europa.html
² http://www.donauschiffahrt.info/fileadmin/group_upload/7/Daten_und_Fakten/Verkehrswege_Donau/Wasserstrasse_300dpi_neu.jpg

Other National Statistics and information:

UK:
³ http://www.dft.gov.uk/excel/173025/221412/221658/347057/benchmarkdata07.xls
⁴ http://www2.dft.gov.uk/adobepdf/162469/221412/221658/223742/waterbornefreight09.pdf
Italia:
⁵ http://www.arni.it/attivita/casale_ticino.htm
⁶ http://www.arni.it/attivita/mantova_po.htm
⁷ http://www.arni.it/attivita/brondolo.htm
⁸ http://www.provincia.mantova.it/UploadDocs/4494_Mantova_Masterplan15_10_10_2.pdf
⁹ http://www.arni.it/attivita/litoranea.htm
¹⁰ http://www.arni.it/attivita/milano_cremona.htm
¹¹ http://www.arni.it/attivita/idro_ferrarese.htm
¹² http://www.atenanazionale.it/convegni/galvani.pdf
Portugal:
¹³ http://www.portugal.alloexpat.com/portugal_information/transportes_portugal.php?page=0%2C1

Moldova:
¹⁴ http://www.miepo.md/public/files/Publicatii/Transportation.pdf
Belgium:
¹⁵ http://binnenvaart.be/nl/waterwegen/kaart_sluizen.html
Finland:
¹⁶ http://www.shortsea.fi/demo/images/pdf/spc-facts-08.pdf

7.3 Methodology

The update of the inland waterway network was done in two steps:

1. Activity in 2011 (as part of 2005 data activity): Addition of missing links and update of the inland waterway characteristics and counts
2. Activity in 2012 (as part of 2010 data activity): Improvements regarding waterway alignments

7.3.1 Step 1: Addition of waterway links and update on characteristics

In the first step, the locations of the waterway links have been manually edited, and missing links have been added.

Three main attributes of the links have been added:

- CEMT classification
- Length
- Counts in shipped tonnes

Input:

GIS data of inland waterways from ETIS-BASE¹ as used in TransTools II
Collected data as described in previous section.

Output:

GIS data with structure defined in Table 7-2 including the non-applicable variables.

Three maps were used to refine the shape of the waterway links and to add the missing links to the GIS layer: European waterways map [1], Wasserstrassenkarte [2] and the GIS data from the PLATINA project.

¹ ETIS-BASE: <http://www.iccr-international.org/etis/base/index.html>

The waterway links in UK and Italy have been added to the GIS layer according to the European Waterways map. The Polish waterway stretches have been corrected. Furthermore the CEMT classification has been checked manually.

For the Danube stretch the Wasserstrassenkarte was used to add or align the waterway links. The waterway links in Ukraine and Moldova have been added. For the Serbian waterways more details on the Danube-Tisa-Danube hydro system are now incorporated.

According to the inland waterway network from the PLATINA the waterway links in Finland, Sweden and Portugal are added. The update of the three attributes were processed manually.

7.3.2 Step 2: Improvement of link alignment

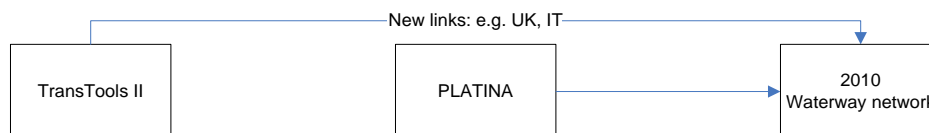
While the first stage of network construction dealt with adding missing inland waterway links to the inherited network structure, the second step was then to improve the network alignment using GIS data from the PLATINA project.

Input:
 GIS data of inland waterways from 2011 update
 GIS data from PLATINA project

Output:
 GIS data with structure defined in Table 7-2 excluding the non-applicable variables (remaining number of variables: 8)

It was not possible to incorporate the GIS resources directly from PLATINA because it was not constructed to function as a modelling network. Therefore only certain attributes were referenced from PLATINA, and added to the structure which had been developed for TRANSTOOLS.

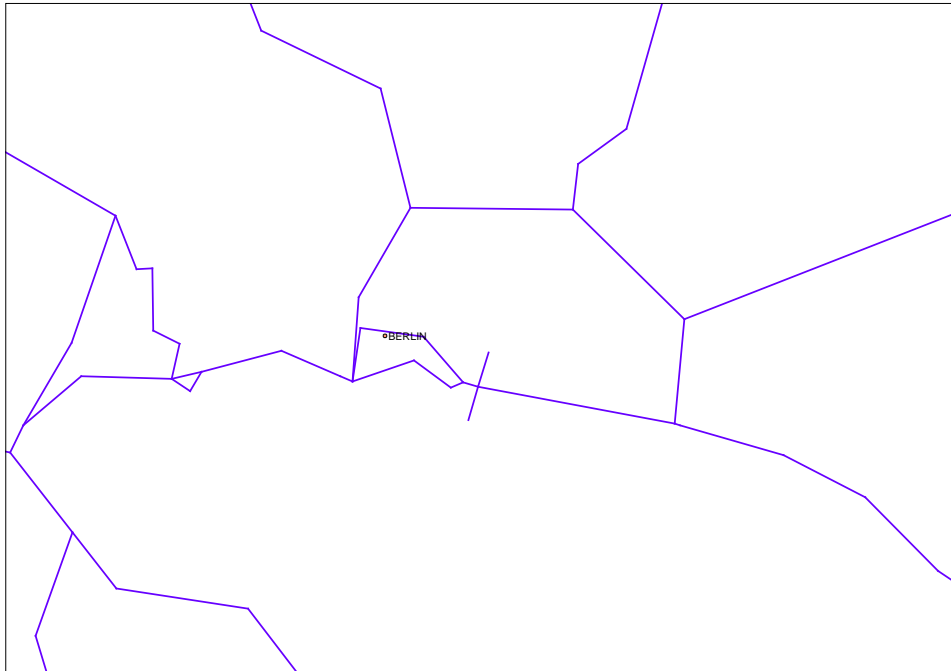
Figure 7-1: Network Construction; Flow Chart



An example of this step is shown in Figure 7-2., waterways of Berlin.

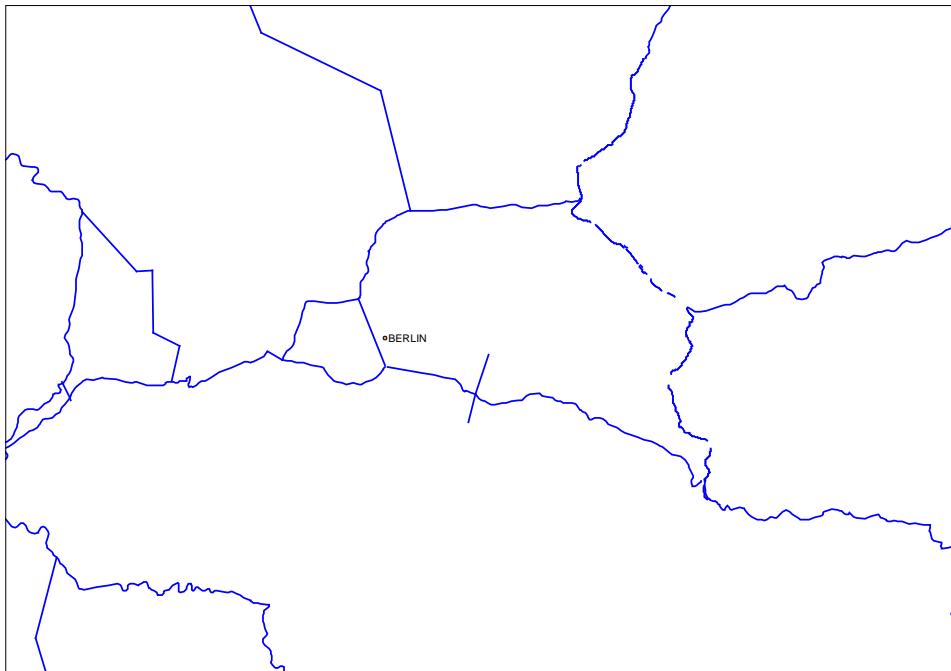
In the first stage of editing (Figure 7-2), the links are connected to form a network but the alignment of the links is only schematic.

Figure 7-2: Inland waterway Networks –Berlin; First Stage of Editing



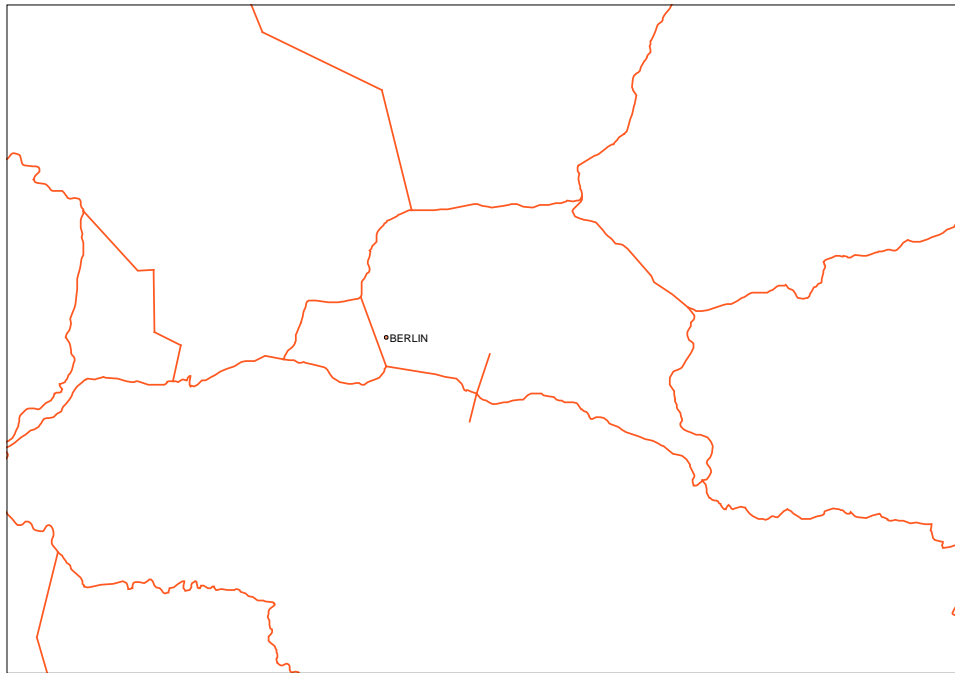
By comparison, the PLATINA network (see Figure 7-3) shows better alignment, but the links are not connected, making them unsuitable for use in a transport model.

Figure 7-3: PLATINA Inland waterway networks



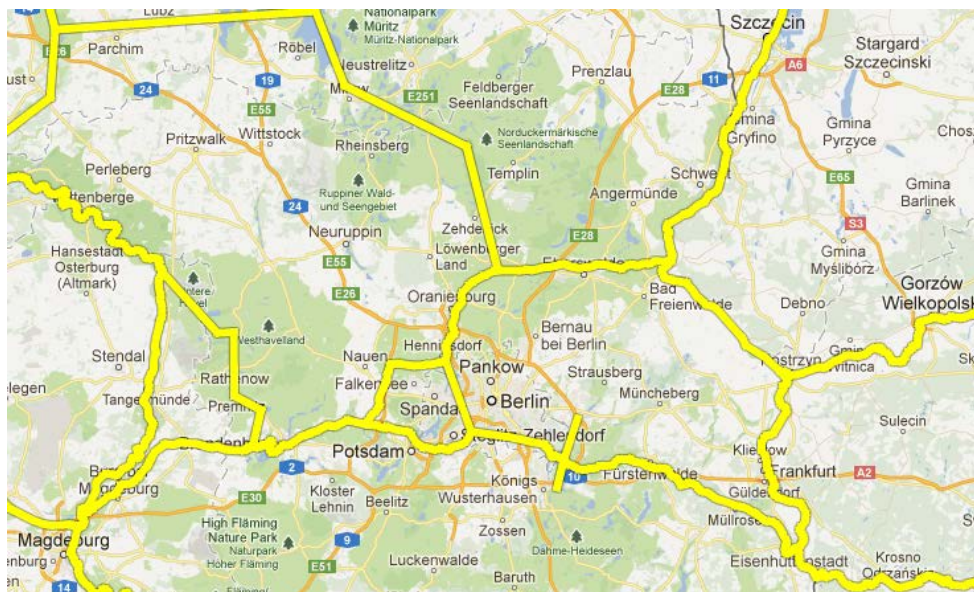
After the second step of editing, the previous schematic networks have been re-drawn to become aligned more realistically, while still functioning as a connected modelling network.

Figure 7-4: Final ETISplus Network; after Step 2.



These improvements can be clearly seen using the ETIS-Netter, where the links are projected onto the Google Maps background.

Figure 7-5: Overlay of ETIS Waterway Network on Google Maps, using ETIS-Netter.



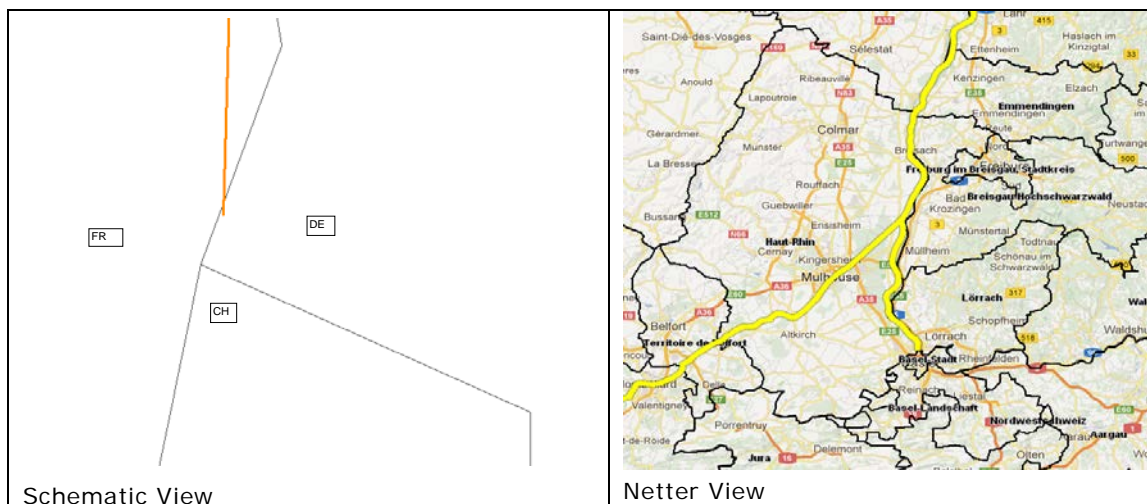
One of the issues arising from this manual construction method was that many of the waterway links were in excess of 80km. Thus, a link might pass through an entire region without having a node or access point in the region. For calculating accessibility from a region or from a terminal, this could distort the results. Therefore the longer links were re-segmented according to:

- Terminal location (nodes should be close to terminals)
- Region borders (to ensure that every region intersected by the network has at least one waterway node)

One particular issue for waterway networks is that rivers often mark administrative borders, so that there is not necessarily a straightforward one-to-one relationship between a link and a region.

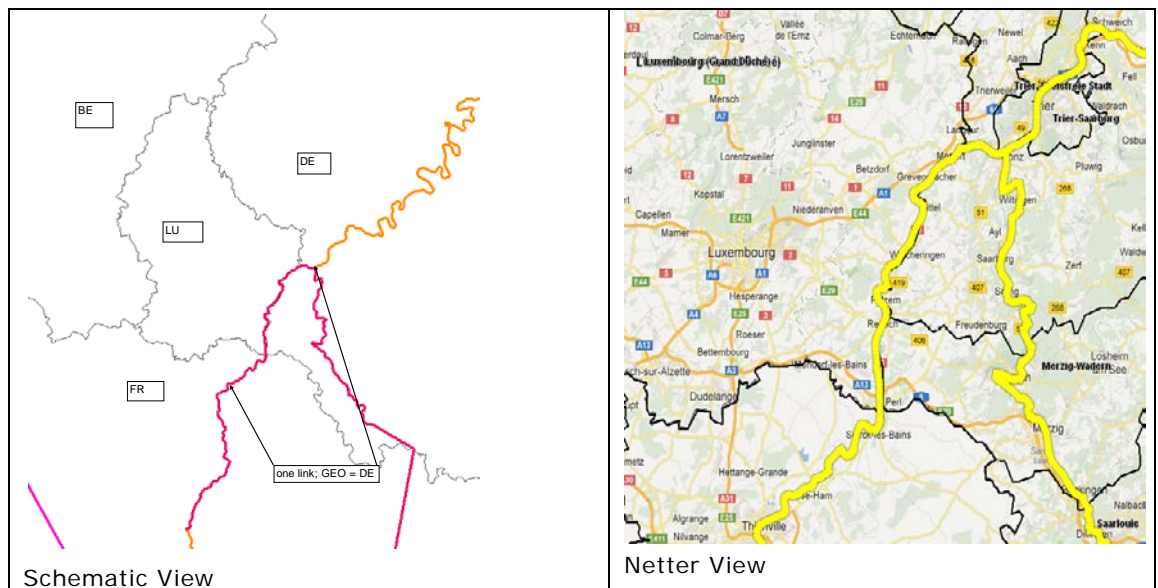
In the case of the Rijn near Basel, it forms the border between Haut Rhin (FR), Lorrach (DE) and Basel Stadt (CH). The network is drawn in such a way that the final node is still 200 metres away from the Swiss border. See Figure 7-6.

Figure 7-6: Waterway connections near Basel



In a second case near Luxembourg, there is a link of 59km starting in France, and finishing in Germany, passing along the border of Luxembourg (Figure 7-7). It is therefore necessary to ensure that estimations of transport volumes by country take into consideration that the association of a link with a country or region may be ambiguous.

Figure 7-7: Waterway network near Luxembourg



7.4 Results

Data can be obtained via the following online links.

Table 7-7: Key Results: Full Network in SHP Format

Access via	Location	Folder	Description
ETIS Bulk Download	Data Bulk Downloads ETIS Data	Additional data Resources	Water network as SHP and MIF/MID (MapInfo) formats.
2010	http://www.etisplus.eu/data/Public/Downloads.aspx Additional data resources: Land_networks_2005_2010.zip ETISplus_water_network_3_0_final_2010.zip (both MapInfo and ESRI formats) <i>(There is no additional data available in the earlier version of the network)</i>		

Table 7-8: Key Results: Editable Online Network

Access via	Location	Toolbar	Description
ETIS NETTER	http://netter.etisplus.net/	Network - Link - Inland Waterway	2010 Waterway network as Editable GIS layer.

The initial ETIS-BASE (TRANSTOOLS v1) network is shown below.

Figure 7-8: Inland waterway Network – ETIS-BASE



Source: ETIS - BASE

After the first stage of editing, the network was extended, but the alignment was still simplified in places.

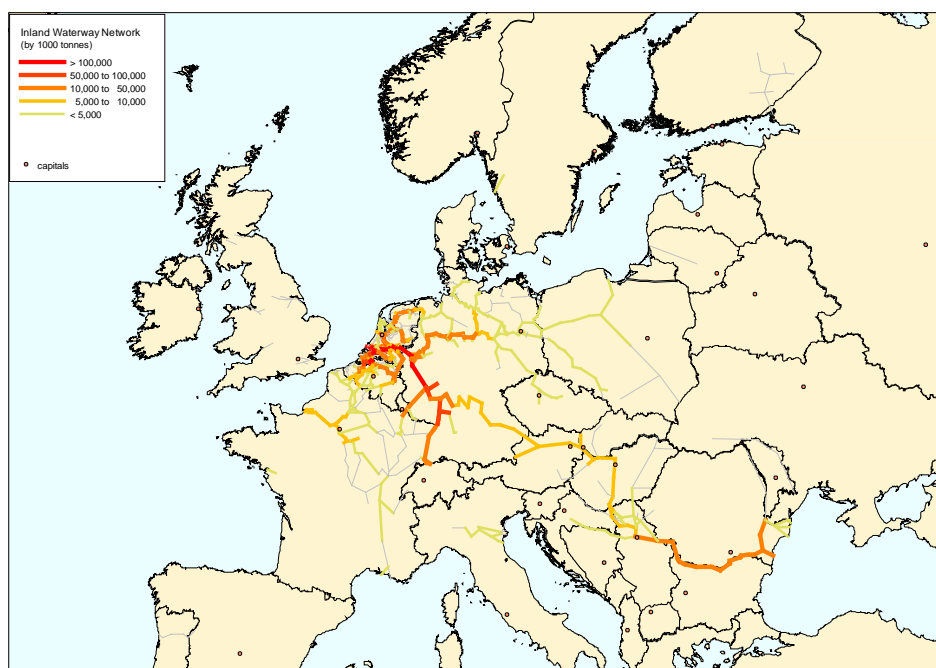
Figure 7-9: Inland waterway Network – after first stage of updating.



Source: ETISplus

Traffic counts have been added.

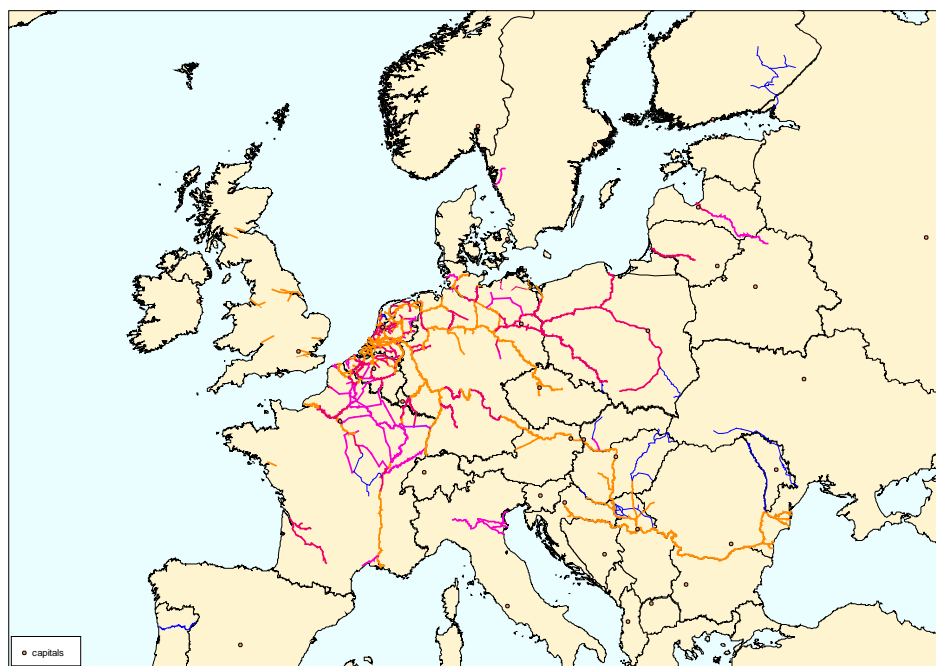
Figure 7-10: Tonnes transported by inland waterways - 2007



Source: ETISplus

In 2012, the network link alignment was radically improved, and the attributes completed.

Figure 7-11: Inland waterway Network – after 2012 activity: per CEMT class



Source: ETISplus



8 Air Network

8.1 Scope of the Database

The infrastructure of air transport does not consist of links like highways or railway lines as in the modes road and rail but of nodes (airports), which – in principle – can all be connected to each other directly. In addition there are several types of ‘flights’ carrying cargo and/or passengers and finally it has to be noted that air transport is an intermodal type of transport and therefore the aviation infrastructure has to be linked to the land based modes which is considered by the main access/egress mode of truck transport for cargo while for passenger transport road as well as rail feeders were considered.

This annex deals with the links representing flights between the airports. The main characteristics of the air network database are summarised in Table 8-1, while their contents are listed in Table 8-2 and Table 8-3.

Table 8-1: Overview of main characteristics of the data set

Air network																														
Data feature	Data specification					Remarks																								
Base year	2010																													
Scope of data	Link	Terminal	O/D relation	Region	Other																									
	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>																									
GIS data	Yes	No																												
	<input checked="" type="checkbox"/>	<input type="checkbox"/>																												
Country coverage	<table><thead><tr><th></th><th>Com-pletely</th><th>Par-tially</th></tr></thead><tbody><tr><td>EU 27</td><td><input checked="" type="checkbox"/></td><td><input type="checkbox"/></td></tr><tr><td>Candidate countries & EFTA</td><td><input checked="" type="checkbox"/></td><td><input type="checkbox"/></td></tr><tr><td>Neighbouring countries</td><td><input checked="" type="checkbox"/></td><td><input type="checkbox"/></td></tr><tr><td>TRACECA</td><td><input type="checkbox"/></td><td><input checked="" type="checkbox"/></td></tr><tr><td>MEDA</td><td><input type="checkbox"/></td><td><input checked="" type="checkbox"/></td></tr><tr><td>Other countries</td><td><input type="checkbox"/></td><td><input checked="" type="checkbox"/></td></tr><tr><td>Total number of countries covered:</td><td>68</td><td>167</td></tr></tbody></table>						Com-pletely	Par-tially	EU 27	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Candidate countries & EFTA	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Neighbouring countries	<input checked="" type="checkbox"/>	<input type="checkbox"/>	TRACECA	<input type="checkbox"/>	<input checked="" type="checkbox"/>	MEDA	<input type="checkbox"/>	<input checked="" type="checkbox"/>	Other countries	<input type="checkbox"/>	<input checked="" type="checkbox"/>	Total number of countries covered:	68	167	Regions equipped with an own ISO Country Code (e.g. Hong Kong, HK) are counted separately. Countries without airports (e.g. Andorra) are covered by linkage to the next available airports.
	Com-pletely	Par-tially																												
EU 27	<input checked="" type="checkbox"/>	<input type="checkbox"/>																												
Candidate countries & EFTA	<input checked="" type="checkbox"/>	<input type="checkbox"/>																												
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Other countries	<input type="checkbox"/>	<input checked="" type="checkbox"/>																												
Total number of countries covered:	68	167																												
Main data sources	Aggregation and analysis of web sites of airports, airlines and tour operators, OAG Max, (www.oagmax.com) and HAFAS Flugplan (www.flugplan.de), EUROSTAT air transport statistics.																													
Main type of data generation	Observed	<input checked="" type="checkbox"/>				Depending on the attribute, all types of data generation have been applied.																								
	Harminised	<input checked="" type="checkbox"/>																												
	Modelled	<input checked="" type="checkbox"/>																												

Table 8-2: Data structure of the air network data set, part 1

Indicator	Description of indicator	Unit
DATA_GROUP	Metadata on dataset level, since the DB-system only supports metadata on table level. Observed, estimated, modelled data	
SOURCE	Metadata on dataset level, since the DB-system only supports metadata on table level. Observed, estimated, modelled data	
FROMDATE	Metadata on dataset level, effective in time range; YEAR or period Fromdate, Todate , e.g. Fromdate 20100101, todate20101231 is preferred	
TODATE	Metadata on dataset level, effective in time range; YEAR or period Fromdate, Todate , e.g. Fromdate 20090101, todate20091231 is preferred	
SEASON	Metadata on dataset level, effective in time range; WINTER SUMMER ALL; so that this information need not be deduced by client programs	
ID	Unique identifier	
FromNodeID	FromNode of the link	
ToNodeID	ToNode of the link	
OpenFor	Indicates whether link is open or not in the forward direction (FromNode to ToNode)	
OpenBack	Indicates whether link is open or not in the backward direction (ToNode to FromNode)	
FreeSpeed	1, not applicable	
QueueSpeed	1, not applicable	
LanesFor	1, not applicable	
LanesBack	1, not applicable	
LinkTypeID	Linktype of the link	
LaneHCFor	-1, not applicable	
LaneHCBack	-1, not applicable	
Active	Indicates whether the link is active or not	
Length	Distance	km
Orig	IATA code of origin airport	
OrigName	Origin airport name	
Dest	IATA code of destination airport	
DestName	Destination airport name	

Table 8-3: Data structure of the air network data set, part 2

Indicator	Description of indicator	Unit
CostB	Ticket fare (business trips)	€
CostP	Ticket fare (private trips)	€
CostH	Ticket fare (vacation trips)	€
LinkTime	Flight time on link	minutes
TransferTime	Extra transfer time on link	minutes
TotalTravelTime	Total travel time	minutes
AnnualDepart	Number of flights per year	
DailyDepart	Number of flights per day	
HeadwayTime	Calculated based on Daily_Depart as: HeadwayTime = $\lceil 2 * (20 / \text{Daily_Depart}) * 60 \rceil$. Minimum 60 minutes and maximum 240 minutes	minutes
LinkClass	Network type (FLC = Flight connection, ETR= External transfer between nearby airports)	
LowCost	Share of low cost connections	%
Transfer1Node	Transfer1node of the link	
Transfer2Node	Transfer2node of the link	
Transfer1	Transfer 1	
Transfer2	Transfer 2	
FrequencyPax	Frequency passenger	connections/week
FrequencyCargo	Frequency cargo	connections/week

The format of the network is oriented as close as possible to the common format of the TRANSTOOLS networks for all modes. This implies – similar to the air network of TRANSTOOLS – that there are a number of attributes which are not applicable for air transport.

8.1.1 Link attributes

The field “DATA_GROUP” informs, if an air-link belongs to (O)bserved, (M)odelled or (E)stimated data. All links which exclusively consist of observed nonstop flights from officially published schedules are indicated with an “O” in this field. Air-links for which existing statistic information on the number of passengers or volume of cargo carried exceeded the capacity available on published flights for that link were enriched by additional flights in line with the statistic values. This air-links are indicated with “M” in the DATA_GROUP field. Finally all air-links consisting of transfer connections of two or more air-links are indicated with “E” in the “DATA_GROUP” field.

The “SOURCE” field differentiates between (O)bserved and (M)odelled sources. Air-links consisting fully of nonstop flights from official schedules in this field come with an “O”, while all other air-links are indicated with an “M”.

The "FROMDATE", "TODATE" and the "SEASON" fields indicate the time period for which these links are valid. As the air network for the year 2010 bases on a representative week for the whole year, in consequence for all links "FROMDATE" is 20100101 and "TODATE" is 20101231, while the value in the "SEASON" field is "ALL".

The attributes "ID", "FromNodeID" and "ToNodeID" relate to the network topology. "FromNodeID" and "ToNodeID" refer to the node connecting two links. The attributes "FromNodeID" and "ToNodeID" contain information on the unique identifier of the nodes a link is connected to. These two entries are directly taken from air terminals data set described in Annex report C3_2010, while "Id" has been generated automatically and is a unique number for every link.

The "OpenFor" and "OpenBack" fields indicate, whether the link is open or not in the directions mentioned. As those links forming the air network representing flights may have different times and other attributes varying from the direction of travel, these air-links in principle are oneway links, meaning the "OpenFor" field has the value 1 and the "OpenBack" field the value 0. Only those links representing transfer connections between nearby situated airports (e.g. like between all airports on London, United Kingdom) by surface transport have the value 1 for both directions. Also the field "Active" has the same value: "1" on all links, as not existing links in 2010 are not reflected in the data base at all.

The Field "LinkTypeId" comes with three different entries: "cargo", "pax" and "both". Air-links available only for passenger transport – which applies when at least one segment of the flight path covered bases exclusively on flights with a cargo capacity of 0 tonnes, are marked with "pax", while air-links available only for cargo transport – which applies when at least one segment of the flight path covered bases on exclusively flights with a passenger capacity of 0 seats, are marked with "cargo". In consequence the value "both" marks air-links, basing on flights for which a passenger and as well a cargo capacity > 0 applies.

The field "Length" contains the flight distance in kilometres of the links' flight path between the airport of origin and destination and – for air-links representing an air travel requiring plane transfer at intermediate airports – the airports in between. This distance indicated is the great-circle distance¹. Detours which may apply on some routes due to missing overflight rights for distinct countries or parts of them, the compulsory usage of defined airways, for complying with ETOPS² rules, etc. are not considered. The calculation bases on the geographic co-ordinates for the airports which are indicated in the air terminals data set described in Annex report C3_2010. Also the fields "Orig", "OrigName", "Dest", "DestName" contain information directly taken from this annex to identify the airports forming the specific air-link. "Orig" and "Dest" refer to the official Three-Letter-Codes defined for each airport by IATA³. The airport names are taken from the web sites of airports and HAFAS flight schedule source.

¹ See http://en.wikipedia.org/wiki/Great_circle_distance for details and calculation formula

² <http://en.wikipedia.org/wiki/ETOPS>

³ http://en.wikipedia.org/wiki/IATA_airport_codes

Cost attributes "CostB", "CostP" and "CostH". These attributes indicate the average price to be paid by a passenger to get from the airport mentioned with "Orig" / "OrigName" to the airport mentioned by "Dest" / "DestName" either on a nonstop flight or on a flight connection with transfers in the airport(s) mentioned with "Transfer1Node" (and "Transfer2Node") – if applicable. The costs vary with the trip purpose: "CostB" indicates the price for passengers travelling for business reasons, which does not mean that those passengers necessarily all use business class. "CostP" indicates the price for passengers travelling for private reasons with a total duration of the trip not exceeding four days and "CostH" shows the price for passengers travelling on private reasons on trips with a longer duration than four days. The prices are modelled and base on a tariff function developed with information received from passenger surveys and adjusted by exemplary observations on booking engines. Within the calibration process which is part of the generation of the air passenger matrix these prices are modified slightly to correct for data errors.

Concerning the travel-time when using a link, the data base has three fields: "LinkTime", "TransferTime" and the sum of both "TotalTime". For air-links all three values base on the schedules of published flights and the connections possible between them. "TotalTime" refers to the duration between the scheduled departing time of an aircraft at the airport of origin between the scheduled arrival time on the airport of destination and includes the necessary transfer time applying for plane change(s) at intermediate airport(s) – if applicable. "TransferTime" indicates the time spent outside of aircrafts at intermediate airports for the purpose of transferring (for passengers) or transshipment (for cargo) between flights. An indication of 0 minutes for "TransferTime" means that the link bases on direct flights between the airport of origin and the airport of destination, without the necessity of changing aircrafts. Note, that these direct flights not necessarily have to be nonstop-flights, also in cases, where the aircraft makes one or more stops at intermediate airports, the "TransferTime" is indicated as 0, as neither a passenger has to change nor cargo has to be transhipped between aircrafts. Finally "LinkTime" is the "TotalTime" minus the "TransferTime" and therefore represents the sum of the scheduled times of all segments forming a link. In consequence for all nonstop or direct flights the "LinkTime" is identical to the "TotalTime". Note that for external links (by surface transport between airports situated nearby) "TotalTime" indicates the amount of time, airlines suggest to their passengers, when travelling between such airports between announced arrival time on the first airport until departure time on the second airport.

The field "AnnualDepart" indicates the number of flights available for the routing covered by the air-link. It is calculated by the number of flights per week projected on a full year. Different to that, the field "DailyDepart" indicates the number of flights available in minimum per day on the air-link. In consequence this means for a route served with six flights per week, the value for "DailyDepart" is 0, while the one for "AnnualDepart" is 312.

"HeadwayTime". This field (and the calculation formula of corresponding values) was adapted from the TRANSTOOLS network layout. It represents the average waiting time in minutes to get on a flight at the airport of origin. Its value varies

between 60 and 240 minutes and is calculated as follows:

$$2 * (20 / \text{Daily_Depart}) * 60.$$

The field "LinkClass" comes with two different entries: "FLC" marks links consisting of flights, while "ETR" marks external flights by surface transport between airports situated nearby, what mainly applies at cities, equipped with several airports (e.g. London, United Kingdom).

"Low Cost": This field indicates the share flights from low cost airlines on all flights on an air-link. The methodology section informs how airlines qualified to be considered as a low cost carrier and lists these carriers in table 8. A value of 100 indicates that an air-link exclusively has been served by low cost carriers, while 0 shows that no low costers had services there.

The fields "Transfer1Node", "Transfer2Node", "Transfer1" and "Transfer2" indicate the intermediate airports where passengers have to change planes (or cargo has to be transhipped) on the specific air-link. The first two fields show the numeric Node Id's of these airports, while the two latter indicate their IATA Three letter codes. For air-links representing nonstop or direct flights these fields in consequence show 0 or "---" respectively.

The last two fields "FrequencyPax" and "FrequencyCargo" indicate the number of services provided per week on the distinct air-link. For passenger only air-links the "FrequencyCargo" field is 0, while for cargo air-links this applies to the field "FrequencyPax". Note that both frequency fields do not need to have the same value, as air-links exist, where the number of available flights for passengers differs from the number of flights available for cargo transport.

8.2 Methodology

8.2.1 General approach

The base of the air network developed for ETISplus are the published flight schedules and air transport statistics, e.g. published by EUROSTAT. The published flight schedules root from web sites of airlines, airports and tour operators and on the sources HAFAS Flugplan (www.flugplan.de) and OAG Max (www.oagmax.com). The latter is considered as a complementary source. These sources are in principle updated daily to cope with the dynamic development of flight schedules, varying permanently, meaning the introduction or cessation of routes, changes in the times of departure and arrival, adding or cutting frequencies on distinct days of the week, shortening or increasing of flight times due to a seasonally or permanent variation of aircraft used etc. In consequence the air network as a whole and therefore the calculation of resulting flight times especially on connections where changing planes applies may vary day by day for a distinct year. It is obvious that such an air network is by far too complex to be handled by shortest path or equilibrium algorithms irrespective if dealing just with time or on generalized costs typically used in transport science with the necessary performance. Another point is that the data from commercial sources must not be made publicly available for free what is intended for all deliverables of ETISplus. For that reasons the web has been

the main source and raw schedule data have been aggregated to generate based on all data an IPR-free network. This has been done separately for the years 2005 and 2010, so that in fact the air networks for these two years are fully independent. So all steps outlined in the following sections in preparing the network have been done twice¹.

Figure 8-1: Scheme of the approach to build the air network

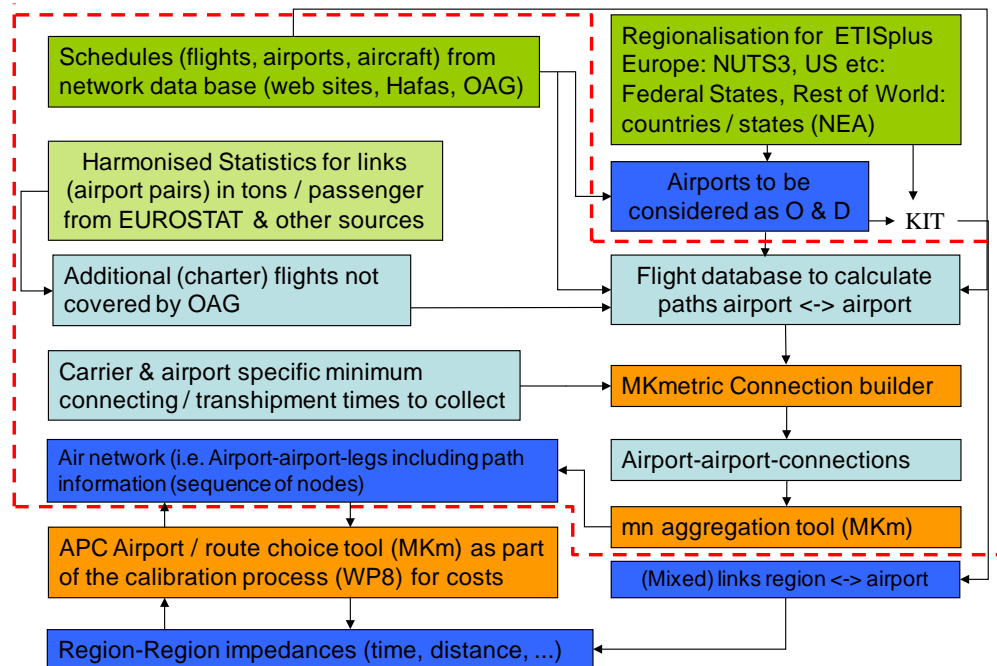


Figure Figure 8-1 summarises the approach to build the air network delivered. Green fields show external inputs (in dark when directly incorporated, in light when to be conditioned first for further usage). Blue fields show (intermediate) results and in-house tools used to build the air network come in orange. This annex for the air network covers just the steps within the red/white bordering.

8.2.2 Building the flight database

The first prerequisite for building the air network is the selection of the airports to be considered as origins and destinations for the air-links building the air network. See the Airports section of this report. Resulting from it we identified 1165 airports worldwide of which 589 are situated in Europe to be connected with air-links. This has been done commonly for both years of consideration 2005 and 2010, resulting in a common number of airports valid both years, irrespective if an airport is actually served in 2005 as well as in the year 2010.

¹ For modellers interested in detailed air transport modelling we recommend to get in contact with a commercial schedule provider to have unlimited access to their data, unless the EC will quote on the memorandum of understanding with EUROCONTROL for data exchange and the basic ATM data for network generation will be made available, which would be a major benefit for research.

All flights for the year to be considered were extracted having as origin or destination one of the 1165 airports. Including flights where only origin or destination but not both of them are among the dedicated airports allows to build transfer connections via other airports which otherwise would be missing in the air network. As it was avoided to choose more than one airport per NUTS3-Region within Europe, in some cases the chosen airport had to take over the role of representing the other(s) situated in the same region. This mainly applies for remote areas, where the NUTS3 region is quite large-scale, e.g. like in Northern Norway, where alone the region "Troms" is equipped with more than a dozen airports and which are represented in the air network by the airport of Tromsø (TOS), the largest one in this region. A similar situation is valid for the Italian island of Lampedusa. This island, administratively belonging to the region of Trapani, situated on the (much larger) island Sicily, has its own airport (LMP), but as it is smaller than the airport of Trapani (TPS), the latter one works as a representative for both. In consequence for the air network, all air-links to and from Lampedusa airport, were changed to links to and from Trapani airport in the network model. The alternative to that procedure – inventing additional regions – has found to be not feasible, as a common regionalisation for the whole project and all its components was defined by the co-ordinator and compulsory has to be used to ensure compatible work of all project partners.

8.2.3 Passenger flights

The flights retrieved from the generated schedule database to be used for passengers can be identified via the operating aircraft type and the number of seats indicated for it. This indication is given specifically per airline and aircraft type on the airlines web sites. Only flights operated by aircraft with a number of seats > 0 are considered as a passenger flight.

In a next step this database is condensed to the flights operating in a "typical" week, for which we chose the second week of June of a distinct year. This week was chosen as a representative, as the majority of vacation routes are already served at that time of the year, while on the other side temporary downgrades on routes more oriented on passengers travelling for business reasons usually materialise later (July and/or August). As there are quite a few routes operated only in winter season (e.g. those dedicated for ski holidays), those flights were transferred to the typical week in all cases where such routes originally were not served in the typical week. The same applies for routes where services were ceased before June or services introduced later in the year. In all these cases, the frequency of flights on such routes transferred was adjusted to the average integer value applying on an annual base, but keeping a minimum frequency of one flight per week. E.g. the flights of a route served six times per week from July to December, were transferred to the reference week with a frequency of three flights per week, while a ski charter route served from December to February on a weekly base, comes to the reference week also once weekly although the correct arithmetical value would be 0.25.

Although the commercial data sources mentioned cover the vast majority of commercial flights, there are quite a few commercial flights missing in them. This mainly are charter flights, to be exclusively used by the customers of tour

operators where no commercial sale by the operating airline applies. Such flights are brought into air network via tour operator web sites and by using corresponding leg statistics e.g. published by EUROSTAT or national sources. For such statistics to be considered as a source to implement additional flights a reported minimum demand of 2,000 passengers per year as sum of both directions applies. This limit was chosen to incorporate charter routes operated from smaller airports with medium sized jet aircraft on a three months seasonal base (i.e. 12 flights with about 85 passengers in average) but to exclude special charters not publically available e.g. like for sport teams applying just once or twice per year on a distinct route. The flight times and frequencies for such routes are estimated by an in-house heuristic approach taking into account the outlined demand for the route, its distance and the service structures (e.g. existing MTOW, dominating airlines and aircraft etc.) of the airports to be connected.

Finally the flight database constructed is checked whether the capacity offered on each route actually is in line with the demand mentioned for it in available air transport statistics. In cases where the statistically proved demand exceeds the offered capacity additional flights were incorporated following the heuristic approach described. For example this may occur on a popular vacation route where beside the published flights additionally numerous charter flights are operated.

8.2.4 Costs for passenger flights

Everyone who flies regularly will have realised that one is never charged the same price on a distinct route when booking a ticket. Furthermore the specific costs for flights per kilometre can vary massively not only between short-haul and long haul flights, but also between flights covering a similar distance, e.g. depending from the competitive situation of a distinct routing. But even on one route the passenger sitting next may have booked months ahead and might have took the chance of a special offer. One power of ten between the lowest and the highest available price for a trip between on distinct pair of airports often applies.

Using <http://matrix.itasoftware.com/> for an analysis of tariffs available in principle, e.g. for a routing from Frankfurt, Germany, to Tokyo, Japan, showed tariffs starting from 529,- Euro up to 7.345,- Euro for a return-ticket in economy class, depending on the carrier or combination of carriers, the routing, the duration of stay at the destination, the number of days between date of booking and date of travelling, the season, the weekday, if a weekend is included in the stay on the destination, a variation of cancellation / rebooking rules, etc. Although it has to be noted that not every carrier uses all these aspects of a trip mentioned actually for its tariff policy the spread of ticket prices furthermore increases, when taking into account, that most airlines offer tickets for business and economy class and many in addition furthermore still provide first class on long-haul flights.

Redoing the analysis using the same website on actually available tariffs for specific travel dates, shows that the minimum fares for each carrier found out in

the first analysis, are not available on every date. It is obvious, that the "starting from" prices a carrier offers are available quite rarely, depending on the booking situation for distinct flights options to be chosen by the traveller.

In addition to this officially published air fares many tickets are also sold on further reduced prices not directly from the airlines but from consolidators offering millions of tariffs often significantly discounted compared to the official tariffs. Meta search engines like <http://www.skyscanner.net> check these consolidator fares and also the official tariffs applying for a distinct route. Completely different prices apply as well when airlines negotiated a company contract. A large number of big to medium sized companies have a special agreement with airlines.

One should also have a look at the even more expensive one-way-tariffs. When taking into account this whole variation of ticket prices we end in specific costs for an airline ticket covering the route Frankfurt – Tokyo between 2.7 Cent (return-ticket in Economy class of Aeroflot via Moscow) and 93.3 Cent (one-way ticket in First class of All Nippon Airways on nonstop flights) per kilometre. And as everyone has at least heard of or maybe was even lucky to gather one of the 1 Cent + taxes tickets offered by a famous Irish low cost carrier, the range of specific costs of an airline ticket goes further down to a level of below 1 Cent per kilometre, while on the other hand Lufthansa charges 744,- Euro for a one-way business class ticket on short-haul flight from Frankfurt to Brussels (304 km). And as a result of that a factor of 200 between the lowest and highest specific airfares per kilometre applies.

So, how to cope with such a pricing system, which more and more seems to be targeting towards individually agreed prices between the traveller and the airline instead of a price building oriented on the costs actually applying for the airlines on specific flights in an air transport network model for Europe?

Information on the average yields achieved on distinct routes belongs to airlines' best kept secrets and for obvious reasons is not published at all. Decades ago where IATA arranged the 'Billing and Settlement Plan (BSP)' between travel agents, airlines and among airlines, such data have been available and there was no much secret about this as 'Air Service Agreements (ASA)' prevented a real competition. Today we have a liberalised aviation market with open sky agreements or mostly ASAs which allow for competition and prices became the most important instrument attracting travellers. But on top of this the electronic possibilities to sell tickets via the internet directly to travellers made IATAs service mostly obsolete as airlines neither want to pay any longer for this service of IATA nor they want to disseminate their price strategy on specific routes. Also the remaining data sample IATA proceeds does no longer reflect reality and therefore any trend estimations based on these data fail as the market moved out of sample means, especially if one considers the very large share of low cost airlines which never reported to IATA and changed the consumers behaviour a lot due to their pricing strategy. In consequence IATA cancelled in 2012 their product PaxIS, which allowed clients to analyse these data and other commercial data provider, using similar data sources like 'Marketing Information Data Tapes (MIDT)', are in the process of changing their products as well as they are facing exactly the same difficulties.

Another source for prices are 'airlines' annual reports as they publish average revenues per passenger kilometre, which are in a range between 7 Cent (low cost airlines) and 10 Cent (legacy airlines). But these numbers are aggregated and the question is what can be derived from that despite a rough benchmark.

From an analysis of ticket prices retrieved for passenger surveys on airports for distinct routes and markets we realised, that there are different levels of costs per kilometre concerning the following Markets

- Domestic
- International services to/from Scandinavia
- International services to/from Western Europe
- International services to/from Southern Europe
- International services to/from Eastern Europe
- International services to/from Middle East
- International services to/from Far East
- International services to/from North America
- International services to/from South America
- International services to/from Africa
- Routes operated by low cost carriers

Furthermore we know from passenger surveys that when travelling for business reasons passengers choose business class seating at a higher percentage than when travelling for private reasons – by far not every business traveller actually uses business class, especially on trips within Europe but they tend to pay more as they book on shorter notice. Furthermore we learned that passengers undertaking trips of a total duration up to four days in average pay slightly less, than passengers doing trips with a longer duration.

With this information we set up a tariff function, which calculates prices for air routes according to the geographic position of origin and destination, the greater circle distance between these airports and if the route is served by a low cost carrier or not. Detours of transfer connections were not taken into account, as in fact in many cases transfer connections are priced lower by the airlines than an existing direct flight of a competitor, to improve the attractiveness of the transfer connection against existing faster nonstop-flights.

On base of these tariffs calculated by a price function, we receive preliminary start-up prices for all links of the network developed, resulting in a air passenger network providing connections on most airport pairs to be considered (to / from and between airports in Europe), providing all necessary attributes (time, cost, frequency, etc.). These prices then later will be slightly adjusted in the calibration process when producing the air passenger matrix.

8.2.5 Cargo flights

The principal approach to build the cargo flight database is the same as that used for passenger flights. The following differences apply:

- Cargo flights on routes for which no schedules exist in the commercial database are implemented when more than 200 tonnes of annual cargo are indicated for them in available statistics from Eurostat or national sources.
- The heuristic to estimate additional cargo flights is an adapted version of the one used for passenger flights implementing flights with pure cargo aircraft.
- As minimum connecting times between flights standard minimum transshipment times depending on the carriers and the alliance they are belonging to were implemented. For details see the following chapter. These standard times were derived from the analysis of multiple (cargo) airline websites.
- Different to air passenger transport the air-links do not have any costs indicated for cargo transport following the agreed way to proceed from the WORLDNET approach. So in consequence there is no adjustment of cost errors in the iterative process of generating the air cargo matrix.

8.2.6 Trans-shipment Times at Airports - Cargo Alliances

As the membership of an airline within a distinct air cargo alliance is vital for the underlying minimum-transshipment-times at airports between flights of different airlines, these cargo alliances and their members have been identified for this project. The alliances and the members differ from the alliances known from passenger transport.

In the year 2010 the following air cargo alliances existed:

- Federal Express (Fedex)
- Skyteam Cargo
- WOW Cargo Alliance
- Cargolux

The 1st alliance "Federal Express" in fact **is** the World largest cargo airline with the same name. Together with its subsidiaries or co-operations this "alliance" consists of the following airlines:

Table 8-4: Alliance members of "Federal Express"

FedEx
Mountain Air Cargo
Wiggins Airways
Empire Airlines
Morningstar Air Express
Air Contractors
Merlin Airways
Baron Aviation Services
Cargojet Airways
Corporate Air
CSA Air
Solinair
West Air Inc.

Note: some of these airlines run some or all of their flights under the code FX of FedEx.

The 2nd alliance, Skyteam, consists of:

Table 8-5: Alliance members of "Skyteam"

Korean Air Cargo
Air France Cargo
Delta Air Logistics
Aeromexico Cargo
Alitalia Cargo
KLM Cargo
Aeroflot Cargo
CSA Cargo

Note: This is only a subset of all airlines belonging to the alliance "Skyteam" for passenger services. E.g. the Spanish Company Air Europa is part of "Skyteam" only for passenger services.

The (regional) co-operation partners of these "Skyteam" members like Comair (partner of Delta Air Lines) were taken up into this alliance additionally.

The 3rd alliance, WOW Cargo Alliance, consists of:

Table 8-6: Members of "WOW Cargo Alliance"

SAS Cargo
Singapore Airlines Cargo

Note: In 2009 Lufthansa left this alliance while Japan Airlines ceased all cargo operations in October 2010. So there are only two airlines remaining in this cargo alliance.

The 4th alliance Cargolux consists of:

Table 8-7: Alliance members of "Cargolux"

China Airlines
Cargolux

The 5th alliance AeroLogic consists of:

Table 8-8: Alliance members of "AeroLogic"

AeroLogic
Lufthansa Cargo
DHL Aero Expreso
DHL Air UK
European Air Transport
SNAS/DHL
Blue Dart Aviation
DHL de Guatemala
Aero Express Del Ecuador
Airborne Express (ABX Air)
Air Hong Kong
Polar Air Cargo
Southern Air
Solenta Aviation
Tasman Cargo Airlines

AeroLogic in fact is formally not an "alliance" of cargo airlines, but a cargo airline founded as a joint-venture of DHL Express and Lufthansa Cargo of which the latter left the "WOW" alliance in 2008. Nevertheless AeroLogic co-operates with the airlines mentioned above or they are affiliates of DHL Express so in fact all these airlines more or less can be considered as one alliance.

The changes within the alliances mentioned meant for updates of the air cargo network for 2010 one had to redefine the existing alliances and add an additional Cargo Alliance. As data sources we considered the websites of the alliances mentioned.

8.2.7 Building the air network

The flight database in its final condition is not usable for typical shortest path or similar algorithms typically used in transport science. Let alone the flights consisting of more than 20 data fields, like airport of origin and destination including information of terminals used, local departure and arrival time, day of arrival, carrier, true carrier (as a published flight may not actually operated by the airline outlined), if it's a true flight or a duplicate of an existing flight (which may occur when code shares apply for flight), the aircraft used, the operation days, if it's a nonstop flight, the elapsed flight time, etc.). Furthermore additional information is needed like the time zones the airports are situated (see e.g. www.timeanddate.com/worldclock/), the minimum connecting times applying (see airport web sites), if an airport is just one of several airports serving a city etc. Finally for all flights the flight type (charter, low cost other scheduled flight, passenger, cargo) has been determined. In general all flights derived from public sources are considered as schedule flights, while those implemented according to statistics for routes where no or insufficient capacity is offered are implemented as charter flights like the ones derived from tour operators publications. A sub set of scheduled passenger flights are flights operated by a low cost carrier. For that reason we set up a list of airlines, considered as low cost carrier. As a base for that list we took the airlines defined

as low costers by the 'Low Cost Monitor' which was published twice per year by the German working group of airports (Arbeitsgemeinschaft der Verkehrsflughäfen Deutschlands, ADV, www.adv.aero until 2010), enriched by the list of low cost airlines available at www.ch-aviation.ch until March of 2012.

As the business models of classical network carrier and low cost airlines more and more overlap, in some cases we decided to add airlines or to remove some from the list derived from these two sources: A major criteria for an airline to be a low cost carrier is its strict focus on point-to-point-services neglecting any through booking to use a combination of two flights without a compulsory check out and full check-in at the intermediate airport. For this reason e.g. Air Berlin, a low cost carrier for the year 2005, lost this status for the year 2010, as this carrier more and more offered (guaranteed) connections involving a transfer between two of its flights.

To provide an air network within the ETISplus project freely to be used we came to the decision to provide an air network consisting of aggregated connections between each possible pair of airports as long as one of them is situated in Europe. This applies irrespective if these connections base on nonstop flights or on a sequence of two or three flight segments, meaning flight connections where the passengers have to transfer at an intermediate airport.

These connections consisting of more than one flight segment are constructed by using an in-house, "connection builder", developed by MKmetric. The working principle is to connect all flights arriving at an airport with all flights departing there using a number of rules if such a connection is considered as valid or not as a first step.

These rules take into account:

- The official minimum-connecting times applying for each airport, which may sum up to more than 60 single rules for one airport. The rules may deal with origin or destination of flights (domestic / international, country or country group specific or apply only for specific airports), with the carrier designated for a flight or in some cases apply only for flights with a specific number. Furthermore there may be varying connecting-times depending of the terminal of departure and arrival or sometimes combinations of that with the other attributes of a flight.
- Maximum connecting times, we defined by the applying minimum connection time plus 8 hours. The share of passengers with a longer transfer time is very small while the share of passengers interrupting their trip due to business or VRF activities is much larger as interviewed airports said.
- If a connection is online (i.e. both flights are designated to the same carrier) or not (different carrier operate the arriving and the departing flight), as online connections beat offline connections when the offline connection shows no advantage in departing later and / or arriving earlier on a distinct routing.
- If a published flight is of real nature or just a virtual duplication (code-share) of it, as no connections are built between two virtual flights.
- Connections fully covered by another one with identical or later departure and identical or earlier arrival time are omitted if compared connections are of the same nature concerning online or offline.

- The detour of the connection when comparing with the distance as the crow flies, as connections meaning detours exceeding 100% are not built.

Having compiled all connections under the framework of these rules, the resulting amount of valid one-stop connections is temporarily stored as one-stop flights. In a second step the procedure of building connections then is repeated combining these one-stop "flights" with a nonstop-flight from the flight database.

In addition the connection builder tool takes into account the inter-airport connections of airports belonging to the same city. This minimum transfer times are derived from the airlines publications. They are also part of the air network delivered.

To give an idea of the complexity of the calculation, the connection builder has to deal with:

- about 300,000 entries of the flight database for the typical week,
- nearly 1.4 million airport pairs (589 European x 1166 worldwide airports in both directions) for which connections have to be built,
- for mega hubs like Frankfurt, Germany alone more than 7 million of potential combinations of flights have to be checked if they form a valid connection or not.

The connection builder tool deals with all connections which can be built within the typical week the flight database covers, resulting in about:

- 130,000 connections just consisting of nonstop-flights,
- 4,000,000 connections including one intermediate transfer,
- 25,400,000 connections including two intermediate transfers.

Depending on the days of operation these connections may exist between once and up to seven times (i.e. daily) in the typical week. Furthermore there are quite a few airport pairs on which more than one connection per day is offered. For that reason a network, consisting of the built connections still would be not feasible to be dealt by shortest path or equilibrium algorithms typically used in transport science.

So these connections have to be aggregated by the specific routing they use. This is done by an algorithm which unites all connections built from the schedule for the same sequence of airports. The values of each connection like flight and transfer times are weighted by the frequency each connection is offered forming together an average value for each attribute, while the total frequency for the aggregated connection sums up all frequencies of the individual connections. For each pair of airports considered (589 European x 1166 worldwide airports in both directions) the fastest aggregated connection (if existing) is chosen.

8.3 Data sources

The following table provides the most important data sources used.

Table 8-9: Data sources used for generating the air network

Source	Link
Transnational databases	
EUROSTAT	http://epp.eurostat.ec.europa.eu (tables avia par and avia paao)
OAG Max	www.oagmax.com
HAFAS Flugplan	www.flugplan.de .
Matrix Airfare Search	http://matrix.itasoftware.com/
Airfare Meta search engine	http://www.skyscanner.net
Delta Airlines	www.delta.com/business_programs_services/delta_cargo/ www.delta.com/
United	www.unitedcargo.com/ www.united.com/
US Airways	www.usairways.com/en-us/traveltools/cargo/default.html www.usairways.com/
Lufthansa	http://lufthansa-cargo.com/ www.lufthansa.com
American Airlines	https://www.aacargo.com/ www.aa.com/
SAS	www.sascargo.com www.flysas.com/
Air France-KLM	www.af-klm.com/cargo/b2b/wps/portal/b2b/ www.klm.com/ www.airfrance.com/
Emirates	www.skycargo.com/ www.emirates.com
FedEx	http://www.fedex.com/
Skyteam Cargo	http://www.skyteamcargo.com/
Cargolux	http://www.cargolux.com/
Singapore Airlines Cargo	http://www.siacargo.com/
Ceva (formerly known as TNT)	http://www.cevalogistics.com/
ICAO	icao.int
IATA	www.iata.org/
EU27	
Austria	http://www.statistik.at/web_de/statistiken/verkehr/luftfahrt/index.html
Denmark	http://www.slv.dk/Dokumenter/dscgi/ds.py/View/Collection-70
France	http://www.aeroport.fr/ http://www.developpement-durable.gouv.fr/Note-trimestrielle-de-l.html http://www.data.gouv.fr/ http://www.aerobuzz.fr/ http://www.dgac.fr/ http://www.developpement-durable.gouv.fr/Bulletin-statistique.html
Germany	https://www.destatis.de/DE/Publikationen/Thematisch/TransportVerkehr/ThemaVerkehr.html
Hungary	http://www.adv.aero/presse/archiv/ for low cost monitor http://portal.ksh.hu/pls/ksh/docs/eng/xstadat/xstadat_infra/e_odmj001.html http://www.bud.hu/?tPath=/english/business-and-partners/aviation/aviation_databank/documents_for_all_airlines
Ireland	http://www.cso.ie/px/pxeirestat/Database/Eirestat/Eirestat.asp
Italy	http://www.enac-italia.it/index.htm http://www.enac-italia.it/La_Regolazione_Economica/Statistiche/index.html
Lithuania	http://simonas.bartkus.lt/blog/
Netherlands	http://statline.cbs.nl/StatWeb/selection/?DM=SLNL&PA=37570HVV&VW=T
Poland	http://www.ulc.gov.pl/index.php?option=com_content&task=view&id=324&Itemid=466 http://www.airport.com.pl/en/show/flight-statistics/year/2010
Spain	http://estadisticas.aena.es/
Sweden	http://www.swedavia.se/sv/Swedavia/press/Trafikstatistik/Utforsligare-flygplatsstatistik1/
United Kingdom	http://www.caa.co.uk/statistics
Candidate countries & EFTA	
Norway	http://www.avinor.no/
Switzerland	http://www.bfs.admin.ch/
Turkey	http://www.turkstat.gov.tr/VeriBilgi.do?tb_id=52&ust_id=15 http://www.turkstat.gov.tr/PrelstatistikTablo.do?istab_id=376
Neighbouring countries	
Serbia	http://webzrs.stat.gov.rs/WebSite/Public/PageView.aspx?pKey=62

Source	Link
Other countries	
Australia	http://www.btre.gov.au/
Russia	http://www.gks.ru/
USA	http://www.transtats.bts.gov/

Please note that not all web sites are listed as they can be found easily when using the airlines, airports or tour operators' names as search item in one of the search engines.

8.4 Results

Table 8-10: Key results, Air Network

Access via	Location	Folder	Description
ETIS Bulk Download	Data Bulk Downloads ETIS Data	Additional data Resources	Air network as XLSX Format
2010	http://www.etisplus.eu/data/Public/Downloads.aspx Additional data resources: Air_networks_2005_2010.zip Air_network_2010_082012.xlsx (passenger and cargo combined)		
2005	http://www.etisplus.eu/data/Public/Downloads.aspx Additional data resources: Air_networks_2005_2010.zip Air_passenger_network_2005.xlsx Air_cargo_network_2005.xlsx		

The aggregation routine bringing the flight database into an air network results in about

- 14,000 aggregated connections consisting of nonstop-flights, of
- 284,000 aggregated connections including one intermediate transfer
- 808,000 aggregated connections including two intermediate transfers.

Referring to this information the following table shows the structure of the air-links with more details.

Table 8-11: Structure of Air-Links Database

Air links by type	Direct	One transfer	Two transfers	In Total
Passenger	6,102	183,954	493,408	683,464
Of which pure low cost	1,429	13,634	5,300	20,363
Of which partly low cost	1,013	3,345	988	5,346
Of which international	4,820	173,330	492,033	670,183
Passenger & cargo*	3,916	n,a,	n,a,	3,916
Of which international*	3,238	n,a,	n,a,	3,238

Air links by type	Direct	One transfer	Two transfers	In Total
Cargo	3,713	99,693	314,612	418,018
Of which international	3,111	94,435	312,139	409,685
Total	13,731	283,647	808,020	1,105,398
Of which international	7,778	108,069	317,439	433,286

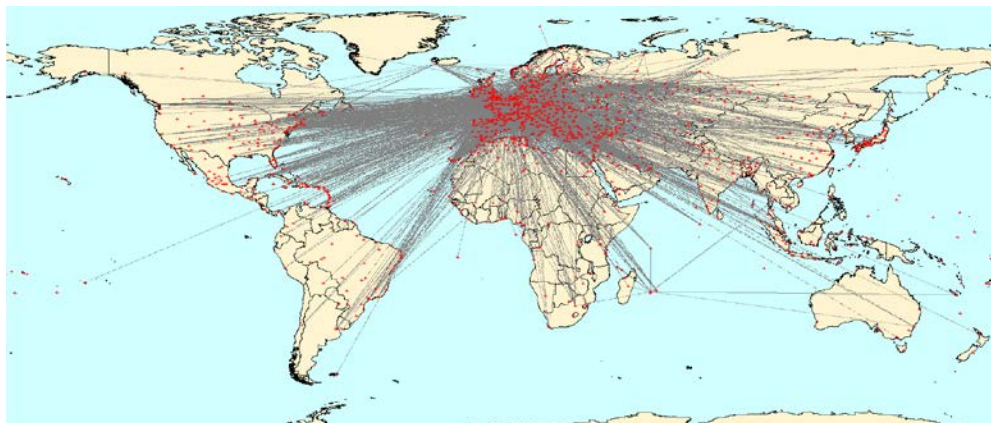
* per definition only direct flights may be built together for links to be used for passenger and cargo.

n.a. = not available.

This forms the air network delivered for ETISplus, covering more than 707,000 airport pairs. In reverse that means that not for every airport pair a connection with up to two transfers at an intermediate airport could be identified. This mainly is valid for airport pairs between regional airports in Europe and airports of remote areas in other continents. It has to be mentioned that for producing an impedance matrix for air transport covering all pairs of regions in Europe and other continents as defined for ETISplus it is not necessary to provide actually air-links for every airport pair, as most regions in Europe are linked to multiple airports by surface feeder links.

As the air network different to the networks of surface transport modes has a point-to-point-structure of links, it is of no value to visualise these links within a graphical network editor such as ETIS-NETTER. Instead the file is provided in Excel format and can be downloaded as a direct link from the data page on the ETISplus site. X and Y co-ordinates of the airports are stored in the database, so the air network or parts of it in principle can be displayed as a GIS layer if required.

Figure 8-2: Air Network, 2010, Worldwide Coverage



Source: MKmetric

By selecting a single airport it is possible to visualise the direct connections from that node. As an example the figure below shows the airport of Karlsruhe Baden-Baden.

Figure 8-3: Direct Connections from Karlsruhe



Source: MKmetric

9 Airports

9.1 Scope of Database

This section deals with the airports (terminals) and their attributes. The main characteristics of the air terminals database is summarised in the following table while their contents is shown in Table 9-1 followed by a detailed description in Table 9-2.

Table 9-1: Overview of main characteristics of the data set

Air terminals						
Data feature	Data specification					Remarks
Base year	2010					
Scope of data	Link	Terminal	O/D relation	Region	Other	
	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
GIS data	Yes	No				
	<input checked="" type="checkbox"/>	<input type="checkbox"/>				
Country coverage				Com-pletely	Par-tially	
	EU 27			<input checked="" type="checkbox"/>	<input type="checkbox"/>	
	Candidate countries & EFTA			<input checked="" type="checkbox"/>	<input type="checkbox"/>	
	Neighbouring countries			<input checked="" type="checkbox"/>	<input type="checkbox"/>	
	TRACECA			<input type="checkbox"/>	<input checked="" type="checkbox"/>	
	MEDA			<input type="checkbox"/>	<input checked="" type="checkbox"/>	
	Other countries			<input type="checkbox"/>	<input checked="" type="checkbox"/>	
	Total number of countries covered:			68	168	
Main data sources	Airports web sites, IATA, ICAO, HAFAS Flugplan					
Main type of data generation	Observed	<input checked="" type="checkbox"/>				Depending on the attribute, all types of data generation have been applied.
	Harmonised	<input checked="" type="checkbox"/>				
	Modelled	<input checked="" type="checkbox"/>				

Table 9-2: Data structure of the air terminals data set

Indicator	Description of indicator	Unit
DATA_GROUP	Metadata on dataset level: type of data	
SOURCE	Metadata on dataset level: data provider	
FROMDATE	Operating time. Year or starting date	
TODATE	Operating time. Year or ending date	
SEASON	Season of operating time	
NodeID	Numeric Identifier	Integer
TLC	Origin [TLC]	Char
AirportName	Official name of airport	Char
XCoordinate	Decimal longitude coordinate	Rational Number
YCoordinate	Decimal latitude coordinate	Rational Number
MaxMtow	Largest maximum take-off weight of a flight observed from the airport	Tonnes
AllDest	Total number of destinations served from this airport by direct flights	Integer
DomesticDest	Number of domestic destinations served from this airport by direct flights. Subset of European destinations	Integer
IntercontDest	Number of intercontinental destinations served from this airport by direct flights	Integer
EuropeanDest	Number of European destinations served from this airport by direct flights. European in this context means destinations situated in the continent Europe	Integer
SchengenDest	Number of Schengen destinations served from this airport by direct flights. Subset of European destinations	Integer
CargoCapacity	Total cargo capacity in tonnes offered in total on all flights arriving and departing from the airport	Tonnes
Seats	Annual seat capacity offered in total on all flights arriving and departing from the airport	Integer
CargoAcMove	Annual number of freight aircraft movements	Integer
PassAcMove	Annual number of passenger aircraft movements	Integer
TotPax	Total number of annual passengers on the airport	Integer
DomPax	Number of annual passengers on domestic flights on the airport	Integer
IntercontPax	Number of annual passengers on intercontinental flights on the airport	Integer
SchengenPax	Number of annual passengers on flights to/from Schengen destinations on the airport	Integer
EuropeanPax	Number of annual passengers on European flights on the airport	Integer
NorthAmericaPax	Number of annual passengers on flights to/from destinations in North America on the airport	Integer
SouthAmericaPax	Number of annual passengers on flights to/from destinations in South America on the airport	Integer
FarEastPax	Number of annual passengers on flights to/from destinations in the Far East (including Australia/Oceania) on the airport	Integer
AfricanPax	Number of annual passengers on flights to/from destinations in Africa on the airport	Integer
MiddleEastPax	Number of annual passengers on flights to/from destinations in the Middle east on the airport	Integer
TotalCargo	Total number of flown cargo at the airport in tonnes	Tonnes
Carrier1	Indicates the airline by its two or three letter designator	Char
Carrier2	Indicates the airline by its two or three letter designator	Char
Carrier3	Indicates the airline by its two or three letter designator	Char
Carrier4	Indicates the airline by its two or three letter designator	Char
Carrier5	Indicates the airline by its two or three letter designator	Char
Carrier6	Indicates the airline by its two or three letter designator	Char
Carrier7	Indicates the airline by its two or three letter designator	Char
Carrier8	Indicates the airline by its two or three letter designator	Char
Carrier9	Indicates the airline by its two or three letter designator	Char
Carrier10	Indicates the airline by its two or three letter designator	Char

Indicator	Description of indicator	Unit
ShareCarrier1	Share in % by seat capacity offered on flights of an airline. In maximum 10 airlines are explicitly mentioned per airport	Rational Number
ShareCarrier2	Share in % by seat capacity offered on flights of an airline. In maximum 10 airlines are explicitly mentioned per airport	Rational Number
ShareCarrier3	Share in % by seat capacity offered on flights of an airline. In maximum 10 airlines are explicitly mentioned per airport	Rational Number
ShareCarrier4	Share in % by seat capacity offered on flights of an airline. In maximum 10 airlines are explicitly mentioned per airport	Rational Number
ShareCarrier5	Share in % by seat capacity offered on flights of an airline. In maximum 10 airlines are explicitly mentioned per airport	Rational Number
ShareCarrier6	Share in % by seat capacity offered on flights of an airline. In maximum 10 airlines are explicitly mentioned per airport	Rational Number
ShareCarrier7	Share in % by seat capacity offered on flights of an airline. In maximum 10 airlines are explicitly mentioned per airport	Rational Number
ShareCarrier8	Share in % by seat capacity offered on flights of an airline. In maximum 10 airlines are explicitly mentioned per airport	Rational Number
ShareCarrier9	Share in % by seat capacity offered on flights of an airline. In maximum 10 airlines are explicitly mentioned per airport	Rational Number
ShareCarrier10	Share in % by seat capacity offered on flights of an airline. In maximum 10 airlines are explicitly mentioned per airport	Rational Number
ShareOtherCarrier	Share in % by seat capacity offered on flights of other airlines beside the top 10.	Rational Number
ShareStar	Share in % by seat capacity offered on flights of this alliance	Rational Number
ShareOneworld	Share in % by seat capacity offered on flights of this alliance	Rational Number
ShareSkyteam	Share in % by seat capacity offered on flights of this alliance	Rational Number
ShareLowcost	Share in % by seat capacity offered on flights of low cost airlines	Rational Number
ShareNonAirlineGroup	Share in % by seat capacity offered on flights of other airlines	Rational Number

9.1.1 Airport attributes

For the airports covered by this database we defined four groups of indicators:

- General indicators, representing important elements of the network topology, which are available for all airports
- Supply indicators, available for European airports
- Demand indicators, available for European airports
- Competition indicators, available for European airports

As the supply, demands and competition indicators are given only for the core countries of this project (Europe), the corresponding fields are filled either with 0 (zero) or left empty for the other airports, depending if the specific indicator is a number or a string.

The development of these indicators took into account as much as possible of the findings from the modellers' workshop held within the ETIS project in spring 2011.

9.1.2 General attributes

The field "DATA_GROUP" informs, if an airport data set belongs to (O)bserved, (E)stimated or (M)odelled data. As the majority of data for each airport are

derived from official schedules publishes airport information and reported statistics of air passenger or air cargo volumes, all data sets are marked with "O" in this field. In the "SOURCE" field all entries are "MKM", meaning all data provided are collected and aggregated by MKmetric as described in the methodology section. The "FROMDATE", "TODATE" and the "SEASON" fields indicate the time period for which these airports are valid. As the air network for the year 2005 bases on a representative week for the whole year, in consequence for all corresponding airports "FROMDATE" is 20050101 and "TODATE" is 20051231, while the value in the "SEASON" field is "ALL". The "Id" field has been generated automatically and is a unique number for every airport.

The field "TLC" (TLC = Three Letter Code) indicates the official IATA airport code assigned to an airport. These codes are used in the commercial sources for air schedules. They are not only available directly from IATA but as well be retrieved from numerous sources in the internet, e.g. <http://worldaerodata.com/> or from Wikipedia¹. From all these sources also the airports' name and / or geographic location is available forming the content of the fields "AirportName", "XCoordinate" and "YCoordinate". All these fields mentioned up to now are static, meaning they are neither supply or demand oriented indicators, and given for all airports in the database, which lists all airports mentioned by the air links described in Annex B3, irrespective if they are situated in Europe or abroad. Europe in this context means the ETIS coding assigned to a region is smaller than 200.000.000. Abroad means the region code is larger than 200.000.000.

9.1.3 Supply attributes

The following fields of the airport database consist of indicators which are supply driven. The supply oriented indicators route in the characteristics of the underlying air network. These indicators were calculated for all airports in Europe (according to the definition of Europe mentioned above).

The field MaxMtow indicates the largest maximum take-off weight of an aircraft which was handled at the airport according to the schedule information published. So this observed value is from supply side information and may vary throughout different years.

Also the next fields "AllDest", "DomesticDest", "IntercontDest", "European Dest", "SchengenDest" are supply driven and indicate the number of destinations to be reached from an airport by direct flights (either by nonstop-flights, or direct-flights with an intermediate stop without the necessity for the passenger / the cargo to transfer / to tranship between aircrafts according to schedules and passenger / cargo statistics. For the groups of destinations mentioned the following definitions apply:

- Domestic in this context means, the region in which the airport of destination is situated belongs to the same country, in which the airport of origin is situated.

¹ http://en.wikipedia.org/wiki/List_of_airports

- The same country in this context means the first three digits of the ETISplus region code of both regions are identical.
- Intercontinental in this context is defined, that the destination airport is situated in a region for which the region code is larger than 200.000.000.
- Europe in this context means that the destination airport is situated in a region for which the region code is below 200.000.000
- Schengen in this context means, that the airport of destination is situated in a region belonging to a country which has implemented the Schengen treaty before 1st of January 2005¹.

The following examples shall illustrate the consequences according to these definitions:

- For the airport of Gibraltar (GIB) flights to London are considered as flights to a European destination, they are neither domestic nor Schengen flights.
- From the airport of Melilla (MLN) in 2010 flights to six destinations on the Spanish mainland existed. They are counted as domestic flights, appear also as European flights and as well as Schengen flights.
- The Romanian regional airport of Arad (ARW) in 2010 had flights to one other airport in Romania. These flights are counted as domestic and also as European flights, but not as Schengen flights: While Romania in 2005 already has signed the Schengen agreement, but it is still implemented for.

The next fields "CargoCapacity" and "Seats" indicate the total capacity offered on the sum of flights arriving and departing at the distinct airport. They are calculated on base of the aircraft type specific passenger and cargo capacities of the flights at an airport. In some cases these capacities may be quite close or even slightly smaller to the passenger figures outlined for a distinct airport. This may apply in cases where to the published flights from the schedules may represent not fully all air craft movements which took place around the whole year or airlines used aircraft equipped with a seat density high above the average for a distinct type of aircraft, as for example a Boeing 737-800 may be equipped with 160 seats (e.g. Turkish Airlines) but also with 189 seats (e.g. Ryanair).

Finally the fields "CargoAcMove" and "PassAcMove" are the last two one to be summarised under the topic of supply indicators. They indicate the sum of all aircraft movements in 2010 of either pure cargo aircraft (i.e. flights with seats capacity =0) or passenger flights (i.e. passenger capacity >0) for each airport. Note that passenger flights also may carry cargo, so it is no contradiction that on airports for which no cargo flights are indicated a cargo volume >0 may be indicated. The capacity indication for the flights summed up for these indicators route from airlines' website information and also from published flight schedules at airports web sites.

¹ http://en.wikipedia.org/wiki/Schengen_Area

9.1.4 Demand attributes

The following fields of the airport database consist of indicators which are demand driven. They come from an assignment of the air passenger trips 2010 or the air cargo flows 2010 respectively to the air network, described in Annex B3_2010.

The fields "TotPax", "DomPax", "IntercontPax", "SchengenPax", "EuropeanPax", "NorthAmericaPax", "SouthAmericaPax", FarEastPax, AfricanPax, MiddleEastPax are supply driven and indicate the number of passengers on direct flights linking the specific airport with airports located in the area covered by the indicator. Note that e.g. a passenger travelling from Frankfurt via Dubai in the United Arabic Emirates to Perth, Australia is counted for Frankfurt airport as a passenger to Middle East), so the first airport of destination of a travel chain is considered for these indicators. For the groups of destinations mentioned the following definitions apply:

- Domestic ("DomPax") in this context means, the region in which the airport of destination is situated belongs to the same country, in which the airport of origin is situated.
- The same country in this context means the first three digits of the ETISplus region code of both regions are identical.
- Intercontinental ("IntercontPax ") in this context is defined, that the destination airport is situated in a region for which the region code is larger than 200.000.000.
- Schengen ("SchengenPax ") in this context means, that the airport of destination is situated in a region belonging to a country which has implemented the Schengen treaty before 1st of January 2010¹.
- Europe ("EuropeanPax") in this context means that the destination airport is situated in a region for which the region code is below 200.000.000.
- North America ("NorthAmericaPax") in this context means that the destination airport is situated in Canada, the United States of America or Saint Pierre and Miquelon
- South America ("SouthAmericaPax") in this context means that the destination airport is situated in a region for which the region code is larger than 500.000.000, i.e. in other parts of the whole American continent, including the Caribbean, remote insular region (e.g. Falkland Island) and the Antarctic, beside those three countries mentioned under North America.
- Far East ("FarEastPax") in this context means that the destination airport is situated in a region for which the region code is between 300.000.000 and 400.000.000, and which is not belonging to the region summarised under Middle East.
- Africa ("AfricanPax") in this context means that the destination airport is situated in a region for which the region code is between 200.000.000 and 300.000.000.
- Middle East ("MiddleEastPax") in this context means that the destination airport is situated in Bahrain, Israel, Iraq, Iran, Jordan, Kuwait, Lebanon, Oman, Palestinian Territories, Qatar, Saudi Arabia, Syria, Yemen.

¹ http://en.wikipedia.org/wiki/Schengen_Area

9.1.5 Competition attributes

The competition attributes all deal with the operators and groups of operators providing passenger flights at an airport.

The "Carrier<\$>" fields with "\$" representing a number between 1 and 10, indicating the top ten airlines providing flights at the specific airport in descending order of the number of seats provided by the carriers. Each carrier is indicated by an airline designator code. These are two-character codes assigned by the International Air Transport Association (IATA) to the world's airlines¹. The standard is described in IATA's Standard Schedules Information Manual and the codes themselves are described in IATA's Airline Coding Directory. The codes are indicated in all schedule sources published used to build the flight data base described in Annex B3_2010, for each and every flight. So adding up the seats offered on all flights to and from a specific airport for all carriers and sorted by the sum of seats, results in this indication of relevant carriers on an airport.

In cases where less than ten airlines were serving an airport, the corresponding fields were filled with "NULL"; i.e. when "NULL" shows up in the field "Carrier10" for an airport, this means this airport was served by less than 10 different airlines. For decoding the airline designators we refer to the following table, indicating the actual airlines using a distinct code in 2005 and which are mentioned in the data base. Note that in cases where an airline stops to provide any service, these codes may be assigned rapidly by IATA to another airline. So the same code may be used by different airlines throughout schedule periods.

It should also be mentioned that not all airlines actually have a two letter code, while some only have a three letter code following the designation of codes to airlines by ICAO². In these cases ICAO codes were used to code the airline and they were also included into the airline list above.

Corresponding to the airlines mentioned in the fields "Carrier1" to "Carrier10", the fields from "ShareCarrier1" to "ShareCarrier10" indicate the share on the total sum of seats offered in all flights to and from the specific airport, an airline provides. A share of e.g. 80% is indicated as 80 and not as 0.8. The field "ShareOtherCarrier" indicates the market share by seats of other carriers serving the airport, so that the sum of all share fields for an airport is 100.

Similar to the carrier specific fields mentioned before, also for alliances of airlines concerning passenger transport the completion situation is mirrored in the airport data base. The alliances considered are:

¹ http://en.wikipedia.org/wiki/Airline_codes#IATA_airline_designator

² http://en.wikipedia.org/wiki/Airline_codes#ICAO_airline_designator

- Star alliance¹,
- Oneworld²,
- Skyteam³

The groups of airlines considered are complimented furthermore by:

- Low Cost airlines and
- Independent airlines, not belonging to one of the four other groups.

The fields "ShareStar", "ShareOneworld", "ShareSkyteam" and "ShareLowcost" indicate the market share these groups of airlines measured by the seat capacity offered on the specific airport. The field "ShareNonAirlineGroup" indicates the share of other airlines not belonging to the groups mentioned before. The values for all these five groups sum up to 100. Note that a share of e.g. 80% is outlined as 80 not as 0.8.

While the members of the alliances could be identified via their websites for decision which airlines to be considered as low cost carrier we took as a base the airlines defined as low costers by the 'Low Cost Monitor' which was published twice per year by the German working group of airports (Arbeitsgemeinschaft der Verkehrsflughäfen Deutschlands, ADV, www.adv.aero until 2010), enriched by the list of low cost airlines available at www.ch-aviation.ch until March of 2012. As the business models of classical network carrier and low cost airlines more and more overlap, in some cases we decided to add airlines or to remove some from the list derived from these two sources: A major criteria for an airline to be a low cost carrier is its strict focus on point-to-point-services neglecting any through booking to use a combination of two flights without a compulsory check out and full check-in at the intermediate airport. For this reason e.g. Air Berlin, a low cost carrier for the year 2005, lost this status for the year 2010, as this carrier more and more offered (guaranteed) connections involving a transfer between two of its flights.

In the following tables we outline the airlines belonging to each alliance or which are considered as low cost airlines. As the issue of the indicators dealing with alliances is competition, we took up all affiliates of alliance members, even when they are formally not a member of their own (e.g. Lufthansa Cityline is considered as a member of STAR, although formally only Lufthansa is a STAR member).

9.2 Methodology

9.2.1 Selecting airports

To set up the data base of airports the first step necessary, is to decide which airports are to be included in the air network. In general a network to be used for transport analysis, forecast and simulation must cope with the underlying

¹ <http://www.staralliance.com>

² <http://www.oneworld.com/>

³ <http://www.skyteam.com/>

regionalisation, i.e. the traffic cells defined and the traffic flows to be considered. For this project a common regionalisation to be used by all partners involved has been defined by the co-ordinator and the focus of the project are passenger and freight flows within Europe and also between Europe and other continents.

This leads to the principle approach, to incorporate all airports located in Europe and those in other continents, which are relevant to represent passenger and cargo flows from that area to and from Europe.

In a first step, we identified all airports existing in the world from published schedules and assigned them to the regions defined for this project via their geographic co-ordinates. In a second step we assigned counting of all flights from the schedules data base to these airports as a "weight" to rank them. In a third step we selected those airports with the highest ranking concerning passenger as well as cargo flights per region. So in consequence of choosing one airport per region in some cases the chosen airport had to take over a representative role for representing the other(s) situated in the same region. This mainly applies for remote areas, where the NUTS3 region is quite large-scale, e.g. like in Northern Norway, where alone the region "Troms" is equipped with more than a dozen airports and which are represented in the air network by the airport of Tromsø (TOS), the largest one in this region. A similar situation is valid for the Italian island of Lampedusa. This island, administratively belonging to the region of Trapani, situated on the (much larger) island Sicily, has its own airport (LMP), but as it is smaller than the airport of Trapani (TPS), the latter one works as a representative for both.

In some cases we decided to opt for more than one airport in a distinct region: e.g. when air services for passenger and cargo are strictly separated between the two biggest airports, like in the Canadian province of Quebec, where Montréal Pierre Elliott Trudeau International Airport (YUL) hosts the passenger flights while cargo operations serve Montréal Mirabel (YMX).

Finally we undertook a check, if any of those airports mentioned in air link as transfer airport, are already covered by the list of airports covered from the steps above. Those airports identified in this step then were taken up additionally into the airport data base with their general attributes.

Resulting from this procedure we identified 1165 airports worldwide of which 589 are situated in Europe for the airport database. This has been done commonly for both years of consideration 2005 and 2010, resulting in a common number of airports valid both years, irrespective if an airport is actually served in 2005 as well as in the year 2010.

9.2.2 Airport attributes

The airport attributes are categorized as general, supply, demand and competition indicators. Supply and competition indicators (which in the very end are also supply oriented, but have a focus on competition) root from the analysis of published schedules or schedules developed on base of air transport statistics forming the flight database. Finally the demand indicators come from the final

assignment of the passenger and cargo flows to the air network, which is part of the iterative calibration process used for setting up the air passenger and air cargo flow matrices described in the corresponding annex.

It has to be mentioned that the approach used is a repeatable process, which does not need any further sources then mentioned, so for preparing a new airport database for a future year it is not necessary to rely on air networks, airport databases etc. developed for former year. Nevertheless the process for setting up the general attributes of the airports it should be sufficient to derive them only for airports popping up for the first time in the schedules of such a future year, while airports which are not any longer served in such a future year can be omitted then. E.g. once the new airport of Berlin (Berlin-Brandenburg International) will be opened, it will be in the published schedules reflected by flights to and from “BER”, which is the three letter code defined for this new airport by IATA. So the general data for this (and other airports which may also pop up for the first time) have to be collected from the sources mentioned or by desktop research using the websites of these airports, while airports where all operations have been ceased then, e.g. Berlin Tegel (TXL) and Berlin-Schönefeld (SXF) can be omitted. It should be mentioned that the process of selecting the airports for the database and the network has also be redone, in the case, the defined regionalisation changes. E.g. if once transport networks have to be developed for a level of regionalisation in Europe beyond NUTS3, then for example it is useful to increase the number of airports to be covered by the air network for Northern Norway.

9.3 Data Sources

The following table provides the most important data sources used.

Table 9-3: Data sources used for generating the airport database

Source	Link
Transnational databases	
EUROSTAT	http://epp.eurostat.ec.europa.eu (tables avia_par and avia_paoa)
HAFAS Flugplan	(www.flugplan.de) aggregations from information available
Airline codes	http://en.wikipedia.org/wiki/Airline_codes#IATA_airline_designator and http://en.wikipedia.org/wiki/Airline_codes#ICAO_airline_designator
Schengen area	http://en.wikipedia.org/wiki/Schengen_Area
List of airports	http://en.wikipedia.org/wiki/List_of_airports
General airport information	http://worldaerodata.com/
STAR Alliance	http://www.staralliance.com
Oneworld Alliance	http://www.oneworld.com/
Skyteam Alliance	http://www.skyteam.com/
ICAO	icao.int
IATA	www.iata.org/
EU27	
Austria	http://www.statistik.at/web_de/statistiken/verkehr/luftfahrt/index.html
Denmark	http://www.slv.dk/Dokumenter/dscgi/ds.py/View/Collection-70
France	http://www.aeroport.fr/ http://www.developpement-durable.gouv.fr/Note-trimestrielle-de-l.html http://www.data.gouv.fr/ http://www.aerobuzz.fr/

Source	Link
Germany	http://www.dgac.fr/ http://www.developpement-durable.gouv.fr/Bulletin-statistique.html https://www.destatis.de/DE/Publikationen/Thematisch/TransportVerkehr/ThemaVerkehr.html
Hungary	http://www.adv.aero/presse/archiv/ for low cost monitor http://portal.ksh.hu/pls/ksh/docs/eng/xstadat/xstadat_infra/e_odmj001.html http://www.bud.hu/?tPath=/english/business-and-partners/aviation/aviation_databank/documents_for_all_airlines
Ireland	http://www.cso.ie/px/pxeirestat/Database/Eirestat/Eirestat.asp
Italy	http://www.enac-italia.it/index.htm http://www.enac-italia.it/La_Regolazione_Economica/Statistiche/index.html
Lithuania	http://simonas.bartkus.lt/blog/
Netherlands	http://statline.cbs.nl/StatWeb/selection/?DM=SLNL&PA=37570HVV&VW=T
Poland	http://www.ulc.gov.pl/index.php?option=com_content&task=view&id=324&Itemid=466 http://www.airport.com.pl/en/show/flight-statistics/year/2010
Spain	http://estadisticas.aena.es/
Sweden	http://www.swedavia.se/sv/Swedavia/press/Trafikstatistik/Utforsligare-flygplatsstatistik1/
United Kingdom	http://www.caa.co.uk/statistics
Candidate countries & EFTA	
Norway	http://www.avinor.no/
Switzerland	http://www.bfs.admin.ch/www.ch-aviation.ch
Turkey	http://www.turkstat.gov.tr/VeriBilgi.do?tb_id=52&ust_id=15 http://www.turkstat.gov.tr/PrelstatistikTablo.do?istab_id=376
Neighbouring countries	
Serbia	http://webzrs.stat.gov.rs/WebSite/Public/PageView.aspx?pKey=62
Other countries	
Australia	http://www.btre.gov.au/
Russia	http://www.gks.ru/
USA	http://www.transtats.bts.gov/

Please note that not all web sites are listed as they can be found easily when using the airlines' or airports' names as search item in a web search engines. There are as well other sources available which combine different type of information but they are commercial and therefore do not qualify for the ETISplus project.

9.4 Results

The airport database delivered in total consists of 1,221 airports for which the general attributes have been collected. 537 of them are situated in Europe, for which demand, supply and competition indicators were calculated according to the air services applying in 2005 for them.

Table 9-4: Airports, Key results

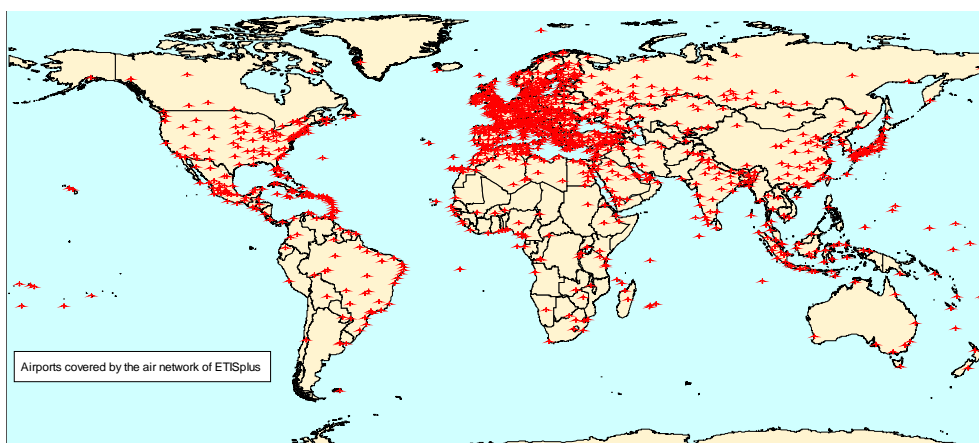
Access via	Location	Folder	Description
ETIS Bulk Download	Data Bulk Downloads ETIS Data	Additional data Resources	Airports as XLS Format (Includes volumes)
2010	http://www.etisplus.eu/data/Public/Downloads.aspx Additional data resources: Air_networks_2005_2010.zip eplus_aptswith_ind_2010.xls		

2005	http://www.etisplus.eu/data/Public/Downloads.aspx Additional data resources: Air_networks_2005_2010.zip eplus_apts_with_ind_2005.xls
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Table 9-5: Airports, Key resources in ETIS-Netter

Access via	Location	Toolbar	Description
ETIS NETTER	http://netter.etisplus.net/	Network - Node - Type: terminal - NetworkType: air	2010 Airport database as Editable GIS layer.

The following figure gives an overview on the worldwide geographic coverage of the airports considered.

Figure 9-1: Map of worldwide airports considered within ETISplus


The following table shows the segmentation of airports covered by continents.

Table 9-6: Airports considered by Continent

Continent	# of Airports
Europe(*)	537
Africa	127
Asia(**)	306
Oceania	34
The Americas	217
Total	1221

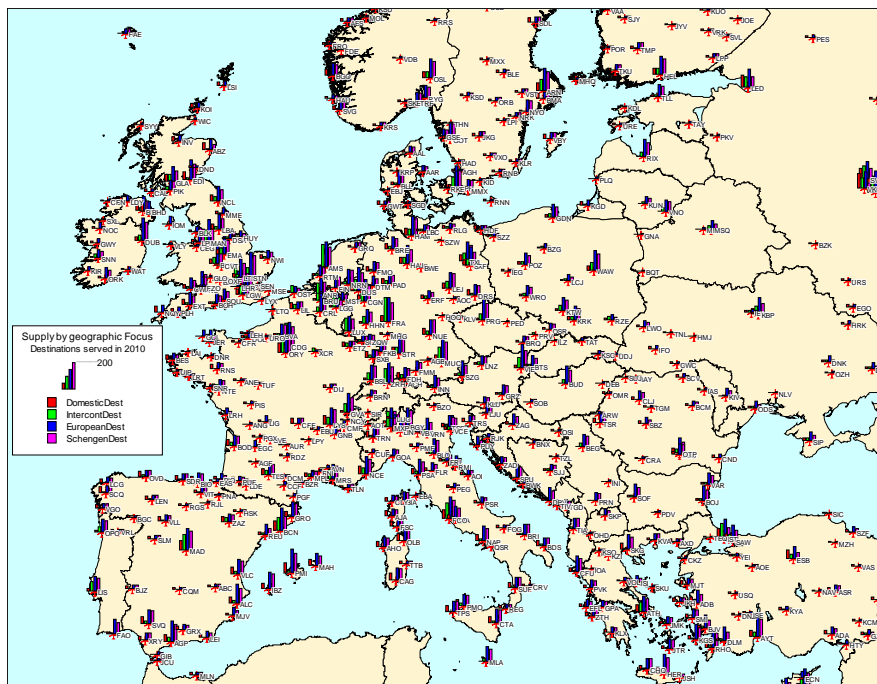
(*) The airports of the French Overseas Départements (e.g. Martinique) are counted to the continents of Africa or the Americas respectively.

(**) Including 70 airports in Russia

The 537 airports covering Europe split up among 49 countries. The following table shows the number of airports covered by every European country. Regardless that some European countries (e.g. Andorra, Liechtenstein) are not equipped with an own airport providing commercial aircraft services modelling of air transport is possible anyway with the air network delivered, as these countries are linked to surrounding airports in other countries.

As the airports in the data base have also geographic information (latitude, longitude) it is possible to produce thematic maps on each and every indicator. The following maps illustrate this possibility for one demand indicator.

Figure 9-2: Passenger demand on European airport by destination groups



10 Rail Passenger Terminals

10.1 Scope of database

The rail passenger terminal database contains rail passenger terminals (stations), which are serviced by long-distance trains. The main characteristics of the rail passenger terminal database are summarised by Table 9-1, while their contents are listed by Table 9-2.

The main focus of this database is EU-27 countries, Candidate countries, EFTA countries and some of the neighbouring countries. The database contains 2,632 terminals.

Table 10-1: Overview of main characteristics of the data set

Rail passenger terminals						
Data feature	Data specification					Remarks
Base year	2010					
Scope of data	Link	Terminal	O/D relation	Region	Other	
	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
GIS data	Yes	No				
	<input type="checkbox"/>	<input checked="" type="checkbox"/>				
Country coverage				Com-pletely	Par-tially	
				<input checked="" type="checkbox"/>	<input type="checkbox"/>	
				<input checked="" type="checkbox"/>	<input type="checkbox"/>	
				<input type="checkbox"/>	<input checked="" type="checkbox"/>	
				<input type="checkbox"/>	<input type="checkbox"/>	
				<input type="checkbox"/>	<input type="checkbox"/>	
				<input type="checkbox"/>	<input type="checkbox"/>	
	Total number of countries covered:			35		
Main data sources	European rail timetables ETISplus rail network model ETISplus zones (NUTS-3)					
Main type of data generation	Observed	<input checked="" type="checkbox"/>				
	Harmonised	<input type="checkbox"/>				
	Modelled	<input type="checkbox"/>				

Table 10-2: Data structure of the rail passenger terminals data set

Indicator	Description of indicator	Unit
Identifier	Unique identifier	
Zone	Zone the terminal is located in	
Country	Country the terminal is located in	
StationName	Name of the station with long-distance services	
TypeOfPassengerServices	Train type servicing the station	

10.2 Methodology

The attribute "Identifier" represents the ID of each terminal and corresponds to the nodes of the ETISplus rail network model. "Zone" informs on the ETISplus zone ID, the station is located in. "Country" contains the country code of the national state the terminal belongs to. The latter two attributes have been generated in an automated way, by joining different geographical layers.

"StationName" contains:

- either the name of the city a station belongs to,
- or the name of the station as shown in tables or maps of international timetables (e.g. Thomas Cook 2005).

The attribute "TypeOfPassengerServices" informs on whether a station is serviced by a high-speed train (TypeOfPassengerServices=1) or any other long-distance train (TypeOfPassengerServices=2). Table gives an overview of how train types per country have been assigned to the categories "high speed train" and "other long-distance train".

Table 10-3: Overview of high-speed and other long-distance trains per country

Country	High speed trains	Other long distance trains
EU27 countries		
Austria	ICE	ÖIC, ÖEC, IC, EC, EN, CNL, D, E, SPR
Belgium	ICE, Thalys	IC, EC, IR
Bulgaria	-	Express, Fast train
Czech Republic	-	IC, EC, SuperCity, Express, Fast train
Denmark	-	IC, EC, Lyn
Estonia	-	Fast train
Finland	S220	IC, Express, Fast train
France	TGV, Thalys, Eurostar	EC, Talgo, Corail
Germany	ICE, Thalys, Cisalpino	IC, EC, NZ, CNL, EN, IR, D
Greece	-	ICE, IC, IR
Hungary	-	IC, EC, EN, Fast train
Ireland	-	IC, Fast train
Italy	Eurostar Italia, Cisalpino	IC, EC, ICN, EN, IR, D, E
Latvia	-	Fast train

Country	High speed trains	Other long distance trains
Lithuania	-	<i>Fast train</i>
Luxembourg	-	<i>IC, EC, Fast train</i>
Netherlands	<i>ICE, Thalys</i>	<i>IC, D</i>
Poland	-	<i>IC, EC, Express, TLK, IR</i>
Portugal	<i>Alfa Pendular</i>	<i>IC, IN, IR</i>
Romania	-	<i>IC, Rapid, Accelerat</i>
Slovakia	-	<i>IC, EC, Express, IR</i>
Slovenia	-	<i>ICS, IC, EC, D</i>
Spain	<i>AVE, Avant, Alaris, Euromed</i>	<i>Arco, Altaria, Talgo, Estrella, Trenhotel, D</i>
Sweden	<i>X2000</i>	<i>IC, Fast train</i>
United Kingdom	<i>Eurostar</i>	<i>Fast train</i>
Candidate countries & EFTA		
Croatia	-	<i>IC, EC, Fast train</i>
FYR Macedonia	-	<i>Fast train</i>
Norway	-	<i>IC, Fast train</i>
Serbia	-	<i>Fast train</i>
Switzerland	<i>ICE, TGV, Cisalpino</i>	<i>IC, EC, ICN, EN, CNL, IR</i>
Turkey	-	<i>Fast train</i>
Neighbouring countries		
Belarus	-	<i>Fast train</i>
Bosnia and Herzegovina	-	<i>IC, Fast train</i>
Moldova	-	<i>Fast train</i>
Russia	-	<i>Fast train</i>
Ukraine	-	<i>Fast train</i>

10.3 Data sources

The main data sources used for creating the rail passenger terminal database have been the ETISplus rail network model 2010 (see Szimba and Kraft 2012), whose network nodes correspond to the ID of terminals in the passenger terminal database.

Information on routes of railway lines, intermediate stops and operating train types, which have been required to compile the dataset, have been taken from various timetables. The most relevant input has been provided by the European rail timetable (Thomas Cook Publishing 2010).

10.4 Results

The current chapter intends to give a rough overview of the scope of the ETISplus rail passenger terminal database.

Error! Reference source not found. informs on the scope of the rail passenger terminals provided within the data set. Figure 10-2 displays the same set of stations, differentiated by stations serviced by high-speed trains and other long-distance trains. Figure 10-3 gives an exemplary overview of scope of contents of the database at the example of Brussels and surroundings.

Figure 10-1: Rail passenger terminals serviced by long-distance trains

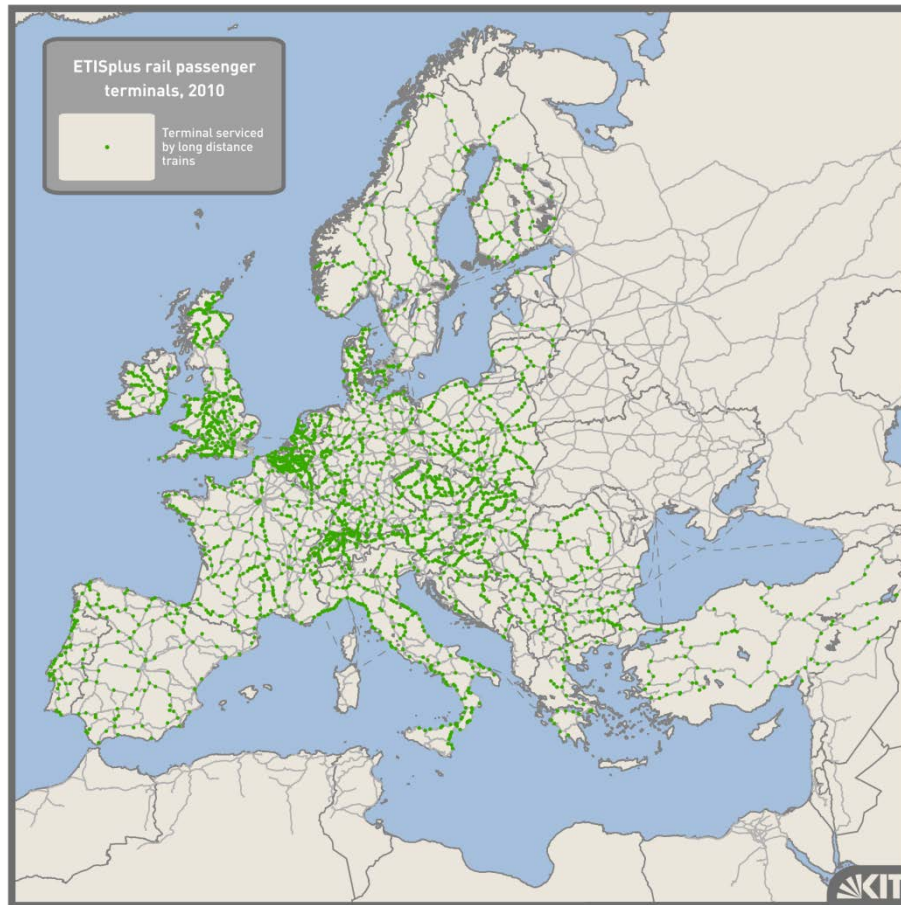


Figure 10-2: Rail passenger terminals by type of long-distance train

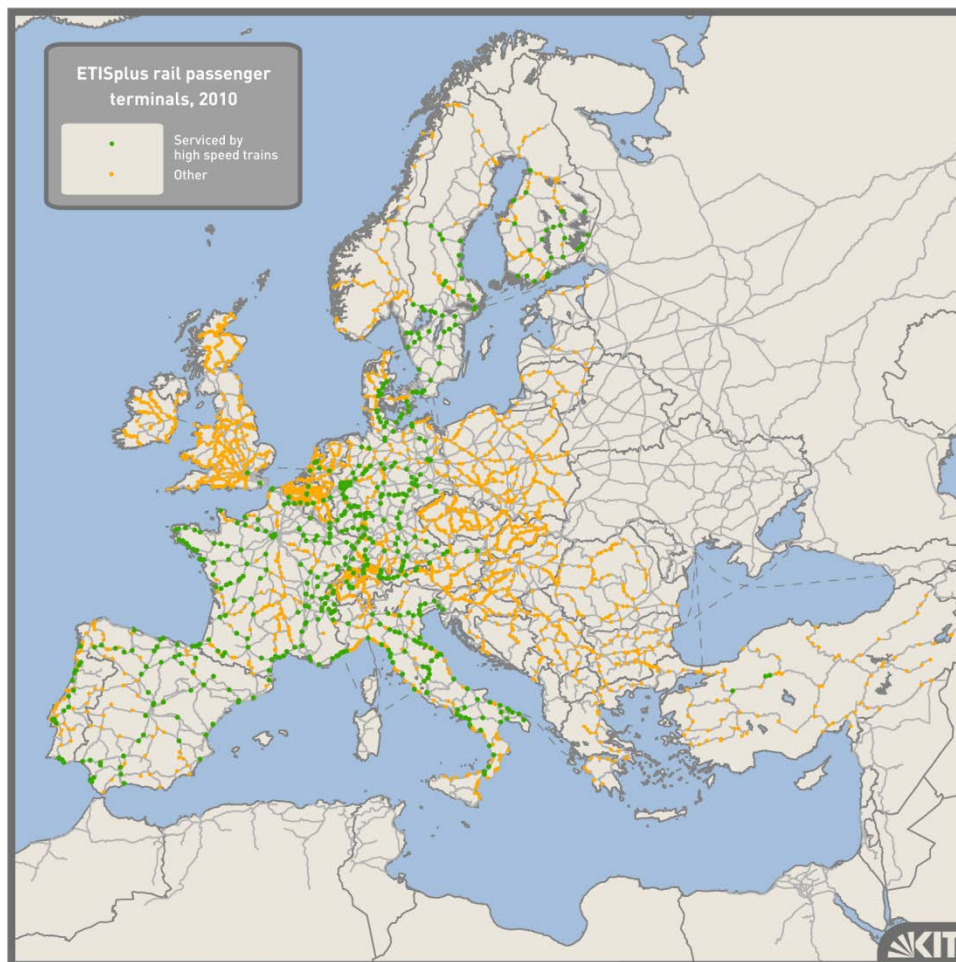
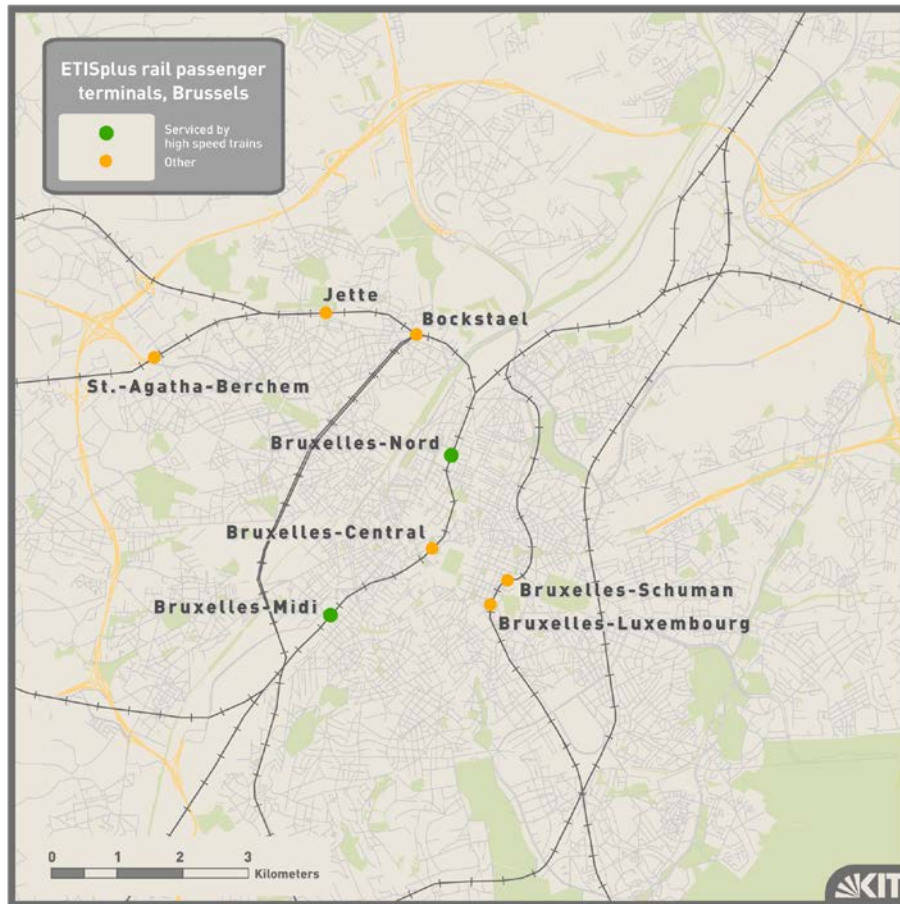


Figure 10-3: Exemplary scope of the rail passenger terminal database



10.5 References

Szimba, E. and Kraft, M. (2012): Rail network, base year 2010, Annex report B2, ETISplus D6 Database Manual: Networks, determinants and indicator database construction (WP 7), August 2012, Karlsruhe.

Thomas Cook Publishing (2010): European Rail Timetable, Summer 2010, Petersborough PE3 8SE, United Kingdom.

11 Seaports

11.1 Scope of the Database

The port traffic database is designed to complement the maritime freight matrix. It is available as a GIS layer, editable in Netter, and it covers a broader range of countries, including non-EU countries. It contains both freight and passenger throughput.

Figure 11-1: Main Characteristics of the Dataset, Port Traffic

Port Traffic		
Data feature	Data specification	Remarks
Base year	2010	
Scope of data	<div> <div>Link</div> <div>Terminal</div> <div>O/D relation</div> <div>Region</div> <div>Other</div> </div> <div> <input type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> </div>	
GIS data	<div>Yes</div> <div>No</div> <div> <input checked="" type="checkbox"/> <input type="checkbox"/> </div>	
Country coverage	<div> <div>Completely</div> <div>Partially</div> </div> <div> <div>EU 27</div> <div>Candidate countries & EFTA</div> <div>Neighbouring countries</div> <div>TRACECA</div> <div>MEDA</div> <div>Other countries</div> </div> <div> <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> </div> <div> <input type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> </div> <div> <div>Total number of countries covered:</div> <div>175</div> </div>	
Main data sources	EUROSTAT Port Authorities WORLDNET (FP7)	
Main type of data generation	<div>Observed</div> <div>Harmonised</div> <div>Modelled</div> <div> <input type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> </div>	

The structure of the database is shown below. Data is accessible via ETIS-Netter, and the visible and editable fields, as implemented in Netter are indicated.

Table 11-1: Structure of database

Field	Text	Example	Type	Visible*	Editable*
ID	Port ID	16902	i	yes	no
WNPORTID	WORLDNET Port ID	102001	i	yes	no
COUNTRY		BELGIUM	t	no	no
PORT	Port Name	ANTWERP	t	yes	yes
DEPTH	Depth of Water (m)	18	f	no	no
DRAUGHT	Maximum Draft (m)	15.5	f	yes	yes
TOTAL_T	Total Tonnage, 2010	160012000	f	yes	yes
LIQBULK_T	Liquid Bulk Tonnage, 2010	40467000	f	yes	yes
DRYBULK_T	Dry Bulk Tonnage, 2010	19438000	f	yes	yes
CONTAINER_T	Container Tonnage, 2010	83644000	f	yes	yes
RORO_T	RoRo Tonnage, 2010	5481000	f	yes	yes
OTHER_T	Other General Cargo Tonnage, 2010	10983000	f	yes	yes
CONTAINER_TEU	Container TEU, 2010	8144379	f	yes	yes
TOTAL_PX	Total Passengers, 2010	52000	f	yes	yes
NONCRUISE_PX	Cruise Passengers, 2010	0	f	yes	yes
CRUISE_PX	Non-cruise Passengers, 2010	52000	f	yes	yes
SOURCE	Data Source	EUROSTAT	t	no	no
TRAF_YEAR	Year for Traffic Data	2010	i	no	no
CTEU_YEAR	Year for TEU Data	2010	i	no	no
NOTES			t	no	no

* Visible and Editable inside Netter

11.2 Data sources

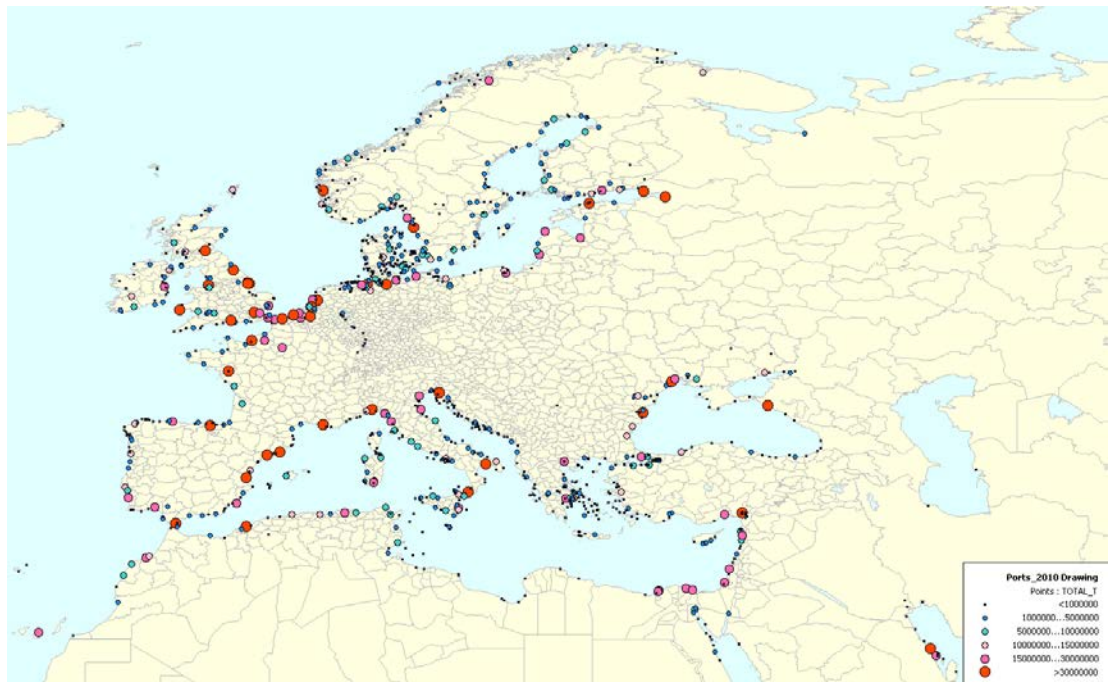
The majority of the data is obtained from the MAR_GO and MAR_PA datasets as published by Eurostat for the year 2010, which split tonnages according to modes of appearance and passenger traffic by 'cruise' and 'non-cruise' categories. Outside Europe, data has been collected either directly from the port authorities or from the WORLDNET project. The sources and the year are indicated in the database.

11.3 Methodology

The first step was to create a geo-coded layer with all the port locations, covering most of the freight and passenger ports in Europe and nearby countries, as well as the main inter-continental ports in other world regions. Some basic depth attributes have been included.

Secondly, these ports have been matched to the EUROSTAT port codes, allowing traffic data (passenger and freight) to be linked to port locations. See below.

Figure 11-2: Overview of Port Data, Tonnage



Data from other world regions have been added, either from port websites, or from the WORLDNET port database.

11.4 Results

Table 11-2: Port data, key results

Access via	Location	Folder	Description
ETIS Bulk Download	Data Bulk Downloads ETIS Data	Additional data Resources	2010 Seaports as GIS Layer MapInfo Mif/Mid
2010	http://www.etisplus.eu/data/Public/Downloads.aspx Additional data resources: Land_networks_2005_2010.zip ETISplus_ports_2_10_final_2010.zip (mif/mid format)		
2005	Not available.		

Table 11-3: Port data, using resources in ETIS-Netter

Access via	Location	Toolbar	Description
ETIS NETTER	http://netter.etisplus.net/	Network - Node - Type: port	2010 seaport database as Editable GIS layer.

Results are summarized in the table below. It shows all the countries with two or more ports in the database. There are a further 96 countries covered with one port per country, notably Singapore.

Table 11-4 : Ports Database, Number of Ports, Total Traffic

Country	Number of Ports	Total Tonnes	Total Pax
ITALY	132	479,126,346	86,809,308
GREECE	106	108,667,703	83,270,892
NORWAY	91	162,836,265	5,876,000
DENMARK	86	78,732,041	47,849,376
UNITED KINGDOM	85	570,632,539	28,881,899
GERMANY	82	270,701,452	28,193,460
SPAIN	74	367,341,000	21,643,695
TURKEY	74	168,563,000	-
SWEDEN	56	168,619,587	30,334,785
FRANCE	40	322,866,041	24,148,535
CROATIA	37	9,327,000	24,258,000
FINLAND	36	102,046,310	17,772,220
USA	36	181,581,000	-
UKRAINE	26	108,667,300	-
EGYPT	22	97,153,000	-
VENEZUELA	20	2,527,000	-
BRAZIL	19	-	-
IRELAND	19	45,962,917	3,088,315
MEXICO	19	50,721,000	-
UNITED ARAB EMIRATES	17	11,200,000	-
PORTUGAL	16	63,778,000	700,000
ARGENTINA	14	21,780,000	-
LIBYA	14	-	-
NETHERLANDS	14	537,668,036	1,994,000
SAUDI ARABIA	14	141,247,000	-
ICELAND	13	4,846,000	-
RUSSIA	13	219,014,000	-
TUNISIA	13	24,105,000	-
ALGERIA	12	126,926,000	-
CHINA	12	552,680,000	-
POLAND	11	59,465,426	2,389,550
ROMANIA	11	37,243,000	185
AUSTRALIA	10	258,198,000	-
MALAYSIA	9	22,142,000	-
MOROCCO	9	48,700,000	-
INDIA	8	64,060,000	-
COLOMBIA	7	10,403,000	-
JAPAN	7	187,480,000	-
NEW ZEALAND	7	-	-
SOUTH KOREA	7	129,927,000	-

Country	Number of Ports	Total Tonnes	Total Pax
CYPRUS	6	6,404,000	107,000
ESTONIA	6	40,336,000	7,523,000
PHILIPPINES	6	-	-
URUGUAY	6	9,904,000	-
CANADA	5	64,981,000	-
ISRAEL	5	38,905,000	-
LEBANON	5	4,989,000	-
ALBANIA	4	3,801,000	-
BELGIUM	4	226,355,000	829,000
GUYANA	4	-	-
INDONESIA	4	-	-
MALTA	4	3,796,000	8,062,000
SYRIA	4	31,782,000	-
TAIWAN	4	251,724,000	-
THAILAND	4	38,982,000	-
IRAN	3	-	-
LATVIA	3	57,227,000	676,000
MONTENEGRO	3	1,956,000	-
MOZAMBIQUE	3	-	-
NIGERIA	3	-	-
SLOVENIA	3	14,645,619	39,428
SURINAME	3	-	-
BRUNEI	2	-	-
BULGARIA	2	22,947,000	1,000
CHILE	2	-	-
DOMINICAN REP	2	-	-
EL SALVADOR	2	-	-
GEORGIA	2	-	-
HAITI	2	-	-
IRAQ	2	-	-
LITHUANIA	2	37,868,000	251,000
MADAGASCAR	2	-	-
MALDIVES	2	-	-
NAMIBIA	2	-	-
NORTHERN MARIANA IS	2	-	-
OMAN	2	-	-
PANAMA	2	-	-
SOMALIA	2	-	-
SOUTH AFRICA	2	45,967,000	-

12 Inland Freight Terminals

12.1 Scope of the Database

The freight terminal set comprises a GIS database that contains inland freight terminals in Europe that are connected to one or more of the following modes of transport: sea, inland waterway, rail and road. This database overlaps the ETISplus seaports database, since there are many rail and barge terminals located at seaports. However the emphasis is upon connectivity and the data structure is different from the seaport database, concentrating on the hinterland linkages.

The main characteristics of the set are summarised by Figure 12-1.

Figure 12-1: Overview of main characteristics of the data set

Freight terminals																														
Data feature	Data specification					Remarks																								
Base year	2010																													
Scope of data	Link	Terminal	O/D relation	Region	Other																									
	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>																									
GIS data	Yes	No																												
	<input checked="" type="checkbox"/>	<input type="checkbox"/>																												
Country coverage	<table><thead><tr><th></th><th>Com-pletely</th><th>Par-tially</th></tr></thead><tbody><tr><td>EU 27</td><td><input type="checkbox"/></td><td><input checked="" type="checkbox"/></td></tr><tr><td>Candidate countries & EFTA</td><td><input type="checkbox"/></td><td><input checked="" type="checkbox"/></td></tr><tr><td>Neighbouring countries</td><td><input type="checkbox"/></td><td><input checked="" type="checkbox"/></td></tr><tr><td>TRACECA</td><td><input type="checkbox"/></td><td><input type="checkbox"/></td></tr><tr><td>MEDA</td><td><input type="checkbox"/></td><td><input type="checkbox"/></td></tr><tr><td>Other countries</td><td><input type="checkbox"/></td><td><input type="checkbox"/></td></tr><tr><td>Total number of countries covered:</td><td colspan="2">32</td></tr></tbody></table>						Com-pletely	Par-tially	EU 27	<input type="checkbox"/>	<input checked="" type="checkbox"/>	Candidate countries & EFTA	<input type="checkbox"/>	<input checked="" type="checkbox"/>	Neighbouring countries	<input type="checkbox"/>	<input checked="" type="checkbox"/>	TRACECA	<input type="checkbox"/>	<input type="checkbox"/>	MEDA	<input type="checkbox"/>	<input type="checkbox"/>	Other countries	<input type="checkbox"/>	<input type="checkbox"/>	Total number of countries covered:	32		
	Com-pletely	Par-tially																												
EU 27	<input type="checkbox"/>	<input checked="" type="checkbox"/>																												
Candidate countries & EFTA	<input type="checkbox"/>	<input checked="" type="checkbox"/>																												
Neighbouring countries	<input type="checkbox"/>	<input checked="" type="checkbox"/>																												
TRACECA	<input type="checkbox"/>	<input type="checkbox"/>																												
MEDA	<input type="checkbox"/>	<input type="checkbox"/>																												
Other countries	<input type="checkbox"/>	<input type="checkbox"/>																												
Total number of countries covered:	32																													
Main data sources	ETIS-BASE, EIA Intermodal Yearbook, BE-LOGIC, RailCargo																													
Main type of data generation	Observed	<input checked="" type="checkbox"/>																												
	Harmonised	<input type="checkbox"/>																												
	Modelled	<input type="checkbox"/>																												

12.2 Data Sources

The ETISplus freight terminal set is comprised of data from a number of sources:

- ETIS-BASE terminal set
- RailCargo Intermodal Terminal Set (version 31)
- Intermodal Yearbook 2011 Terminal Set
- BE-LOGIC terminal set

12.3 Methodology

The ETISplus freight terminal dataset was compiled manually from a number of sources. The starting point was the ETIS-BASE terminal set. In addition a more recent terminal set from RailCargo was used to update terminal information and add missing terminals. Some of these sources are geo-coded and others not, so the objective has been to merge the information across sources to produce a list where every terminal is correctly geocoded.

In a further step terminal sets from the EIA Intermodal Yearbook 2011 and BE-LOGIC were manually integrated, resulting in the current set. Adding the BE-LOGIC data makes it possible to relate terminal data to services data.

During the integration and merging of the different sources the following improvements were applied:

- Addition of missing terminals
- Improvement of terminal location (GIS co-ordinates)
- Improvement of 'connects to' data
- Enhancement of terminal attributes

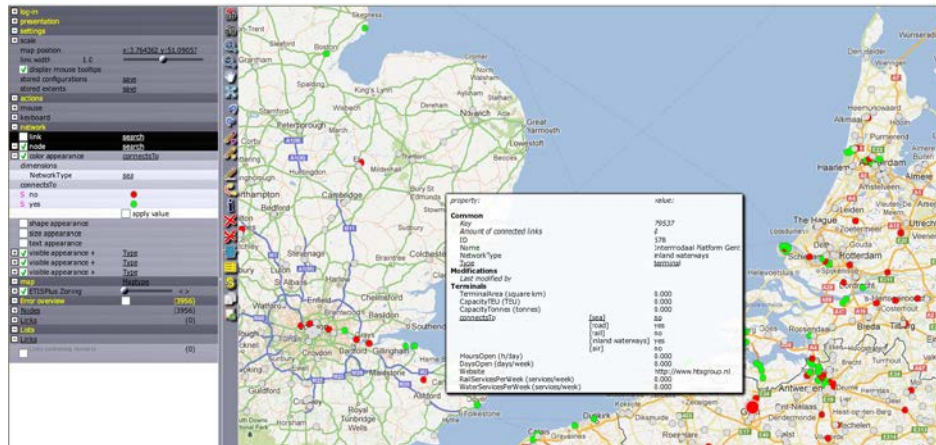
Table 12-1: Structure of Terminal Database

Field Name	Description	Example
TerminalName	Name of Terminal	Puerto Rosario
Country	Country of Location	Spain
ConnectsToRail	1 if connected to rail	0
Connects to Waterway	1 if connected to waterway	0
ConnectsToRoad	1 if connected to road	1
ConnectsToSea	1 if connected to sea	1
Website	Terminal website	http://www.palmasport.es
TerminalArea	Terminal Area (square-km)	0
HrsOpen	Hours Open Per Day	0
DaysOpen	Days Open per Week	0
RailServicesPerWeek	Number of Rail Departures per Week	0
WaterServicesPerWeek	Number of Waterway Departures per Week	0
CapacityTEU	Annual capacity in TEU	24765
CapacityTonnes	Annual capacity in Tonnes	0
Notes	Additional Information	ptorosario@palmasport.es

The terminals layer is accessible via ETIS Netter:

<http://netter.etisplus.net>

Figure 12-2: Terminal data inside ETIS-Netter



12.4 Results

Table 12-2: Key results, Freight Terminals

Access via	Location	Folder	Description
ETIS Bulk Download	Data Bulk Downloads ETIS Data	Additional data Resources	2010 Inland Freight Terminals as SHP file.
2010	http://www.etisplus.eu/data/Public/Downloads.aspx Additional data resources: Land_networks_2005_2010.zip ETISplus_inland_terminals_3_0_final_2010.zip		
2005	Not available.		

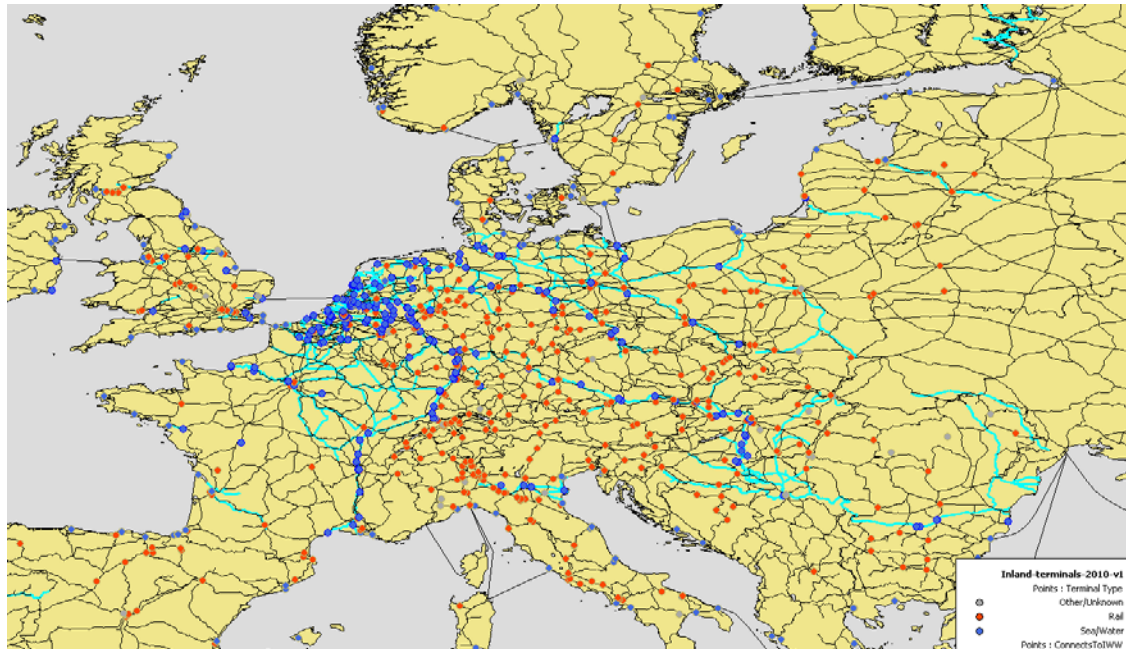
Table 12-3: Key resources inside ETIS-Netter, Freight Terminals

Access via	Location	Toolbar	Description
ETIS NETTER	http://netter.etisplus.net/	Network - Node - Type: terminal - NetworkType: rail or inland waterway	2010 Terminals database as Editable GIS layer.

This map shows the location of rail (red) terminals and sea/water (blue) terminals relative to the inland rail and waterway networks. It is assumed that

the majority of terminals connect to road. Rail/waterway terminals are classified in the map as waterway terminals. A total of 971 terminals are included.

Figure 12-3: Extent of Terminals Database



13 Air Passenger Impedances

13.1 Scope of the Database

Air passenger impedances describe the attributes applying for a passenger trip between a region of origin and a region of destination, when using air transport as a main mode. The impedances also include information about the access between a region and an airport where passengers switch to air transport aircraft and as well the egress between the airport of destination where passengers change to surface transport and the region of destination. So the air passenger impedances delivered in this project cover the full intermodal transport chain.

The following table gives an overview on the main characteristics of the data set.

Table 13-1: Overview of main characteristics of the data set

Air passenger impedances						
Data feature	Data specification					Remarks
Base year	2010					
Scope of data	Link	Terminal	O/D relation	Region	Other	
	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
GIS data	Yes	No				
	<input type="checkbox"/>	<input checked="" type="checkbox"/>				
Country coverage				Com-pletely	Par-tially	
	EU 27			<input checked="" type="checkbox"/>	<input type="checkbox"/>	
	Candidate countries & EFTA			<input checked="" type="checkbox"/>	<input type="checkbox"/>	
	Neighbouring countries			<input checked="" type="checkbox"/>	<input type="checkbox"/>	
	TRACECA			<input type="checkbox"/>	<input checked="" type="checkbox"/>	
	MEDA			<input type="checkbox"/>	<input checked="" type="checkbox"/>	
	Other countries			<input type="checkbox"/>	<input checked="" type="checkbox"/>	
	Total number of countries covered:			68	167	
Main data sources	Air network, Airports, Feeder links prepared by MKmetric (see corresponding annexes). Airport / Route choice algorithms developed by MKmetric.					
Main type of data generation	Observed	<input type="checkbox"/>				
	Harmonised	<input type="checkbox"/>				
	Modelled	<input checked="" type="checkbox"/>				

Table 13-2: Data structure of the air passenger impedances data set

Indicator	Description of indicator	Unit
DATA_GROUP	Metadata on dataset level, since the DB-system only supports metadata on table level. Observed, estimated, modelled data	
SOURCE	Metadata on dataset level, since the DB-system only supports metadata on table level. Data provider, e.g. UN, EUROSTAT, NEA, IWW, MKm, TRT, ...	
FROMDATE	effective in time range; YEAR or period Fromdate, Todate , e.g. Fromdate 20090101, todate20091231 is preferred	
TODATE	effective in time range; YEAR or period Fromdate, Todate , e.g. Fromdate 20090101, todate20091231 is preferred	
SEASON	effective in time range; WINTER SUMMER ALL; so that this information need not be deduced by client programs	
ID	A unique identifier	
FromReg	ETISZone3_ID	
ToReg	ETISZone3_ID	
Purpose	Business, Private, Vacation	
TotalTime	total travel-time in minutes	Minutes
AccessTime	access time in minutes	Minutes
FlightTime	flight time (including transfer times, check-in/-out etc.) in minutes	Minutes
CostAccess	costs [€]	Euro
CostFlight	flight costs [€]	Euro
Frequency	connections per week	
AccessDistance	access distance in kilometres	Kilometres
FlightDistance [km]	distance of flight in kilometres	Kilometres

The impedances are given for each pair of regions considered, i.e. at least one of the regions must be situated in Europe. Europe in this context means the region code has a value below 200.000.000. The impedances outlined are calculated under the precondition that at least one flight segment has to be used, irrespective if one would consider the usage of a flight between a distinct pair of regions as useful or not, what especially may apply for impedances between neighbouring regions.

The field "DATA_GROUP" informs, if an impedance entry belongs to Observed, Estimated or Modelled data. As all impedances are modelled (a combination of impedances on up to 16 routes between region of origin and region of destination on base of modelled route choice probabilities, see section 13.2) they are all indicated with "Modelled" in the DATA_GROUP field.

The "SOURCE" mentions the data provider. As the impedances are all calculated by an in-house route choice algorithm of MKmetric on base of the air network, etc developed within ETISplus by MKmetric, all impedances are marked with "MKm" in this field.

The "FROMDATE", "TODATE" and the "SEASON" fields indicate the time period for which these impedances are valid. As the air network for the year 2010 is the base for preparing these impedances, in consequence for all entries "FROMDATE" is 20100101 and "TODATE" is 20101231, while the value in the "SEASON" field is "ALL".

The attributes "ID", "FromReg" and "ToReg" relate to the network topology. "FromReg" and "ToReg" refer to the code defined within ETISplus to identify the regions considered and provided by the co-ordinator of this project to all partners. The "Id" field contains a unique identifier number and has been generated automatically.

The "Purpose" field indicates for which type of travel the impedance apply. For each pair of origin and destination region three entries for specific trip purposes, "Business", "Private" and "Vacation" exist in the database. While "Business" indicates the impedances for passengers travelling for business reasons, "private" belongs to non-business trips with a total duration of up to four days and "Vacation" is valid for those trips which are non business related with a total duration of the trip exceeding four days.

For all fields following it has to be noted that the numbers indicated are average values derived from up to 16 different routing options between the region of origin and the region of destination mentioned by the fields "FromReg" and "ToReg". For details of calculating these averages see section 13.2. Note that for the same pair of regions mentioned these values vary depending on the trip purpose, as passengers travelling for business reasons may prefer a routing offered with a higher frequency (e.g. twice times daily) even when it requires a plane change at an intermediate airport instead of using a nonstop-flight offered only on a weekly base e.g. at the week-end. More general: the route choice, which takes into account total travel-time, costs, number of plane changes, frequency, availability of low cost carriers, if flights are offered during the week or on weekends only and many other attributes varies significantly according to the trip purpose.

The field "TotalTime" indicates the total travel-time in minutes between the region of origin and the region of destination mentioned in the corresponding fields. This value is the sum of the fields "AccessTime" and "FlightTime".

The field "AccessTime" indicates the amount of time needed to reach the starting airport from the region of origin plus the travel-time from the arriving airport to the region of destination by surface transport. This value combines travel-time by rail or public transport and travel-time by car according to the trip purpose specific mode choice incorporated in the air connector link.

"Flight time" indicates the amount of time spent on the "airside" of a trip between the region of origin and the region of destination, including transfer times needed for a plane change at an intermediate airport.

The field "CostAccess" indicates the costs applying for the access and the egress segment of the trip between the region of origin and the starting airport plus those for the segment between the arriving airport and the region of destination.

This value combines costs for rail or public transport usage and costs applying when using a car according to the trip purpose specific mode choice incorporated in the air connector link.

“CostFlight” is the field where the costs for the flight segment which may or may not include an intermediate plane change for the distinct pair of regions is indicated. These costs vary significantly according to the trip purpose, as the average costs on a distinct air link are differentiated by trip purpose. Furthermore the route choice for a distinct pair of regions differs depending on the trip purpose as mentioned before.

The “Frequency” field indicates the number of travel options per week which are available between the region of origin and the region of destination. Also this value is an average of the different frequencies applying for different route alternatives according to the trip purpose specific route choice.

The last two fields “AccessDistance” and “FlightDistance [km]” indicate the distances of the surface transport segment or the flight segment between the region of origin and the region of destination in kilometres. Like the other fields mentioned before these fields are average values calculated of the route choice probabilities applying on the underlying air network connectors or the links from the air network.

13.1.1 Definition of Air Connectors

Air network connectors are links between regions according to the underlying regionalisation defined for ETISplus and the airports. Together with the airport links they form a modelled network for air transport in which all regions are connected to each other.

The air connector database has more than 25,000 entries with the structure as outlined in the following table:

Table 13-3: Data structure of the air network connectors passenger set

Indicator	Description of indicator	Unit
DATA_GROUP	Metadata on dataset level, since the DB-system only supports metadata on table level. Observed, estimated, modelled data	Char
SOURCE	Metadata on dataset level, since the DB-system only supports metadata on table level. Observed, estimated, modelled data	Char
FROMDATE	effective in time range; YEAR or period Fromdate, Todate , e.g. Fromdate 20100101, Todate 20101231 is preferred	Integer
TODATE	effective in time range; YEAR or period Fromdate, Todate , e.g. Fromdate 20100101, Todate 20101231 is preferred	Integer
SEASON	effective in time range; WINTER SUMMER ALL; so that this information need not be deduced by client	Char

Indicator	Description of indicator	Unit
	programs	
ID	A unique identifier for each link	Integer
Type	[cargo/pax/both]	Char
Zoneld	Region Id	Integer
AirportIdentifier	e.g. FRA	Char
TimePassengerPT		minutes
TimePassengerRoad		minutes
TimeInVehiclePT		minutes
TimeInVehicleRoad		minutes
TimeCargo		minutes
DistancePT		km
DistanceRoadPassenger		km
DistanceRoadCargo		km
FrequencyPT		Integer
RailCostBusiness		Euro
RailCostPrivate		Euro
RailCostVacation		Euro
RoadCostBusiness		Euro
RoadCostPrivate		Euro
RoadCostVacation		Euro
PTShareBusiness		Integer
PTSharePrivate		Integer
PTShareVacation		Integer

The field "DATA_GROUP" informs, if an impedance entry belongs to Observed, Estimated or Modelled data. As all air connectors are modelled they are all indicated with "Modelled" in the DATA_GROUP field.

The "SOURCE" mentions the data provider. As the air network connectors are all calculated from impedances for rail and road transport computed from the networks developed for ETISplus (see corresponding annexes) by an in-house mode choice model developed within ETISplus by MKmetric, all impedances are marked with "MKm" in this field.

The "FROMDATE", "TODATE" and the "SEASON" fields indicate the time period for which these links are valid. As the rail and road networks for the year 2010 are the base for preparing these air connectors, in consequence for all entries "FROMDATE" is 20100101 and "TODATE" is 20101231, while the value in the "SEASON" field is "ALL".

The "Id" field contains a unique identifier number for each entry and has been generated automatically.

The "Type" field indicates if an entry is a link for passenger transport only (PAX), for cargo transport only (CARGO) or valid as well for passenger and cargo (BOTH).

"ZoneId" indicates the region's numeral code defined within ETISplus to identify the region which is connected to an airport.

"AirportIdentifier" indicates the airport to which a region is connected. The official Three-Letter-Code assigned by IATA to an airport is used (see Annex C3_2010 for details).

The field "TimePassengerPT" indicates the total travel-time in minutes needed by public transport (i.e. by rail to the railway station of the airport or the one situated next to him including a potential transfer between this station and the airport itself). Note that not in all cases access to an airport by public transport is possible. In these cases the field contains the value "NULL". This also applies for air connectors linking the region in which the airport itself is situated to the airport. For details of calculating this time we refer to the corresponding annex concerning the rail network / rail impedances.

The "TimePassengerRoad" field shows the total travel-time in minutes needed by car between a region and an airport. For details of calculating this time we refer to the corresponding annex concerning the road network / road impedances.

The fields "TimeInVehiclePT" contains the travel-time, which is actually spent within the vehicle(s) used to access the airport. The difference to the value in the "TimePassengerPT" field mentioned before is the time needed to change between trains on intermediate stations or e.g. between a train and the bus shuttle between the railway station situated next to an airport and the airport itself if necessary. In cases where both fields show identical values, this indicates that there are direct train connections available between on the distinct relation between region and airport.

Also for car usage a field referring to the time actually spent in the vehicle ("TimeInVehicleRoad") exists. For this mode the difference to the value of "TimePassengerRoad" indicates the amount of time, used for a break during the road trip or for refill the tank. This value is calculated as a percentage value of in vehicle time, decreasing with the distance. It does not apply on short distances.

The field "TimeCargo" shows the total transport time in minutes by truck between the region and the airport mentioned by the entry. For details of calculating this time we refer to the corresponding annex concerning the road network / road impedances.

The fields "DistancePT", "DistanceRoadPassenger" and "DistanceRoadCargo" indicate the distances one has to cover on the rail or the road network between the region and the airport mentioned. Note that there may occur differences in the road distances between passenger and cargo transport as, the route chosen in these cases may differ, due to possible maximum speeds on distinct roads. Also the distinct (secondary) roads may be blocked for trucks resulting in a different routing than for passenger cars may apply.

The field "FrequencyPT" indicates the number of train connections available per week on the distinct region / airport pair per week.

Since pure 1st class trains (which preferably were used by business-travellers) are out of service all over Europe since decades the travel-times by rail are independent from the trip purpose. This does not hold for the travel costs applying, where first class usage is assigned to business travellers, while passengers travelling for other reasons are supposed to travel in 2nd class. In consequence this assignment of trip purposes by the costs for public transport indicated in the fields "RailCostBusiness", "RailCostPrivate" and "RailCostVacation".

A similar variation applies for the costs of car usage used for the impedances between region and airport. While for business-travel a full cost approach (including recovery costs of the vehicle) applies, for private car usage an out-of-pocket cost calculation was chosen. This leads to average costs for car usage of 40 Eurocent / kilometres on which the value in the field "RoadCostBusiness" has been calculated. On contrary for car usage cost of 10 Eurocent/kilometre apply which is the base for the value in the fields "RoadCostPrivate" and "RoadCostVacation". Both values are valid for the year 2010.

The last three fields "PTShareBusiness", "PTSharePrivate" and "PTShareVacation" indicate the percentage of travellers' choosing public transport on the distinct relation between a region and an airport. These values are a result of a modal split model especially applied for access and egress between regions and airports. The modal has been estimated on base of information retrieved from passenger surveys. Notably, a general observation from these data has been that usage of public transport increases with the distance between region and airport, what especially holds for business-travellers. But this does not mean that business travellers in total use public transport at a higher share than passengers travelling for private reasons, as the number of business travellers who actually travel very long-distances to an airport is quite rare. Moreover they prefer to fly to or from the airports situated next to the region of destination or origin, while leisure passengers tend to use airports in a larger distance, if their usage implies the availability of nonstop connections or lower prices for the flight segment of their trip.

13.2 Methodology

Different to the surface transport modes road and rail, in air transport the route chosen by the individual traveller may vary quite significantly depending how the attributes of different possible routings between a region of origin and a region of destination compare to each other and how these attributes are weighted by the traveller. For that reason the impedance values (i.e. the average travel-time, costs, the frequency etc.) applying for a trip on a distinct pair of regions should be an average on base of different travel alternatives. This average should be weighted by the choice probability applying to each travel alternative, if the resulting impedance values shall represent the reality properly.

13.2.1 Airport Choice

Instead of using the routing for which the shortest travel-time applies, some passengers may strictly go for the cheapest option, well accepting flights by a low cost carrier from a remote airport. And others may favour a routing which requires a plane change at an intermediate airport but offered with high frequency over an alternative nonstop flight offered just once per week.

To handle the individual route choice, MKmetric has set up an airport and route choice model which assigns route choice probabilities for a set of travel alternatives. The model has been estimated on passenger survey data from multiple airports in Germany and other countries of the EU, and from international passenger surveys, e.g. dateline. Beside travel-time, costs and frequency as core attributes, the model takes into account quite a lot of additional attributes applying for the specific travel option, like:

- the weekdays of operation,
- if the departing airport is in the same country like the region of origin,
- if it's a nonstop flight,
- if a flight connection is with the same carrier or alliance,
- the time slice(s) of the day in which flights are available,
- the share of flights operated by low cost carriers,
- the access distance between region of origin and starting airport or
- the quality of access by public transport between region and airport

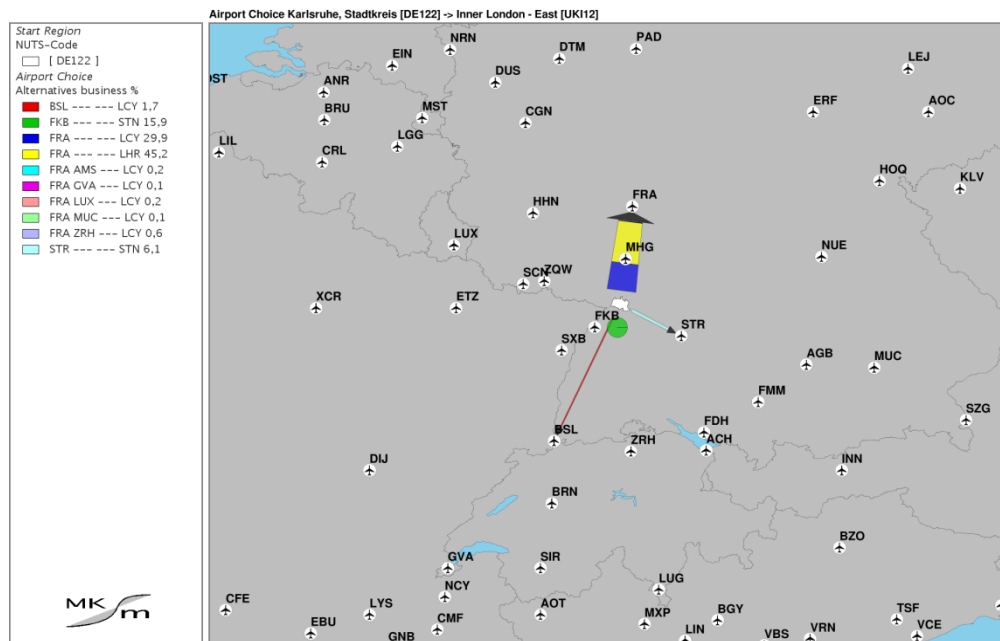
to mention just a few of them. Note that the weights applying to these attributes differ with the trip purpose and not every attribute has turned out to be relevant for each trip purpose, when setting up the model. Concerning the number of alternatives to be considered, we found out that considering:

- 6 alternatives on domestic trips,
- 10 alternatives on international but continental trips and
- 16 alternatives for intercontinental trips

is sufficient to simulate the observed airport and route choice properly.

The following examples of trip purpose specific airport choice shall illustrate the results when applying this model.

Figure 13-1: Airport choice Karlsruhe -> London East on business trips



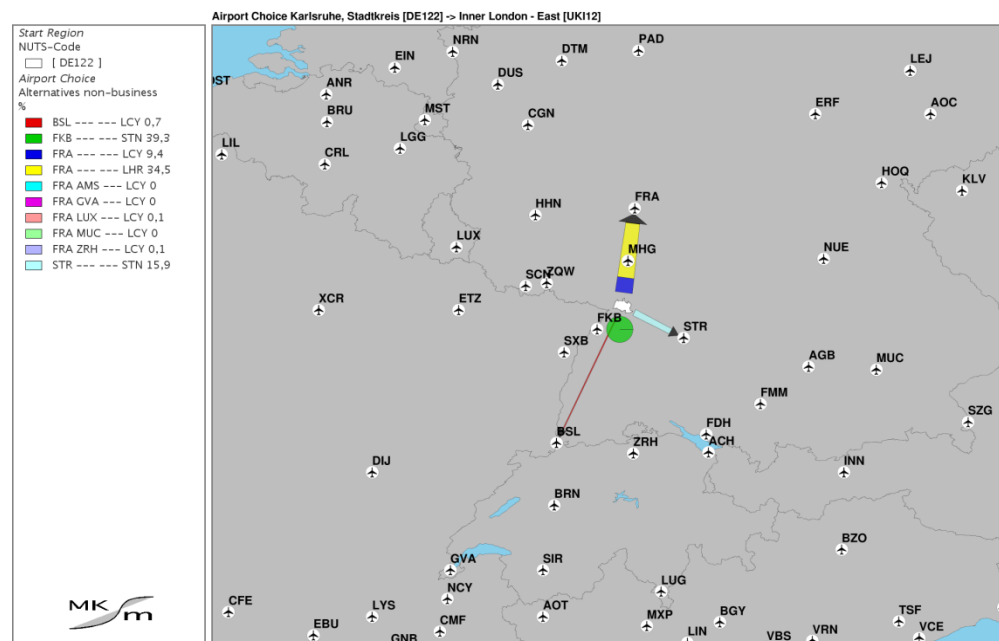
The figure above indicates the route choice probabilities when travelling between the city of Karlsruhe and Inner London East for business reasons.

The majority of passengers prefer to use the nonstop flights from Frankfurt airport (FRA) to London Heathrow (LHR) with a share of 45%. Other relevant route alternatives are the nonstop flights from FRA to the London City airport (LCY) with 30% of share while the flights from the Karlsruhe/Baden-Baden airport (FKB) to London Stansted (STN) are chosen by less than 16% percent of all business travellers on this relation and finally 6% use the flights from Stuttgart airport (STR) to STN.

Surprisingly flying from FRA is prior against using flights from STR and especially from FKB, which in fact is the closest airport to Karlsruhe. This results from the much higher frequencies offered on FRA-LHR (almost every hour) as on FKB-STN (just once daily), although these flights are relatively cheap as they are operated by Ryanair, a low cost carrier. Furthermore FRA is accessible excellent by ICE trains within one hour from Karlsruhe, while public transport to the other airports is quite poor (FKB) or at least time consuming (STR). On the other hand the FRA-LCY route is not that much chosen when comparing it with flying to LHR: a result of the lower frequencies offered to this airport, combined with the higher price level applying for this destination. And finally for the route STR-STN (operated by the cow cost carrier Germanwings) it has to be stated, that it hardly can compete in business travel concerning frequency and public transport access (FRA to LHR and also LCY) or travel-time and costs (FKB-STN) with the other routes here.

Quite a different picture applies when looking at passengers travelling for private reasons as indicated in the following figure.

Figure 13-2: Airport choice City of Karlsruhe -> London East non-business



For passengers travelling on private reasons between Karlsruhe and London East the alternative number one are the low cost flights offered from FKB to STN, with a choice probability of more than 39%, while the trunk route FRA-LHR lies at less than 35%. In consequence the costly flights to LCY are chosen by less than 10% from this group of travellers, while the low cost flights from STR to STN at least accumulate a market share of nearly 16%. Concerning the other alternatives considered in the route choice model, which mainly are transfer connections to LCY, it has to be stated that such alternatives at least are chosen by some business travellers for various reasons (e.g. like availability on short notice, when a distinct nonstop flights may be fully booked) and sum up to a market share of nearly 3%, while such alternatives are virtually not chosen when travelling on private reasons (0.2%).

13.2.2 Building the impedance matrix

The input for the airport choice, as mentioned in the section before is a set of up to 16 different route alternatives. They are constructed as follows: In a combined network of air links and air network connectors, the shortest time path between these regions is identified and stored with its attributes (time, costs, frequency, etc.). Then the air link used on this path is blocked and the shortest path identified in remaining network is also stored. This procedure is repeated until in maximum 6 (for domestic trips), 10 (for European trips) or 16 (for intercontinental trips) different travel options have been identified for each pair of regions to be considered.

In some cases of connections between regions both situated in quite a remote area, it may occur, that the number of alternatives mentioned before cannot be

reached. In these cases the number of routes which can be considered is lower, but as long as at least one routing can be identified, impedance values for a pair of regions can be calculated.

In a second step then the route choice probabilities for each pair of regions is calculated with the route choice model described.

In a third step the impedance attributes as listed in Table 13-2 for all routings of a distinct pair of regions then are weighted by the route specific probability shares. This procedure result in the weighted average impedances delivered.

Finally the resulting impedances are checked if all relevant pairs of regions (i.e. all relations to and from regions in Europe) are covered. This is necessary, as in some very rare cases it is not possible to identify even a single route for a distinct pair of regions. This applies for example for many routes to and from the Falkland Islands, as they are only served by military flights which also can be used by civilians from the air base Brize Norton. As Brize Norton does not have any other flights available for public usage, travelling e.g. from Karlsruhe to the Falklands requires an intermediate transport by surface modes e.g. between one of the London airports and Brize Norton air base. For these remaining cases we combine the Cartesian product from all impedances for the "FromReg" and the impedances for the "ToReg" and pick out that combination of impedances which in sum shows the shortest travel-time. This combination of impedances mirrors the actual path to travel in such cases quite well. For example for the impedance between Karlsruhe and the Falklands we combine the impedance values applying for the relation between Karlsruhe and Oxfordshire (which is the region where the air base of Brize Norton is situated) and the impedance between Oxfordshire and the Falklands.

13.3 Data sources

The main data sources to calculate the impedances for the ETISplus project are the ETISplus air network, the ETISplus air network connectors and the in-house airport / route choice model developed by MKmetric. For an in depth description on that modelling we refer to:

1. "Airport Choice & Competition – a Strategic Approach, a paper from the 3RD AIR TRANSPORT RESEARCH GROUP (ATRG) CONFERENCE 1999, IN HONG KONG to be downloaded at http://mkm.de/content_files/publications/airport_choice_and_competition.pdf
2. "Measuring Competition in Air Transport", a paper published at the CONFERENCE: AIRPORT AND AIR TRAFFIC– REGULATION, PRIVATISATION AND COMPETITION –HAMBURG, FEBRUARY 1998 to be downloaded at http://mkm.de/content_files/publications/measuringcompetition.pdf and
3. "The interdependency of airport choice and travel demand", a paper published at the SYMPOSIUM 'TAKING STOCK OF AIR LIBERALISATION' AT THE ICAO IN MONTRÉAL 04.1997. To be downloaded at

http://mkm.de/content_files/publications/interdependency_airportchoice_and_travel_demand.pdf

The airport surveys mentioned are commercial data from airports or airport authorities and are not freely published. At least some of them can be purchased and then internally used, but still may not be published freely. For example the surveys regularly undertaken by British Civil Aviation Authority (CAA) can be bought:

<http://www.caa.co.uk/default.aspx?catid=81&pagetype=90>

To give an idea, what type of information is gathered from these interviews see <http://www.caa.co.uk/default.aspx?catid=81&pagetype=90> and for the methodology of the survey see

<http://www.caa.co.uk/default.aspx?catid=1279&pagetype=90&pageid=7629>

Please note that these links may change. So in case the links given may not work start at <http://www.caa.co.uk/> and use the search field with "passenger survey" to find that information.

13.4 Results

The impedances delivered within this project for the year 2010 cover all relations for region pairs, according to the regionalisation defined within ETISplus for this year¹. European in this context means, that one of the two regions must be situated in Europe (i.e. the region code has a value below 200.000.000). So intra-European impedances are covered as well as impedances between regions in Europe and regions on other continents, but impedances between two regions, both situated in other continents are not covered. Impedances are given for three trip purposes: business, private, vacation.

Table 13-4: Key results, Air passenger impedances

Access via	Collection	Group	Description
ETIS View	Modelled Data	Passenger	Flight times, flight distances and travel costs per O/D.
2010	http://viewer.etisplus.net/ select collection: ETISplus-2010-Modelled highlight: Passenger open table: Air Impedances - Passenger		
2005	http://viewer.etisplus.net/ select collection: ETISplus-2005-Modelled highlight: Passenger open table: Air Impedances - Passenger		

¹ The regionalisation defined for the year 2010 differs from the one for the year 2005

The impedances delivered for 2010 consist of 14,535,690 entries covering the three trip purposes of 2,422,615 pairs of regions. As the impedances are shown for each direction of travel and not necessarily are symmetric this means they cover 4,845,230 relations between a region of origin and a region of destination. The following table shows the number of relations considered by geographic scope:

Table 13-5: geographic scope of relations covered by the impedance matrix

<i>From / To</i>		<i>Europe</i>	<i>Africa</i>	<i>Asia***</i>	<i>Oceania</i>	<i>The Americas</i>	<i>Total</i>
	#Regions	1.586	196	336	34	169	2.321
<i>Europe**</i>	1,586	2,513,810*	310,856	532,896	53,924	268,034	3,679,520
<i>Africa</i>	196	310,856	-	-	-	-	310,856
<i>Asia***</i>	336	532,896	-	-	-	-	532,896
<i>Oceania</i>	34	53,924	-	-	-	-	53,924
<i>The Americas</i>	169	268,034	-	-	-	-	268,034
<i>Total</i>	2,321	3,679,520	310,856	532,896	53,924	268,034	4,845,230

* $2,513,810 = 1,586 * 1,585$ relations, as no impedances to a region itself are computed.

** The airports of the French Overseas Départements (e.g. Martinique) are counted to the continents of Africa or the Americas respectively.

*** Including regions in Russia.

14 Air Freight Impedances

14.1 Scope of the Database

Air cargo impedances describe the attributes applying for a freight transport between a region of origin and a region of destination, when using air transport as a main mode. The impedances also include information about the feeder transport between a region and an airport where the freight is transhipped to an aircraft and as well between the airport where the freight is unloaded from an aircraft and transhipped to a truck to carry it to the final region of destination. So the air cargo impedances delivered in this project cover the full intermodal transport chain.

The following table gives an overview on the main characteristics of the data set.

Table 14-1: Overview of main characteristics of the data set

Air freight impedances						
Data feature	Data specification					Remarks
Base year	2010					
Scope of data	Link	Terminal	O/D relation	Region	Other	
	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
GIS data	Yes	No				
	<input type="checkbox"/>	<input checked="" type="checkbox"/>				
Country coverage				Com-pletely	Par-tially	
	EU 27			<input checked="" type="checkbox"/>	<input type="checkbox"/>	
	Candidate countries & EFTA			<input checked="" type="checkbox"/>	<input type="checkbox"/>	
	Neighbouring countries			<input checked="" type="checkbox"/>	<input type="checkbox"/>	
	TRACECA			<input type="checkbox"/>	<input checked="" type="checkbox"/>	
	MEDA			<input type="checkbox"/>	<input checked="" type="checkbox"/>	
	Other countries			<input type="checkbox"/>	<input checked="" type="checkbox"/>	
	Total number of countries covered:			68	167	
Main data sources	Air network, Airports, Feeder links prepared by MKmetric (see corresponding annexes). Airport / Route choice algorithms developed by MKmetric.					
Main type of data generation	Observed	<input type="checkbox"/>				
	Harmonised	<input type="checkbox"/>				
	Modelled	<input checked="" type="checkbox"/>				

Table 14-2: Data structure of the air freight impedances data set

Indicator	Description of indicator	Unit
DATA_GROUP	Metadata on dataset level, since the DB-system only supports metadata on table level. Observed, estimated, modelled data	
SOURCE	Metadata on dataset level, since the DB-system only supports metadata on table level. Data provider, e.g. UN, EUROSTAT, NEA, IWW, MKm, TRT, ...	
FROMDATE	effective in time range; YEAR or period Fromdate, Todate , e.g. Fromdate 20100101, todate 20101231 is preferred	
TODATE	effective in time range; YEAR or period Fromdate, Todate , e.g. Fromdate 20100101, todate 20101231 is preferred	
SEASON	effective in time range; WINTER SUMMER ALL; so that this information need not be deduced by client programs	
ID	A unique identifier	
FromReg	ETISZone3_ID	
ToReg	ETISZone3_ID	
Purpose	Business, Private, Vacation	
TotalTime	total transport-time in minutes	Minutes
AccessTime	access time in minutes	Minutes
FlightTime	flight time (including transshipment times) in minutes	Minutes
Frequency	connections per week	
AccessDistance	access distance in kilometres	Kilometres
FlightDistance [km]	distance of flight in kilometres	Kilometres

The impedances are given for each pair of regions considered, i.e. at least one of the regions must be situated in Europe. Europe in this context means the region code has a value below 200.000.000. The impedances outlined are calculated under the precondition that at least one flight segment has to be used, irrespective if one would consider the usage of a flight between a distinct pair of regions as useful or not, what especially may apply for impedances between neighbouring regions.

The field "DATA_GROUP" informs, if an impedance entry belongs to Observed, Estimated or Modelled data. As all impedances are modelled (a combination of impedances on up to 16 routes between region of origin and region of destination on base of modelled route choice probabilities, see section 14.2) they are all indicated with "Modelled" in the DATA_GROUP field.

The "SOURCE" mentions the data provider. As the impedances are all calculated by an in-house route choice algorithm of MKmetric on base of the air network, etc developed within ETISplus by MKmetric, all impedances are marked with "MKm" in this field.

The "FROMDATE", "TODATE" and the "SEASON" fields indicate the time period for which these impedances are valid. As the air network for the year 2010 is the base for preparing these impedances, in consequence for all entries "FROMDATE"

is 20100101 and "TODATE" is 20101231, while the value in the "SEASON" field is "ALL".

The attributes "ID", "FromReg" and "ToReg" relate to the network topology. "FromReg" and "ToReg" refer to the code defined within ETISplus to identify the regions considered and provided by the co-ordinator of this project to all partners. The "Id" field contains a unique identifier number and has been generated automatically.

For the following fields it has to be noted that the numbers indicated are average values derived from up to 16 different routing options between the region of origin and the region of destination mentioned by the fields "FromReg" and "ToReg". For details of calculating these averages see section 13.2.

The field "TotalTime" indicates the total transport-time in minutes between the region of origin and the region of destination mentioned in the corresponding fields. This value is the sum of the fields "AccessTime" and "FlightTime".

The field "AccessTime" indicates the amount of time needed to reach the starting airport from the region of origin plus the transport-time from the arriving airport to the region of destination by surface transport, which relies solely on road transport impedances, as rail transport isn't used regularly anywhere as feeder for air cargo for the time being. All attempts to establish rail feeders for air cargo, e.g. like the Cargo Sprinter in Germany¹ failed due to a lack of commercial sustainability.

"Flight time" indicates the amount of time needed on the "airside" of an intermodal transport between the region of origin and the region of destination, including transshipment times needed at an intermediate airport.

The "Frequency" field indicates the number of transport options per week which are available between the region of origin and the region of destination. Also this value is an average of the different frequencies applying for different route alternatives according to the trip purpose specific route choice.

The last two fields "AccessDistance" and "FlightDistance [km]" indicate the distances of the surface transport segment or the flight segment between the region of origin and the region of destination in kilometres. Like the other fields mentioned before, these fields are average values calculated by the route choice probabilities applying on the underlying air network connectors or the links from the air network.

14.2 Methodology

Different to the surface transport modes road and rail, in air transport the route on which cargo is transported may vary significantly from the time shortest path. So calculating impedance values for air cargo should take into account the actual

¹ <http://en.wikipedia.org/wiki/CargoSprinter>

paths on which air cargo is carried, when providing a matrix of impedances for air cargo close to reality is the target.

While this phenomenon has already been observed in passenger transport, the relevant attributes in route choice in air cargo differ significantly from those in passenger transport for various reasons.

From the supply side two main types of operations can be identified:

- **Integrators.** They operate an own network of flights which are connected to each other on distinct hubs, where cargo is transhipped between these flights, in cases where starting airport and destination airport of the air segment along a cargo transport are not linked by their own flights directly. This air network is complemented by an extensive network of trucking links to and from these airports, which allows offering a full door-to-door-service on their own, although exceptions from that principle may apply in some cases. In consequence integrators solely rely on their own network, so that in consequence quite long surface trucking may apply for transport to / from regions which are situated quite remote to the next airport served by the flights of a distinct integrator. DHL, FedEx or UPS are examples for operators of air cargo transport belonging to this type of services.
- **Airlines providing airport to airport services co-operating with (regional) freight forwarders.** Here usually a freight forwarder co-operates with several airlines, irrespective if these are operating pure cargo flights only, carry freight with their passenger flights (belly cargo) or do a mixture of both.

A third type of cargo services – ad hoc charter flights - for one-time non-recurring demand on a distinct point-two-point-relation, has not been taken into account for the calculation of impedances in air cargo. Such flights connect a pair of airports by a direct flight, where an intermediate stop only applies in cases where the transports distance exceeds the aircraft's technical range. Calculating impedances on that base would lead to significantly shorter transport time values compared to the usage of a network consisting of regular flights and therefore distort the resulting average impedance values, to be delivered within this project.

From the demand side it has to be stated, that the end customer usually does not decide on the explicit path air cargo is carried, but for a distinct provider, offering the freight service needed. This decision furthermore is not taken anew on each and every transport order. So in the very end it's the service provider (integrator or freight forwarder) deciding on airport and route choice, resulting in a combination of attributes to satisfy best the transport needs of an end customer.

14.2.1 Airport Choice

Assignment tests undertaken when setting up the air cargo matrix 2005 relying on pure time-shortest paths showed unsatisfying results. So, similar to air passenger transport, we decided to set up an airport and route choice model which assigns route choice probabilities for a set of air transport alternatives for

air cargo transport to handle the route choice applying. As we learned in the previous section, the service providers are those who decide on the airport and the route choice applying for a distinct transport. So modelling route choice patterns for air cargo must reflect their preferences prior to those of end customers.

An extensive literature research identified the following aspects to be quite relevant for route choice in air cargo

- transport time
- distance on the surface feeder link, as well as for the flight segment
- frequency of services available
- number of transshipments as a core attribute
- if a flight connection is offered by the same carrier or cargo alliance
- attributes of the starting airport / destination airport describing its relevance for air cargo, like
 - number of (international) destinations served
 - number of pure cargo flights offered

The number of transshipments is of extraordinary relevance, as different to air passengers, this implies additional handling procedures and therefore costs and significantly longer time is needed to enable a connection between two flights.

The airport attributes mentioned turned out to be relevant as first integrators are bound to the flights operated by them and the airports they serve. Secondly freight forwarders prefer to combine air cargo collected by trucking feeder services efficiently to multiple destinations of flights or in reverse to distribute air cargo by truck collected from many different flights. In many cases this trucking includes freight which isn't transported by air at all. So they implemented transshipment centres at airports and preferably do that on airports, where a wide variety of air cargo services exist. This lumping of supply at distinct airports is best represented in modelling with the airport variables mentioned above.

Other attributes which showed relevance in air passenger transport but did not so for air cargo are for example the weekdays on which flight services are operated or the access distance between region and airport to mention just two of them. Also defining cost variables and trying to bring them into the airport / route choice modelling turned out to bring no improvement to the calibration and assignment routines. As their absolute level is about ten times as high as the costs for surface transport (i.e. for shipping in intercontinental cargo transport), their relevance for route choice when air transport is used at all is limited. So relying on the distances and especially the airport attributes showed much better results. So we kept the approach chosen for modelling the air cargo matrix (see corresponding report in WP 8), which has been adapted from the WORLDNET project, what furthermore has been agreed when setting up this project.

All these findings were used to modify the airport and route choice modelling applied for air passenger transport and lead to a specific route choice model of MKmetric for air cargo. The following example where route choice is compared for the OD-pair of Karlsruhe and Thailand shows the main differences resulting

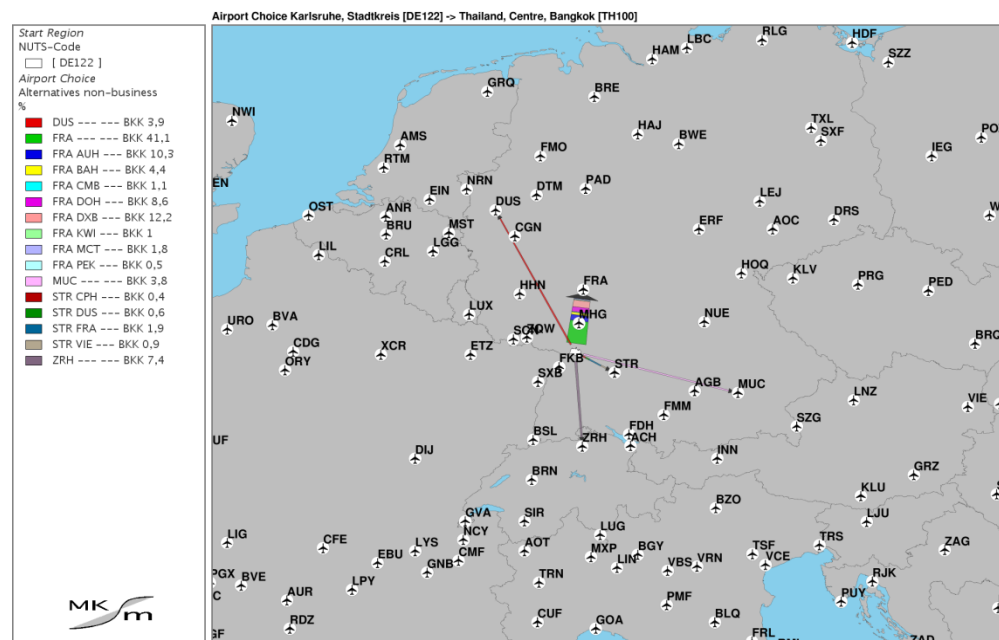
from the diverging attributes and their weight in airport choice between passenger transport and air cargo.

Table 14-3: Comparison of airport choice in passenger and freight transport

Airport / Route Choice	Passengers (non-business)	Cargo
Usage of Direct Flights	56,3%	90,9%
Usage of Transfer Flights	43,7%	9,1%
Starting from DUS	3,9%	0%
Starting from FRA	81,0%	69,2%
Starting from LUX	0%	10,0%
Starting from MUC	3,9%	5,0%
Starting from STR	3,8%	0,4%
Starting from ZRH	7,4%	15,5%

The table above illustrates quite well that different to passenger transport there is quite a strict focus in route choice on direct flights, irrespective if operated non-stop or with intermediate stops, to avoid any transshipment of cargo within the flight segment of the transport, resulting in more than 90% of cargo on the OD-pair mentioned is transported by nonstop-flights, while passengers on the same route only with a slight majority of 56% prefer nonstop flights.

Figure 14-1: Airport choice Karlsruhe -> Thailand, Centre for passengers

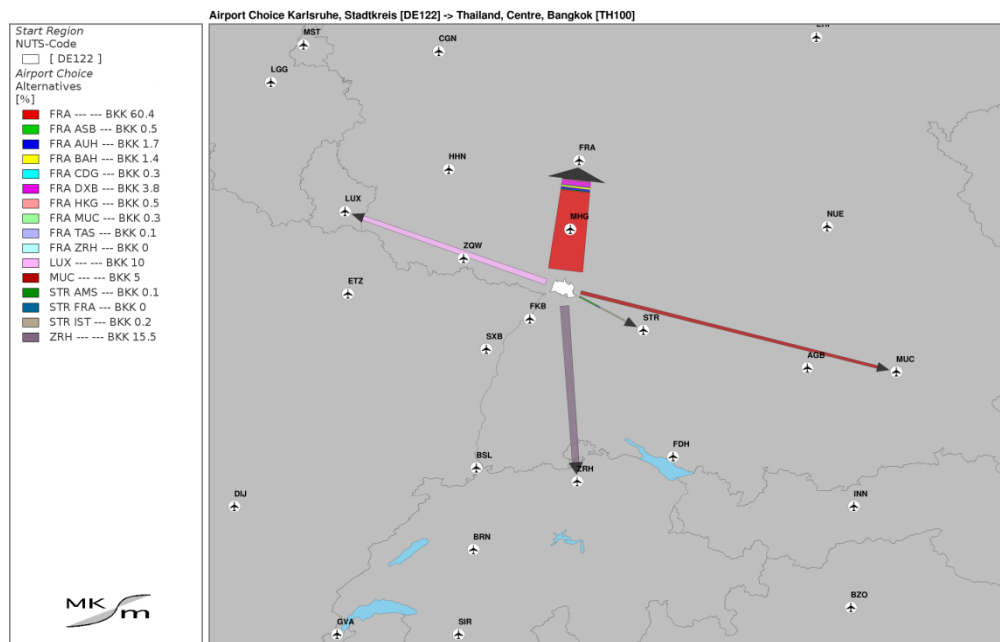


The second core difference between air passenger and air cargo transport is in the choice of the starting airport: Passengers tend more to use the next available airports, while for air cargo the availability of cargo services in total at the starting airport is of higher relevance. This especially comes clear in case of

Luxembourg (LUX), where the cargo airline Cargolux has its base and from where it serves multiple destinations all over the world by direct flights.

In passenger transport as outlined in the figure above, a significant part of the demand towards Thailand is routes via one of the Gulf carriers' hubs like AUH (Abu Dhabi), BAH (Bahrain), DOH (DOH) or Dubai (DXB), which does not apply for air cargo at all or at least not in an amount of that quantity (see following) figure.

Figure 14-2: Airport choice Karlsruhe -> Thailand, Centre for air cargo



14.2.2 Building the impedance matrix

The input for the airport choice, as mentioned in the section before is a set of up to 16 different route alternatives. They are constructed as follows: In a combined network of air links and air network connectors, the shortest time path between these regions is identified and stored with its attributes. Then the air link used on this path is blocked and the shortest path identified in the remaining network is also stored. This procedure is repeated until in maximum 6 (for domestic flights connections), 10 (for European flights connections) or 16 (for intercontinental flights connections) different transport options have been identified for each pair of regions to be considered.

In some cases of connections between regions both situated in quite a remote area, it may occur, that the number of alternatives mentioned before cannot be reached. In these cases the number of routes which can be considered is lower, but as long as at least one routing can be identified, impedance values for a pair of regions can be calculated.

In a second step then the route choice probabilities for each pair of regions is calculated with the route choice model developed for air cargo.

In a third step the impedance attributes for all routings of a distinct pair of regions then are weighted by the route specific probability shares. This procedure results in the weighted average impedance delivered.

Finally the resulting impedances are checked if all relevant pairs of regions (i.e. all relations to and from regions in Europe) are covered. This is necessary, as sometimes it is not possible to identify even a single route for a distinct pair of regions.

For these remaining cases we combine the Cartesian product from all impedances for the "FromReg" and the impedances for the "ToReg" and pick out that combination of impedances which in sum shows the shortest travel-time. This combination of impedances mirrors the actual path to travel in such cases quite well.

An example for such a situation is the impedance which applies for air cargo between the region of Tirana, Albania and Nauru. In this case the air cargo impedance is calculated on base of combining the impedances from Tirana to Singapore and from Singapore to Nauru resulting to the shortest path as follows:

1. Trucked to Tirana, the national airport of Albania,
2. flown from Tirana to Athens, Greece
3. transhipped and flown from Athens to Singapore
4. transhipped and flown from Singapore to Brisbane, Australia
5. transhipped and flown to the airport of Nauru and
6. trucked "the last mile" to the destination.

14.3 Data sources

The main data sources to calculate the impedances for the ETISplus project are the air network, the air network connectors and the MKmetric airport/route choice model. For an in depth description on that modelling we refer to:

1. "Airport Choice & Competition – a Strategic Approach, a paper from the 3RD AIR TRANSPORT RESEARCH GROUP (ATRG) CONFERENCE 1999, IN HONG KONG to be downloaded at http://mkm.de/content_files/publications/airport_choice_and_competition.pdf
2. "Measuring Competition in Air Transport", a paper published at the CONFERENCE: AIRPORT AND AIR TRAFFIC– REGULATION, PRIVATISATION AND COMPETITION –HAMBURG, FEBRUARY 1998 to be downloaded at http://mkm.de/content_files/publications/measuringcompetition.pdf and
3. "The interdependency of airport choice and travel demand", a paper published at the SYMPOSIUM 'TAKING STOCK OF AIR LIBERALISATION' AT THE ICAO IN MONTRÉAL 04.1997. To be downloaded at

http://mkm.de/content_files/publications/interdependency_airportchoice_and_traveldemand.pdf

For the adaption of these routines, originally developed for air passenger transport, to air cargo we refer to the following literature:

1. Morell, Peter S., *Moving boxes by air: the economics of international air cargo* / by Peter S. Morell. Ashgate Publishing Limited, Farnham, UK, 2011.
2. Scholz, Aaron B., *Network Structures of Cargo Airlines: An Empirical and a Modelling Approach* / by Aaron B. Scholz. KIT Scientific Publishing, Karlsruhe, Germany, 2012.
3. Scholz, Aaron B. & Mandel, Benedikt & Schaffer, Axel, 'Implications on short-term Cargo Collapses on European Airports', *Der öffentliche Sektor – The public Sector*, vol. 37, issue 3-4/2011, pp 39 - 52

14.4 Results

The impedances delivered within this project for the year 2010 cover all relations for region pairs, according to the regionalisation defined within ETISplus for this year¹ by the co-ordinator, which have a European focus. European in this context means, that one of the two regions must be situated in Europe (i.e. the region code has a value below 200.000.000). So intra-European impedances are covered as well as impedances between regions in Europe and regions on other continents, but impedances between two regions, both situated in other continents are not covered.

Table 14-4: Air Freight Impedances, key results

Access via	Collection	Group	Description
ETIS View	Modelled Data	Freight	Flight times, flight distances and number of connections per O/D.
2010	http://viewer.etisplus.net/ select collection: ETISplus-2010-Modelled highlight: Freight open table: Air Impedances - Freight		
2005	http://viewer.etisplus.net/ select collection: ETISplus-2005-Modelled highlight: Freight open table: Air Impedances - Freight		

¹ The regionalisation defined for the year 2010 differs from the one for the year 2005

The impedances delivered consist of 4,845,230 relations between a region of origin and a region of destination. The following table shows the number of relations considered by geographic scope:

Table 14-5: geographic scope of relations covered by the impedance matrix

<i>From / To</i>		<i>Europe</i>	<i>Africa</i>	<i>Asia***</i>	<i>Oceania</i>	<i>The Americas</i>	<i>Total</i>
	<i>#Regions</i>	1.586	196	336	34	169	2.321
<i>Europe**</i>	1,586	2,513,810*	310,856	532,896	53,924	268,034	3,679,520
<i>Africa</i>	196	310,856	-	-	-	-	310,856
<i>Asia***</i>	336	532,896	-	-	-	-	532,896
<i>Oceania</i>	34	53,924	-	-	-	-	53,924
<i>The Americas</i>	169	268,034	-	-	-	-	268,034
<i>Total</i>	2,321	3,679,520	310,856	532,896	53,924	268,034	4,845,230

* $2,513,810 = 1,586 * 1,585$ relations, as no impedances to a region itself are computed.

*** Including regions in Russia.

15 Road Passenger Impedances

15.1 Scope of the Database

The dataset on road passenger impedances represents a 1601x1601 matrix of travel impedances between the ETISplus traffic zones. Furthermore, it contains an accessibility indicator at the level of traffic zones and average data at national level. The main characteristics of this database are summarised by Table 15-1, while their contents are listed Table 15-2.

All road impedance values at O/D level refer to the relations between the regions' administrative capitals.

Table 15-1: Overview of main characteristics of the data set

Road passenger impedances						
Data feature	Data specification					Remarks
Base year	2010					
Scope of data	Link	Terminal	O/D relation	Region	Other	
	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
GIS data	Yes	No				
	<input type="checkbox"/>	<input checked="" type="checkbox"/>				
Country coverage				Com-pletely	Par-tially	Total number of countries covered by the impedance matrix: 42
	EU 27			<input checked="" type="checkbox"/>	<input type="checkbox"/>	
	Candidate countries & EFTA			<input checked="" type="checkbox"/>	<input type="checkbox"/>	
	Neighbouring countries			<input checked="" type="checkbox"/>	<input type="checkbox"/>	
	TRACECA			<input type="checkbox"/>	<input checked="" type="checkbox"/>	
	MEDA			<input type="checkbox"/>	<input checked="" type="checkbox"/>	
	Other countries			<input type="checkbox"/>	<input checked="" type="checkbox"/>	
	Total number of countries covered:			66		
Main data sources	ETISplus socio-economic data ETISplus road network TEN-CONNECT					
Main type of data generation	Observed	<input checked="" type="checkbox"/>				Depending on the attribute, all types of data generation have been applied.
	Harmonised	<input checked="" type="checkbox"/>				
	Modelled	<input checked="" type="checkbox"/>				

Table 15-2: Data structure of the road passenger impedances data set

Indicator	Description of indicator	Unit
OriginRegion	Origin region id	
OriginName	Name of origin region	
DestinationRegion	Destination region id	
DestinationName	Destination region name	
Distance	Passenger car distance (business/ non-business trips)	km
Time	Passenger car travel time (business/ non-business trips)	min
UserCosts	Direct passenger car user costs (business/ non-business trips)	€
TollCosts	Toll costs for passenger cars (business/ non-business trips)	€
AvgCosts	Average out-of-vehicle costs per passenger-km (business/ non-business trips)	€
AvgToll	Average value of toll cost for passenger cars per charged road-km	€
RegionalDailyAccessibility	Number of inhabitants accessible within 3 hours by passenger car transport	inhabitants

15.2 Methodology

15.2.1 General approach

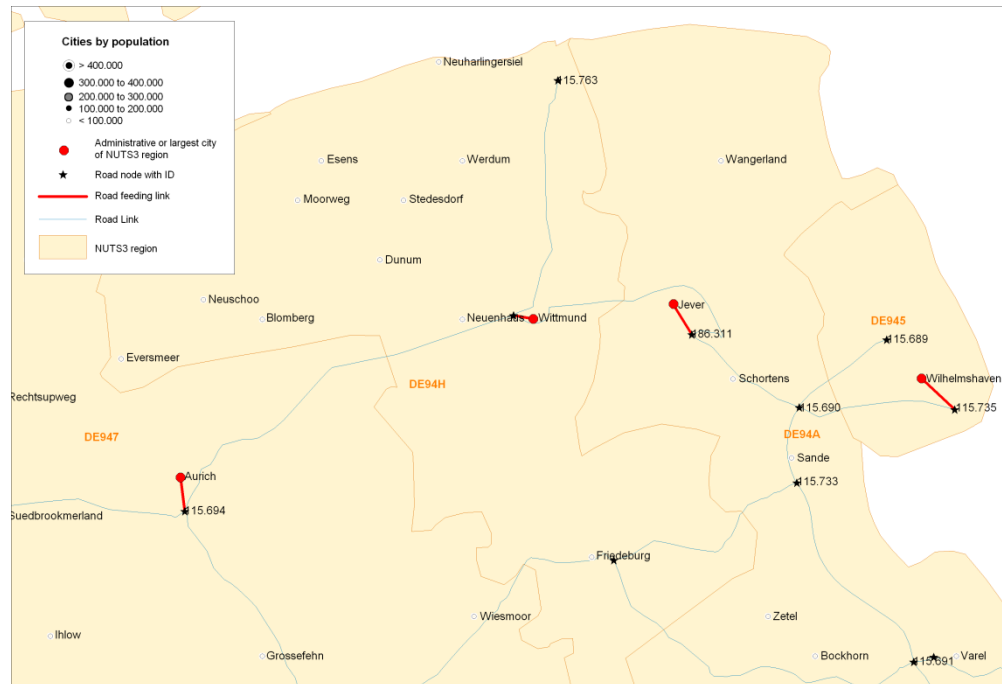
In order to compile the road passenger impedance matrix, the ETISplus road network model (see Szimba and Kraft 2012) has been integrated into the European transport model VACLAV¹. Under application of the Dijkstra algorithm the fastest path is identified for each O/D relation. All impedances refer to the fastest route in an uncongested network.

In order to define the ‘reference nodes’ (feeding nodes) per traffic zone for the computation of travel impedances, the following approach has been applied: After reducing the ETISplus zoning to 1601 core zones, a ‘capital city’ has been determined for each zone. Such capital either represents the administrative capital of the region, or the largest city in cases where administration resides in a neighbouring zone. Subsequently, the closest road network node within the zone was identified and assigned to the capital as feeding node. For eleven cities a feeding node within the scope of a capital’s region was not available. In these cases, the nearest road node in a neighbouring zone has been used as feeding node instead. The identified feeding nodes and the regional capitals were connected by virtual road links.

Figure 15-1 illustrates this approach: it displays some road feeding links for the cities of Wilhelmshaven (only city in DE945), Jever (administrative city for DE94A), Wittmund (administrative city for DE94H) and Aurich (administrative city for DE947) to the nearest road nodes.

¹ A model documentation is provided by Szimba and Kraft (2011).

Figure 15-1: Example for main cities and their road feeding links



15.2.2 Travel time and distance

The attributes “Distance” and “Time” represent travel distance and time of passenger cars **on the fastest path of an uncongested network**. Furthermore, impedances to access the feeding node from the origin region’s capital, as well as impedances to egress from the feeding node to the destination region’s capital have been considered on the basis of following assumptions: The distance was estimated to 1.3 times the as-the-crow-flies distance, the travel speed was set to 20km/h in case the destination zone was an island and 50km/h else.

The travel impedances for each relation have been computed on the basis of fastest paths identified in the ETISplus road network model (see Szimba and Kraft 2012).

Assuming the optimal route from the origin region i and the destination region j is represented by a sequence of links l of the road network model ($l=1, \dots, m$).

The road passenger travel time between i and j , t_{ij} , is largely determined by link attributes of the ETISplus road network model “Length” and “FreeSpeedPass” and is computed as follows:

$$t_{ij} = t_i^{access} + \sum_{l=1}^m 60 * \frac{Length_l}{FreeSpeedPass_{Link}} + t_j^{egress}$$

with

t_i^{access}	the travel time estimated to access the feeding node of the origin region i,
$Length_l$	the length of the link in km,
$FreeSpeedPass_{Link}$	the maximum speed for passenger cars on the link in km/h.
t_j^{egress}	the travel time estimated to egress from the feeding node of the destination region j.

Respectively, the travel distance between i and j, d_{ij} , is computed as follows:

$$d_{ij} = d_i^{access} + \sum_{l=1}^m Length_l + d_j^{egress}$$

With

d_i^{access}	the distance estimated to access the feeding node of the origin region i,
$Length_l$	the length of the link in km,
d_j^{egress}	the distance estimated to egress from the feeding node of the destination region j.

15.3 User cost

User costs at the level of O/D relations are represented by the attributes "UserCosts" and "TollCosts". These cost variables are related to a person travelling by passenger car.

The attribute "UserCosts" informs on out-of-pocket costs occurring on the fastest route between an origin i and a destination j.

The attribute "UserCosts" represent following cost components:

- Road charges
 - Generic road tolls
 - Link-specific toll costs
- Fuel costs

The methodology to derive these cost components are explained in the documentation of the ETISplus road network model (Szimba and Kraft 2012).

Within the ETISplus road network level, the components of user costs are contained in the variable "LinkCostPC". Assuming the optimal route from the origin region i and the destination region j is represented by a sequence of links l of the road network model (l=1, ..., m).

Thus, the attribute "UserCosts" for trip purpose p on the route from origin i to destination j , UC_{ij}^p , has been computed on the basis of the link attribute "LinkCostPC", divided by the occupancy rate, and the modelled access to/ egress from the selected feeding node:

$$UC_{ij}^p = d_i^{access} \cdot \frac{AvgCost^c}{POR_p^c} + \sum_{l=1}^m \frac{LinkCostPC_l}{POR_p^c} + d_j^{egress} \cdot \frac{AvgCost^c}{POR_p^c}$$

with

d_i^{access}	the distance the travel time estimated to access the feeding node of the origin region i ,
$AvgCost^c$	average out-of-pocket costs per vehicle-km in country c ,
POR_p^c	passenger car occupancy rate in country c for trip purpose p ,
$LinkCostPC_l$	user cost on link l (per passenger car),
d_j^{egress}	the distance estimated to egress from the feeding node of the destination region j .

Accordingly, the attribute "TollCosts" on the route from origin i to destination j , TC_{ij} , has been computed on the basis of the link attribute "TollCostPC":

$$TC_{ij} = \sum_{l=1}^m \frac{TollCostPC_l}{POR_p^c}$$

$TollCostPC_l$ informs on the toll cost for passenger car on network link l .

Table 15-3 and Table 15-4 summarise the assumed occupancy rates for passenger cars. The data originate from TEN-CONNECT (Petersen et al. 2009), except for those countries which have an entry in the column "Proxy".

Table 15-3: Occupancy rates for business and non-business (part 1)

NUTS0	Country	Business	NonBusiness	Proxy
	EU27			
AT	Austria	1.22	1.57	
BE	Belgium	1.22	1.77	
BG	Bulgaria	1.31	2.09	
CY	Cyprus	1.45	2.32	
CZ	Czech Republic	1.45	2.32	
DK	Denmark	1.22	1.63	
EE	Estonia	1.45	2.32	
FI	Finland	1.22	1.83	
FR	France	1.22	1.88	
DE	Germany	1.22	1.57	
GR	Greece	1.22	1.76	
HU	Hungary	1.31	2.09	
IE	Ireland	1.22	1.71	
IT	Italy	1.22	1.78	
LV	Latvia	1.45	2.32	
LT	Lithuania	1.45	2.32	
LU	Luxembourg	1.22	1.57	
MT	Malta	1.45	2.32	
NL	Netherlands	1.22	1.38	
PL	Poland	1.37	2.21	
PT	Portugal	1.22	1.65	
RO	Romania	1.45	2.32	
SK	Slovakia	1.45	2.32	
SI	Slovenia	1.45	2.32	
ES	Spain	1.29	2.10	
SE	Sweden	1.22	1.74	
UK	United Kingdom	1.22	1.74	
	Candidate countries & EFTA			
HR	Croatia	1.31	2.09	
MK	FYR Macedonia	1.45	2.32	
IS	Iceland	1.22	1.69	
LI	Liechtenstein	1.22	1.69	
ME	Montenegro	1.45	2.32	
NO	Norway	1.22	1.69	
RS	Serbia	1.45	2.32	
CH	Switzerland	1.22	1.88	
TR	Turkey	1.22	1.76	

Table 15-4: Occupancy rates for business and non-business (part 2)

NUTS0	Country	Business	NonBusiness	Proxy
	Neighbouring countries			
AL	Albania	1.45	2.32	Spain
AD	Andorra	1.29	2.10	
BY	Belarus	1.45	2.32	
BA	Bosnia and Herzegovina	1.45	2.32	Serbia
XK	Kosovo	1.45	2.32	
MD	Moldova	1.45	2.32	
RU	Russia	1.45	2.32	Italy
SM	San Marino	1.22	1.78	
UA	Ukraine	1.45	2.32	
	TRACECA			
AM	Armenia	1.45	2.32	Russia
AZ	Azerbaijan	1.45	2.32	Russia
GE	Georgia	1.45	2.32	Russia
KZ	Kazakhstan	1.45	2.32	Russia
KG	Kyrgyzstan	1.45	2.32	Russia
TJ	Tajikistan	1.45	2.32	Russia
TM	Turkmenistan	1.45	2.32	Russia
UZ	Uzbekistan	1.45	2.32	Russia
	MEDA			
DZ	Algeria	1.45	2.32	Russia
EG	Egypt	1.45	2.32	Russia
IL	Israel	1.45	2.32	Russia
JO	Jordan	1.45	2.32	Russia
LB	Lebanon	1.45	2.32	Russia
MA	Morocco	1.45	2.32	Russia
PS	Palestine	1.45	2.32	Russia
SY	Syria	1.45	2.32	Russia
TN	Tunisia	1.45	2.32	Russia
	Other countries			
AF	Afghanistan	1.45	2.32	Russia
CN	China	1.45	2.32	Russia
IR	Iran	1.45	2.32	Russia
IQ	Iraq	1.45	2.32	Russia
LY	Libya	1.45	2.32	Russia
MN	Mongolia	1.45	2.32	Russia

The attributes "AvgCost" and "AvgToll" refer to country-specific average values.

"AvgCosts" informs on the average out-of-pocket costs per passenger-km (business/ non-business trips). "AvgToll" represents the average value of toll cost for passenger cars per charged road-km.

15.3.1 Regional daily accessibility

The attribute "RegionalDailyAccessibility" refers to the number of inhabitants who can access the road within three hours of travel. The regional daily accessibility of a traffic zone i , RDA_i , is determined by following equation:

$$RDA_i = \sum_{j=1}^n Inh_j \cdot \beta_{ij}$$

with

$$\beta_{ij} = \begin{cases} 1, & \text{if } t_{ij} \leq 180 \text{ minutes} \\ 0, & \text{else} \end{cases}$$

Inh_j Number of inhabitants of region j

t_{ij} Road travel time between i and j

The data on number of inhabitants applied for the computation of the daily accessibility values originate from the ETISplus socio-economic database module (Siegele et al. 2012).

15.4 Data sources

The data compiled for road passenger impedances rely on data elements of the ETISplus road network model. Data sources used for the compilation of the ETISplus road network model are summarised in the network model's documentation report (Szimba and Kraft 2012).

15.5 Results

The current chapter intends to give a rough overview of the scope and selected contents of the ETISplus road passenger impedance dataset.

Table 15-5: Road Impedances (passenger cars), key results

Access via	Collection	Group	Description
ETIS View	Modelled Data	Passenger	Travel times, distances and estimated costs for passenger car transport.
2010	http://viewer.etisplus.net/ select collection: ETISplus-2010-Modelled highlight: Passenger open table: Road Impedances - Passenger		
2005	http://viewer.etisplus.net/ select collection: ETISplus-2005-Modelled highlight: Passenger open table: Road Impedances - Passenger		

Table 15-6 and Table 15-7 give an overview over the average out-of-pocket in €- Cent per passenger-km ("AvgCost" for business and non-business), as well as

the average toll costs in €-Cent per vehicle-km ("TollCost"). The values for average toll costs do not relate to an average of all network links of a country, but rather to those links which are subject to a charging system for passenger cars.

Figure 15-2 shows the performance of regional daily accessibility by passenger cars at the level of the ETISplus zoning system.

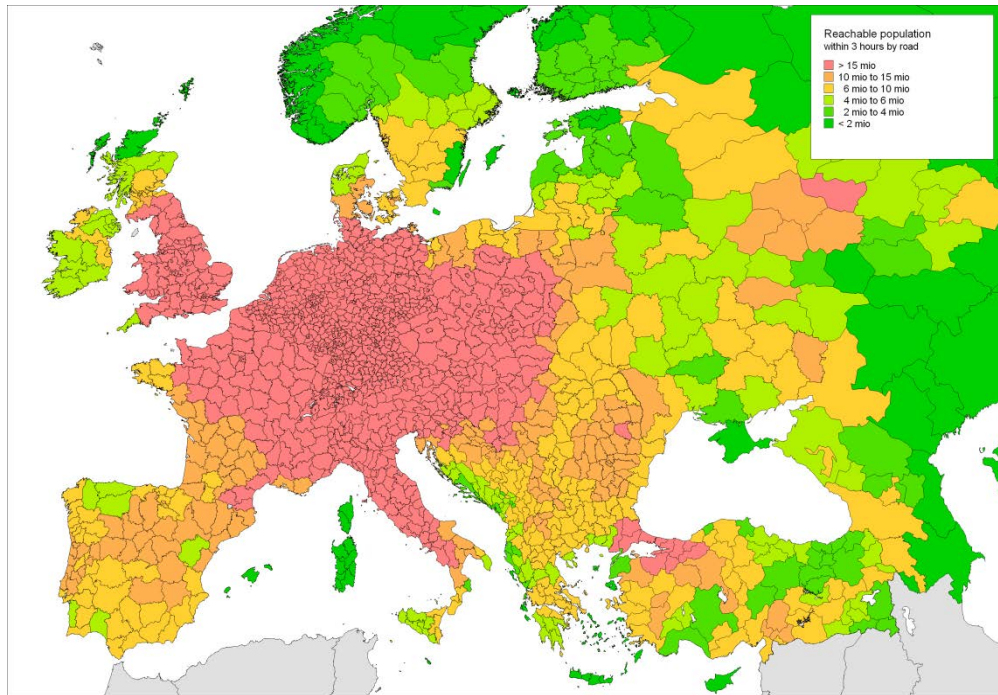
Table 15-6: Average user cost per person and toll cost per passenger car (part 1)

NUTS0	Country	AvgCostsBusiness €-Cent/pass-km	AvgCostsNonBusiness €-Cent/pass-km	AvgToll €-Cent/veh-km	Proxy
	EU27				
AT	Austria	7.27	5.65	0.00	
BE	Belgium	7.22	4.97	0.00	
BG	Bulgaria	5.90	3.71	0.00	
CY	Cyprus	6.42	4.02	0.00	
CZ	Czech Republic	6.12	3.82	0.00	
DK	Denmark	9.78	7.31	0.00	
EE	Estonia	6.22	3.89	0.00	
FI	Finland	9.85	6.58	0.00	
FR	France	7.32	4.75	9.98	
DE	Germany	8.46	6.57	0.00	
GR	Greece	10.34	7.16	4.10	
HU	Hungary	6.86	4.31	0.00	
IE	Ireland	8.23	5.87	3.07	
IT	Italy	8.28	5.67	8.20	
LV	Latvia	6.15	3.84	0.00	
LT	Lithuania	6.54	4.09	0.00	
LU	Luxembourg (Grand-Duché)	5.67	4.40	0.00	
MT	Malta	6.43	4.02	0.00	
NL	Netherlands	9.67	8.55	0.00	
PL	Poland	5.97	3.71	0.00	
PT	Portugal	7.28	5.38	8.20	
RO	Romania	6.07	3.80	0.00	
SK	Slovakia	5.66	3.54	0.00	
SI	Slovenia	7.11	4.45	0.00	
ES	Spain	6.44	3.96	9.95	
SE	Sweden	10.29	7.20	0.00	
UK	United Kingdom	8.49	5.95	0.00	
	Candidate countries & EFTA				
HR	Croatia	7.20	4.52	6.15	
MK	Former Yugoslav Republic of Macedonia, the	6.09	3.81	2.90	
IS	Iceland	8.48	6.10	0.00	
LI	Liechtenstein	8.52	6.13	0.00	
ME	Montenegro	6.61	4.13	0.00	
NO	Norway	10.40	7.49	0.00	
RS	Serbia	3.38	2.11	3.42	
CH	Switzerland	8.52	5.54	0.00	
TR	Turkey	9.26	6.41	1.40	

**Table 15-7: Average user cost per person and toll cost per passenger car
(part 2)**

NUTSO	Country	AvgCostsBusiness €-Cent/pass-km	AvgCostsNonBusiness €-Cent/pass-km	AvgToll €-Cent/veh-km	Proxy
	Neighbouring countries				
AL	Albania	6.00	3.75	0.00	
AD	Andorra	5.94	3.66	0.00	
BY	Belarus	4.29	2.68	0.00	
BA	Bosnia and Herzegovina	5.89	3.68	0.00	
XK	Kosovo	3.38	2.11	3.42	Serbia
MD	Moldova, Republic of	4.91	3.07	0.00	
RU	Russian Federation	6.05	3.79	0.00	
SM	San Marino	8.28	5.67	0.00	
UA	Ukraine	4.11	2.57	0.00	
	TRACECA				
AM	Armenia	4.40	2.75	0.00	
AZ	Azerbaijan	2.95	1.84	0.00	
GE	Georgia	4.69	2.93	0.00	
KZ	Kazakhstan	2.77	1.73	0.00	
KG	Kyrgyzstan	3.47	2.17	0.00	
TJ	Tajikistan	4.13	2.59	0.00	
TM	Turkmenistan	0.90	0.56	0.00	
UZ	Uzbekistan	3.74	2.34	0.00	
	MEDA				
DZ	Algeria	1.22	0.76	0.00	
EG	Egypt	1.85	1.16	0.00	
IL	Israel	7.69	4.81	0.00	
JO	Jordan (Hashemite Kingdom of)	4.05	2.53	0.00	
LB	Lebanon	4.38	2.74	0.00	
MA	Morocco	4.80	3.00	0.00	
PS	Palestinian Authority	6.94	4.34	0.00	
SY	Syrian Arab Republic	3.54	2.22	0.00	
TN	Tunisia	3.79	2.37	0.00	
	Other countries				
AF	Afghanistan	4.64	2.90	0.00	
CN	China	4.54	2.84	0.00	
IR	Iran (Islamic Republic of)	0.33	0.21	0.00	
IQ	Iraq	3.05	1.90	0.00	
LY	Libyan (Arab Jamahiriya)	0.67	0.42	0.00	
MN	Mongolia	4.54	2.84	0.00	

Figure 15-2: Regional daily accessibility: inhabitants accessible within three hours by passenger car



15.6 References

Schimke, A., Stoller, A., Siegele, J., and Ihrig, J. (2012): Socio-economic data, base year 2010, Annex report A, ETISplus D6 Database Manual: Networks, determinants and indicator database construction (WP 7), July 2012, Karlsruhe.

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Szimba, E. and Kraft, M. (2011): The Strategic Passenger Model VACLAV: Methodology and Application, model documentation, v3.1, September 2011, Karlsruhe.

Petersen M.S., Bröcker J., Enei R., Gohkale R., Granberg T., Hansen C.O., Hansen H.K., Jovanovic R., Korchenevych A., Larrea E., Leder P., Merten T., Pearman A., Rich J., Shires J., Ulled A. (2009): Report on Scenario, Traffic Forecast and Analysis of Traffic on the TEN-T, taking into Consideration the External Dimension of the Union – Final Report, Funded by DG TREN, Copenhagen, Denmark.

http://ec.europa.eu/transport/wcm/infrastructure/studies/2009_12_ten_connect_final_report.pdf

16 Rail Passenger Impedances

16.1 Scope of the database

The dataset on rail passenger impedances represents a 1615x1615 matrix of travel impedances between the ETISplus traffic zones. Furthermore, it contains an accessibility indicator at the level of traffic zones and data at national level. The main characteristics of this database are summarised by Table 16-1, while their contents are listed by Table 16-2.

All rail impedance values at O/D level refer to the relations between the regions' administrative capitals.

Table 16-1: Overview of main characteristics of the data set

Rail passenger impedances																														
Data feature	Data specification					Remarks																								
Base year	2010																													
Scope of data	Link	Terminal	O/D relation	Region	Other																									
	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>																									
GIS data	Yes	No																												
	<input type="checkbox"/>	<input checked="" type="checkbox"/>																												
Country coverage	<table><thead><tr><th></th><th>Com-pletely</th><th>Par-tially</th></tr></thead><tbody><tr><td>EU 27</td><td><input checked="" type="checkbox"/></td><td><input type="checkbox"/></td></tr><tr><td>Candidate countries & EFTA</td><td><input checked="" type="checkbox"/></td><td><input type="checkbox"/></td></tr><tr><td>Neighbouring countries</td><td><input checked="" type="checkbox"/></td><td><input type="checkbox"/></td></tr><tr><td>TRACECA</td><td><input type="checkbox"/></td><td><input checked="" type="checkbox"/></td></tr><tr><td>MEDA</td><td><input type="checkbox"/></td><td><input checked="" type="checkbox"/></td></tr><tr><td>Other countries</td><td><input type="checkbox"/></td><td><input checked="" type="checkbox"/></td></tr><tr><td>Total number of countries covered:</td><td>66</td><td></td></tr></tbody></table>						Com-pletely	Par-tially	EU 27	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Candidate countries & EFTA	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Neighbouring countries	<input checked="" type="checkbox"/>	<input type="checkbox"/>	TRACECA	<input type="checkbox"/>	<input checked="" type="checkbox"/>	MEDA	<input type="checkbox"/>	<input checked="" type="checkbox"/>	Other countries	<input type="checkbox"/>	<input checked="" type="checkbox"/>	Total number of countries covered:	66		Total number of countries covered by the impedance matrix: 42
	Com-pletely	Par-tially																												
EU 27	<input checked="" type="checkbox"/>	<input type="checkbox"/>																												
Candidate countries & EFTA	<input checked="" type="checkbox"/>	<input type="checkbox"/>																												
Neighbouring countries	<input checked="" type="checkbox"/>	<input type="checkbox"/>																												
TRACECA	<input type="checkbox"/>	<input checked="" type="checkbox"/>																												
MEDA	<input type="checkbox"/>	<input checked="" type="checkbox"/>																												
Other countries	<input type="checkbox"/>	<input checked="" type="checkbox"/>																												
Total number of countries covered:	66																													
Main data sources	ETISplus rail network model																													
	HaCon Fahrplan-Auskunfts-System (HAFAS) ETISplus socio-economic data																													
Main type of data generation	Observed	<input checked="" type="checkbox"/>				Depending on the attribute, all types of data generation have been applied.																								
	Harmonised	<input checked="" type="checkbox"/>																												
	Modelled	<input checked="" type="checkbox"/>																												

Table 16-2: Data structure of the rail passenger impedances data set

Indicator	Description of indicator	Unit
OriginRegion	Origin region id	
OriginName	Name of origin region	
DestinationRegion	Destination region id	
DestinationName	Destination region name	
Distance	Distance on fastest path (modelled)	km
Time	Passenger travel time on fastest path	min
HighSpeed	Indicates whether or not the fastest path is aligned to a high-speed rail section	
Frequency	Number of train connections per day	connections/day
ShareTimeTable	Measures the extent in how far travel time and frequency are based on real-world time tables	
AccessEgressTimeTableCode	Indicates whether another station was used for starting or ending the trip	
ShareNetworkDistance	Measures the extent in how far the distance is based on the modelled network (i.e. total - access/egress)	
AccessEgressDistanceCode	Indicates whether another station was used for starting or ending the modelled trip and whether the modelled trip aligns to the travel time given by the timetable	
UserCostsBusiness	Fare on fastest path for business trips	€
UserCostsNonBusiness	Fare on fastest path for non-business trips	€
AvgFaresHSR	Average rail fare of a 200-km journey with high-speed trains (business/ non-business trips)	€
AvgFaresLongDistance	Average rail fare of a 200-km journey with trains of category IC/ EC (business/ non-business trips)	€
RegionalDailyAccessibility	Number of inhabitants accessible within 3 hours by rail transport	inhabitants

16.2 Methodology

16.2.1 Travel time and frequency

The attribute “time” represents the shortest rail travel time between the administrative capitals of two zones. “Frequency” relates to the number of daily connections between these cities.

The rail connections used for the computation of “frequency” consider all ‘advantageous’ options of a passenger to travel from A to B. ‘Advantageous’ is defined as follows: assume a rail service S1 between A and B. Another service, S2, is only counted as ‘advantageous’ travel option if it either allows the passenger to leave the origin A later than with S1, or allows the passenger to reach the destination earlier than with S1.

An example: given a service S1 from A to B departing in A at 7am and arriving in B at 10am. Another service S2 departs at A at 7.12am and arrives in B at 10.45am, whereas S3 departs in A at 7am and arrives in B at 10.30am. While S2

is counted as an advantageous travel option (as it allows the passenger to leave A later than with connection S1), S3 is not regarded as advantageous (because the point of departure equals S1, but its arrival in B is later than with S1).

Both the values for travel time and frequency have been largely computed under application of real-world timetables. For this purpose, the "HaCon Fahrplan-Auskunfts-System" (HAFAS) software published by Deutsche Bahn was used (HAFAS 2011)¹. After installing the software, automated queries for each station/station relation were applied to the system via multiple virtual machines, and the generated data was then further processed. All queries were made within a 24-hour timeframe and for a reference day (Tuesday) in June 2011.

Since travel time and frequency values have been generated by a timetable based approach, they are not necessarily symmetric.

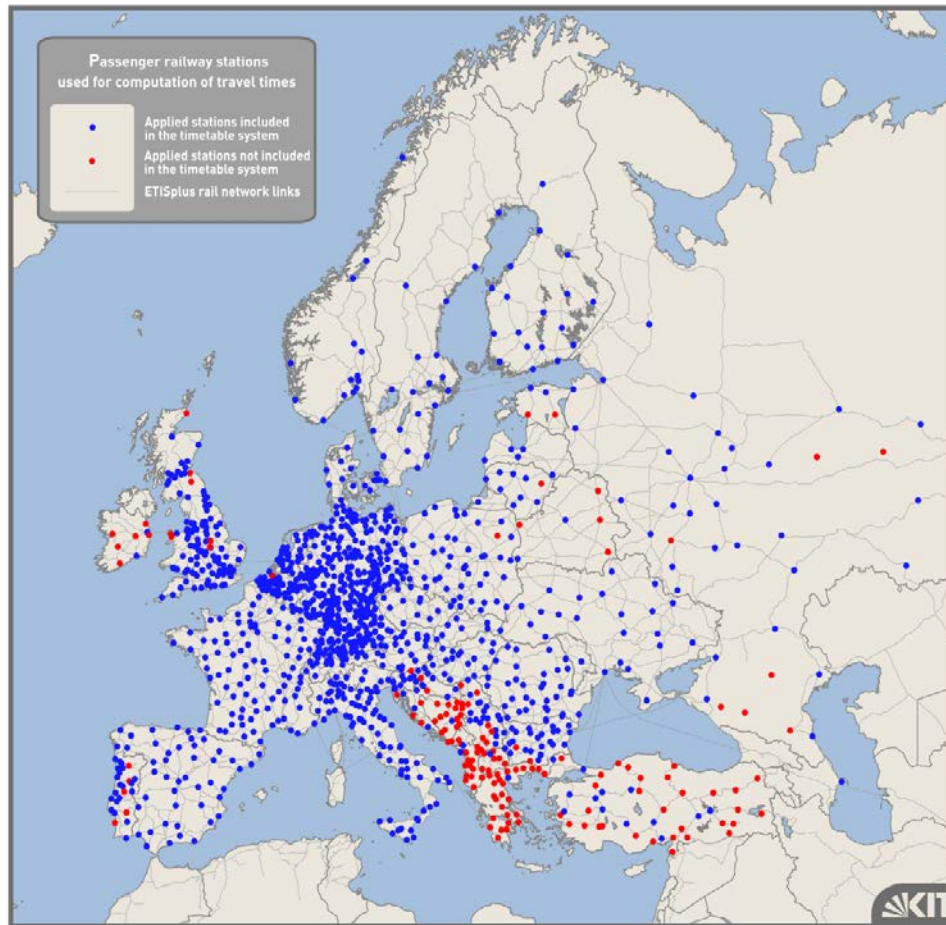
16.2.2 Identification of 'reference stations' per region

Travel time and frequency had to be determined for rail trips between all regions of the ETISplus zoning system. Thus, for each of the 1601 specific NUTS-3 regions a 'reference station' has been identified, which represents a reference node for the computation of level-of-service indicators. As far as possible the administrative capital of a region has been assigned as 'reference station'. If the region's main city's railway station was not available within the HAFAS system, the closest larger city was selected instead. Due to local isolation (e.g. islands) or the lack of a station in the HAFAS timetable system, 248 regions had to be connected via a station located in another region ('virtual station').

Figure 16-1 illustrates the scope of the stations used for the computations. While the blue dots indicate stations of regional capitals which are included in the timetable system, while the red dots indicate stations of regional capitals which are not part of the applied timetable system.

¹ <http://www.bahn.de/p/view/buchung/karten/dbfahrplanbest.shtml>.

Figure 16-1: Scope of rail stations considered for impedance computation



16.2.3 Methodology applied for computing travel time data

For the set of identified relations between the 'reference stations', the timetable queries were carried out according to the settings described above. The computed travel time values represent the fastest travel time within a 24-hour time-frame and for the selected reference day (Tuesday) in June 2011.

Virtual connections

For all regions whose administrative capital could not be used as a basis for the queries to the timetable system, a special approach was followed. Listed below are the cases for such special treatment:

- (1) A region's administrative capital is not represented in the HAFAS system, but another city of the same region is;
- (2) A region is not at all connected to the rail network (e.g. islands);
- (3) A region has access to the rail network, but none of its cities are represented within the HAFAS system.

In order to tackle these cases, “virtual connections” (VC) are introduced which virtually connect:

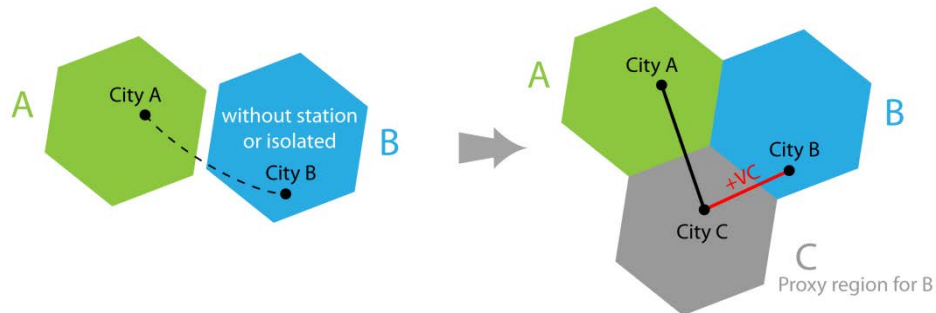
- A region’s administrative capital with the city in the same region which is represented in HAFAS;
- A region’s administrative capital with the city in another region which is represented in HAFAS.

To quantify the travel time on these virtual connections, the following methods have been applied:

- Manual collection of travel times (e.g. by using local rail timetables, or in the case of islands, ferry timetables);
- Estimation of travel times on the road network under application of route planning software.

Subsequently, the travel times on these virtual connections have been added to the travel times computed by exploiting HAFAS queries. The procedure is depicted in Figure 16-2.

Figure 16-2: Connecting an isolated region via a virtual connection



In general terms, the rail passenger travel time between region i and region j , t_{ij} , is computed as follows:

$$t_{ij} = t_i^{access} + t_{ij}^{timetable} + t_j^{egress}$$

with

t_i^{access}

the travel time estimated to access the feeding node of the origin region i ,

$t_{ij}^{timetable}$

the minimum travel time obtained from the timetable information system between the stations allocated to region i and region j ,

t_j^{egress}

the travel time estimated to egress from the feeding node of the destination region j .

In most of the cases, i.e. if both region i and region j have an administrative capital, which is included in the HAFAS timetable system, t_i^{access} and t_j^{egress} are zero.

Assumptions to complete the matrix

For most of the station/ station relations, exploiting the outputs of the queries has directly resulted in the contents of the travel time impedance matrix. However, for very long relations with many transfers (e.g. Lisbon – Istanbul) in particular, the system did not find any connection. In such cases, the following approach has been applied to bridge the data gaps in the impedance matrix:

Symmetry criterion

For several station pairs, the query A->B has been successful, while B->A has not resulted in any timetable information. In such cases, symmetry of travel time has been assumed to estimate the travel time on the relation which had not been covered by the HAFAS queries.

Frequencies have however not been estimated on the basis of the symmetry criterion, as in particular for longer international journeys with many transfers such symmetry assumption is not plausible.

Connecting stations via intermediate stations

For a certain number of station pairs, HAFAS delivered connections for the relations A->B and B->C, but not for A->C. In such cases, the relation A->C has been computed by connecting A to C via B.

The travel time between A and C, T_{AC} , has been assumed as the sum of travel time between A and B, T_{AB} , as well as B and C, T_{BC} , and an estimated transfer time in B by 30 minutes:

$$T_{AC} = T_{AB} + T_{BC} + 30 \text{ minutes}$$

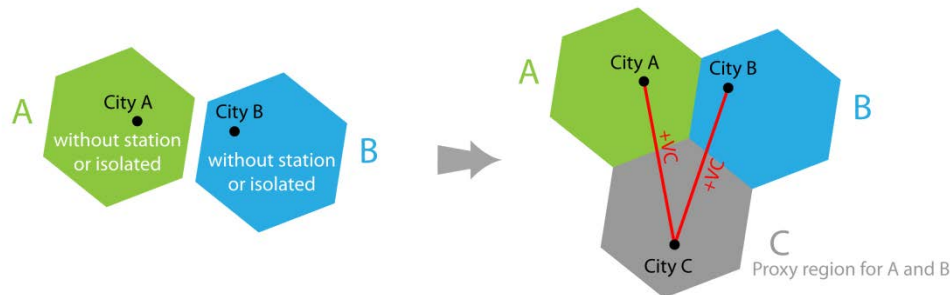
Such procedure however could not be applied to frequency, since the frequency for A->B and B->C does not allow conclusions on frequency between A and C.

For a limited number of relations, a connection has been established by using two intermediate stations.

The quality value

Although the approach for the computation of travel times for rail passenger is largely based on real-world timetables, certain limitations exist. The (relatively rarely applied) method to use virtual connections does not exactly represent realistic conditions. The error made by this method is negligible for long-distance journeys, but can be substantial for shorter ones. The worst case is depicted in Figure 16-3: If two regions are connected to the network using the same proxy region, the travel time between them is calculated purely from the virtual connections.

Figure 16-3: Worst case scenario for the virtual connection method: Two isolated regions mapped to the same proxy station.



In order to allow the data user to distinguish between real-world travel times and modelled values, a quality indicator Q_t is provided for each O/D relation, informing on the share of the travel time which stems from the real-world timetable system:

$$Q_t = \frac{t_{ij}^{timetable}}{t_{ij}^{mod}}$$

Thus, Q_t is an indicator on the origin of the travel time data and the contribution of virtual connections. $Q_t=1$ means that no virtual connection was used and the data was purely provided from real-world timetables (optimal case), whereas $Q_t=0$ means that solely the virtual connections contribute to the travel time (worst case).

Furthermore, Q_t informs on the whether the travel time value has been computed under application of the symmetry criterion, or by establishing connections through intermediate stations: Q_t was set to 2 if an entry was obtained by using its symmetric counterpart. It was set to 31 (or 32) if the entry's data was generated using one (or two) intermediate station(s). Table 16-3 summarises the values Q_t and their meaning.

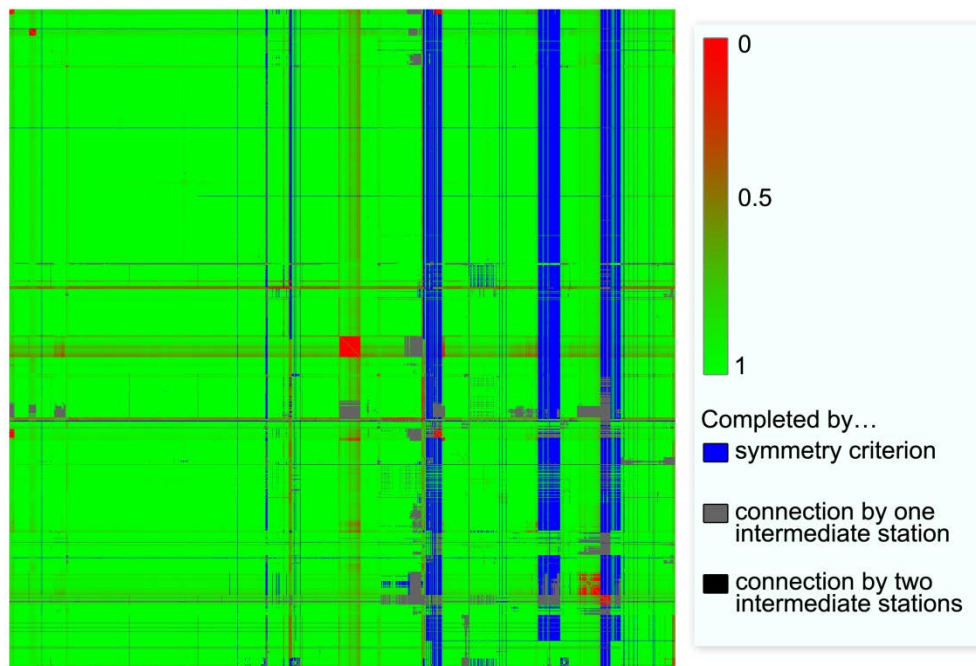
Table 16-3: Range of values of Q_t

Q_t	Description
[0...1]	Travel time computed under application of real-world timetable information and/ or modelled values
2	Travel time computed under application of the symmetry criterion
31	Value computed with generating connections with one intermediate station
32	Value computed with generating connections with two intermediate stations

Figure 16-4 represents a visualisation of the travel time impedance matrix for rail passenger. Along the x-axis and the y-axis all traffic zones are depicted in alphabetical order. Each grid represents an O/D relation. The different colours give an overview of frequency and distribution of the performance of the quality criterion Q_t .

¹ In the provided database, Q_t is represented by the attribute "ShareTimeTable".

Figure 16-4: Overview of value of Q_i per O/D relation



Furthermore, the attribute "AccessEgressTimeTableCode" indicates whether another station was used for starting or ending the trip. The possible values are summarised by Table 16-4.

Table 16-4: Range of values of "AccessEgressTimeTableCode"

<i>AccessEgressTimeTableCode</i>	<i>Description</i>
0	For both origin and destination region, the stations of the regions' administrative capitals have been used to compute the travel time under application of the timetable system
1	The access from the capital of the origin region to the assigned station of the origin region has been estimated
2	The egress from the destination station to the capital of the destination region has been estimated
3	The access from the capital of the origin region to the assigned station of the origin region and the egress from the destination station to the capital of the destination region has been estimated

16.2.4 Methodology applied for computing frequencies

For the set of identified relations between the 'rail capitals', the timetable queries were carried out according to the settings described above. The frequency values published represent the number of travel alternatives, according to the definition explained above, within a 24-hour timeframe and for

the selected reference day (Tuesday) in June 2011. However, in case of lack of data from the timetable system, a value for frequency has not been estimated or modelled due to lack of foundation for such assumptions.

16.2.5 Travel distance

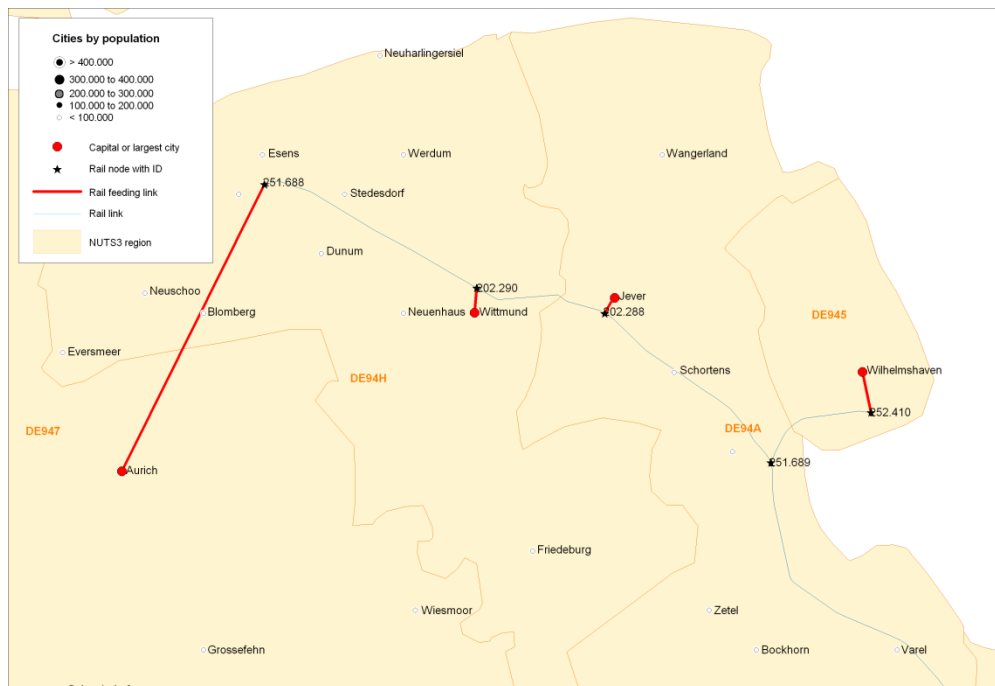
Travel distances are not an output of timetable systems such as HAFAS. Therefore, a modelling approach has been applied to generate data on travel distances. For this purpose, the ETISplus rail network model (Szimba and Kraft 2012) has been integrated into the European transport model VACLAV (Szimba and Kraft 2011).

For each zone, a capital city has been identified (see 16.2.2), and subsequently, the nearest rail network node in the zone was identified and assigned to the capital city as feeding node.

In the case that an adequate feeding node was not available within a zone, the nearest rail node in the same country was used as feeding node instead. Islands were connected to the node closest to the land-harbour in which the island is connected via ferries. These virtual feeding nodes and cities were connected by virtual feeding links. The travelled distance was set to 1.3 times the geodesic distance between rail nodes.

In order to illustrate the approach to connect administrative capitals to the ETISplus rail network model, Figure 16-5 illustrates the rail feeding links for the cities of Wilhelmshaven (only city in DE945), Jever (administrative city for DE94A), Wittmund (administrative city for DE94H) and Aurich (administrative city for DE947) to the nearest rail nodes. There are no rail links present in DE947, so Aurich has been connected to the rail node in Esens.

Figure 16-5: Example for regional capitals and their rail feeding links



With these settings, each region was connected either directly or virtually to the ETISplus rail network model. Under application of the VACLAV model, distances were computed on the fastest route.

Assuming the optimal route from the origin region i to the destination region j is represented by a sequence of links l of the road network model ($l=1, \dots, m$). The travel distance between i and j , d_{ij} , is computed as follows:

$$d_{ij} = d_i^{access} + \sum_{l=1}^m Length_l + d_j^{egress}$$

With

d_i^{access}

the distance estimated to access the feeding node of the origin region i ,

$Length_l$

the length of the link l ,

d_j^{egress}

the distance estimated to egress from the feeding node of the destination region j .

In order to allow the data user to distinguish between travel distances which have completely been computed on the basis of the ETISplus rail network model and travel distances which are based on virtual connectors, a quality indicator

Q_d ¹ is provided for each O/D relation, indicating the share of distance travelled in the ETISplus network model:

$$Q_d = \frac{\sum_{l=1}^m Length_l}{d_{ij}}$$

In order to give further information on the quality of the modelled travel distance, a second indicator named *AccessEgressDistanceCode_{ij}* has been introduced. Two problematic situations are covered:

- (1) If the distance between the capital city and the modelled network is larger than 10km, it is likely that either the region has no rail links or that there are only regional links which are not covered in the rail network model.
- (2) The speed, which is computed from the modelled travel distances and the travel times from HAFAS, is checked for plausibility. For relations using high-speed links a threshold of 290 km/h is applied and speeds higher than 200 km/h are considered suspicious on non-high-speed relations.

The values of *AccessEgressDistanceCode_{ij}* depend on the distances between the capitals of the regions and their corresponding feeding nodes, the calculated speed based on the modelled distance, and the times collected from the time tables. Values equal or greater than 4 indicate suspiciously high speeds, i.e. the modelled distance is significantly too large. This, for instance, is the case when the modelled network is missing regional links, or a part of the travelled distance was covered by bus. *AccessEgressDistanceCode_{ij}* values below 4 denote unsuspecting speeds. Values 0 and 4 are used when the feeding nodes are within 10km of the capital of the region. Other values identify relations where the distance at the origin or the destination is greater than 10km. This is the case for regions with no rail network either in the model, or in reality.

Thus, *AccessEgressDistanceCode_{ij}* indicates if the travel distance between region i and region j includes access/ egress trips greater than 10km, and if the travel speed derived from the modelled network distance is suspicious. If the travel speed between region i and region j is above 290kph (high-speed links are used) or above 200kph (high-speed links are not used), the speed value is labelled "suspicious".

¹ In the provided database, Q is presented by the attribute "ShareModelledNetDistance".

Table 16-5 gives an overview of the possible values of *AccessEgressDistanceCode_{ij}*.

Table 16-5: Range of values of “AccessEgressDistanceCode”

<i>AccessEgressDistanceCode_{ij}</i>	Length of the virtual connector at the origin $\geq 10km$	Length of the virtual connector at the destination $\geq 10km$	Suspicious speed
0	No	No	No Both lengths are less than 10km and the speed is not suspiciously high.
1	Yes	No	No Length of the virtual connector at the origin is larger than 10km and the speed is not suspiciously high.
2	No	Yes	No Length of the virtual connector at the destination is larger than 10km and the speed is not suspiciously high.
3	Yes	Yes	No Both lengths at the origin and the destination are larger than 10km and the speed is not suspiciously high.
4	No	No	Yes Both lengths are less than 10km and the speed is suspiciously high.
5	Yes	No	Yes Length of the virtual connector at the origin is larger than 10km and the speed is suspiciously high.
6	No	Yes	Yes Length of the virtual connector at the destination is larger than 10km and the speed is suspiciously high.
7	Yes	Yes	Yes Both lengths at the origin and the origin and the destination are larger than 10km and the speed is suspiciously high.

16.2.6 User cost data

In contrast to the situation with travel times and frequencies, there is no database available for rail fares at European level. Rail fares reveal significant country-specific peculiarities (see Szimba et al. 2007).

Figure 16-6: Rail fares – empirical data illustrating differences among countries

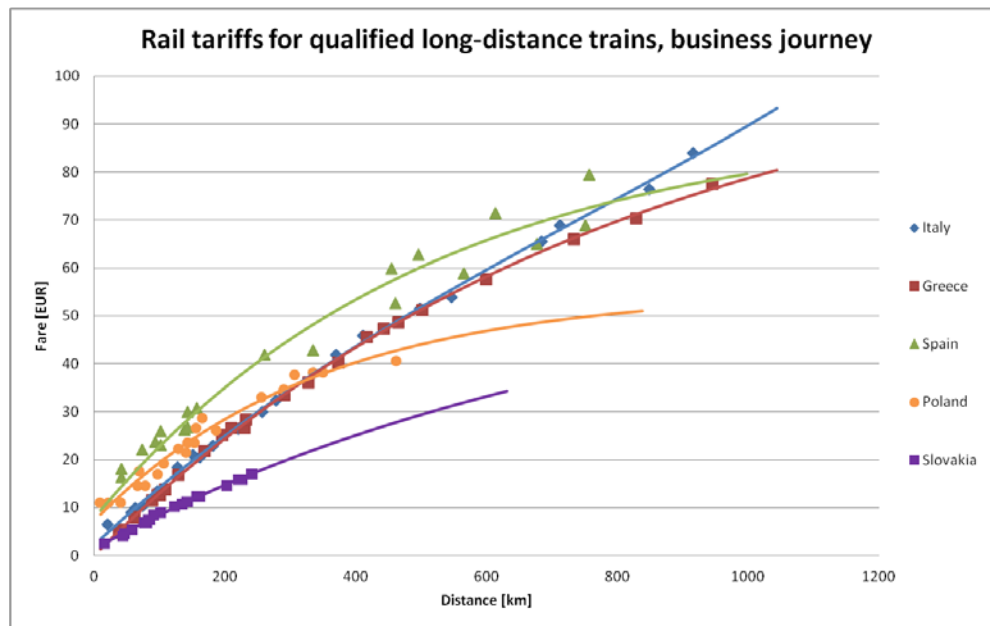
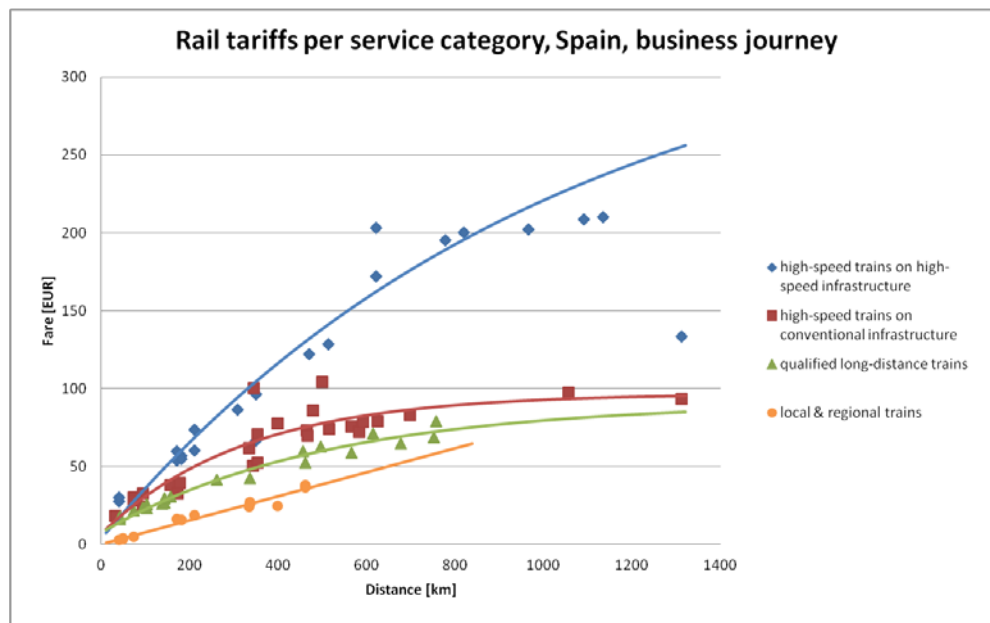


Figure 16-7: Rail fares – empirical data illustrating differences among countries



The user costs for passenger rail trips were modelled under application of a method which has been developed within the ETIS-BASE project (Szimba et al. 2004, Szimba et al. 2007), considering country-specific peculiarities.

The attributes "UserCostBusiness" and "UserCostNonBusiness" reflect the user costs for business travellers and non-business travellers, respectively. The attributes "AvgFaresHSR" inform at the country level on the modelled fares of a 200-km journey with a high-speed train using high-speed infrastructure. "AvgFaresLongDistance" contains the referring values for the usage of a qualified long-distance trains over a distance of 200km.

The contents of the methodology description in this section are largely based on Szimba et al (2007).

16.2.7 Determinants of tariffs and market segments

The ticket price a railway company charges for a journey can – from the viewpoint of the user – be regarded as depending on the following determinants:

- (1) distance travelled,
- (2) wagon class used,
- (3) comfort on board and service facilities,
- (4) travel speed,
- (5) point of time of booking,
- (6) competitiveness of the rail mode against other modes
- (7) and the flexibility of the ticket.

Furthermore, the operator's internal cost structure, the charging system for the use of railway infrastructure, or the business concept are further factors to be considered. As data on a railway company's internal cost structure is often confidential information, it cannot be taken into account here.

The objective is to develop an approach that allows modelling rail fares as a function of the distance travelled and the other determinants listed above. This could be achieved by defining market segments, which incorporate the determinants besides the distance travelled. If this is possible, the tariff can then be expressed for each market segment as a function of the distance travelled.

The determinants "wagon class used", "point of time of booking" and "flexibility of booking" represent passengers' traveling pattern and can be incorporated in the definition of the demand segments. The determinants "travel speed" and "comfort on board and service facilities" are mainly determined by the supply side. Under the assumption, that high-speed rail services are highly competitive against the other modes, the factor "competitiveness of the rail mode against other modes" can be regarded as being associated with the supply side as well.

Regarding to an adequate segmentation of the supply side, following patterns should be taken into account. First, the tariffs for high-speed rail services may depend significantly on the relation considered. If the rail service provided is highly competitive against other modes, the tariffs may tend to be higher than for relations where the rail mode is less competitive. Second, it should be taken into account that there are conventional long-distance trains, for which – since certain on-board services are provided – higher tariffs are charged than for conventional long-distance services, which do not provide such on-board facilities. Third, for local and regional rail services the tariffs can be subject to

regulations, as such services are often operated on behalf of public authorities. Taking these aspects into account, the following supply segments are distinguished:

- (1) high-speed rail services on high-speed rail infrastructure, such as ICE service Frankfurt – Cologne, TGV service Paris – Lyon – Marseille, AVE service Madrid – Sevilla;
- (2) high-speed rail on conventional infrastructure, such as ICE service Mannheim – Frankfurt, TGV service Toulouse – Bordeaux, ES service Torino – La Spezia;
- (3) qualified long-distance trains, such as trains with EuroCity/ InterCity standard;
- (4) other long-distance trains, such as direct trains/ inter-regional trains;
- (5) and regional trains.

Table 16-6 and Table 16-7 give a country-wise overview on the allocation of train types to supply segments.

Table 16-6: Train types per country and allocation to supply segments (part 1)

Country	High speed trains on high-speed Infrastructure	High speed trains on conventional Infrastructure	Qualified long distance trains	Other long distance trains	Regional Trains
EU27 countries					
Austria	-	ICE, RJ	ÖIC, ÖEC, IC, EC, EN, CNL	D, E, SPR	R, S
Belgium	ICE, Thalys	ICE, Thalys	IC, EC	IR	R
Bulgaria	-	-	Express	Fast train	R
Czech Republic	-	-	IC, EC, SuperCity, Express	Fast train	R
Denmark	-	ICE	IC, EC, Lyn	-	R
Estonia	-	-	Fast train with restaurant	Fast train	R
Finland	-	S220	IC, Express	Fast train	R
France	TGV, Thalys, Eurostar, ICE	TGV, ICE	EC, Talgo, Intercités, Téo	Corail	RER, TER
Germany	ICE, Thalys, TGV	ICE, Thalys, TGV, RJ	IC, EC, NZ, CNL, EN	IR, D	IRE, RE, RB, S
Greece	-	-	ICE, IC	IR	R
Hungary	-	RJ	IC, EC, EN	Fast train	R
Ireland	-	-	IC	Fast train	R
Italy	Eurostar Italia	Eurostar Italia	IC, EC, ICN, EN	IR, D, E	IR, R
Latvia	-	-	Fast train with restaurant	Fast train	R
Lithuania	-	-	Fast train with restaurant	Fast train	R
Luxembourg	-	TGV	IC, EC	Fast train	R, RE, RB
Netherlands	Thalys	ICE, Thalys	IC	D	RE, R
Poland	-	-	IC, EC, Express	TLK, IR	RE, R
Portugal	-	Alfa Pendular	IC, IN	IR	R
Romania	-	-	IC, Rapid	Accelerat	Persoane
Slovakia	-	-	IC, EC, Express	IR	R
Slovenia	-	-	ICS, IC, EC	D	R

Country	High speed trains on high-speed Infrastructure	High speed trains on conventional Infrastructure	Qualified long distance trains	Other long distance trains	Regional Trains
Spain	<i>AVE, Alvia, Avant</i>	<i>Alvia, Alaris, Euromed</i>	<i>Arco, Altaria, Talgo, Estrella, Trenhotel</i>	<i>D</i>	<i>R</i>
Sweden	-	<i>X2000</i>	<i>IC</i>	<i>Fast train</i>	<i>R</i>
United Kingdom	<i>Eurostar</i>	-	<i>Fast train with restaurant</i>	<i>Fast train</i>	<i>R</i>

Table 16-7: Train types per country and allocation to supply segments (part 2)

Country	High speed trains on high-speed Infrastructure	High speed trains on conventional Infrastructure	Qualified long distance trains	Other long distance trains	Regional Trains
Candidate countries & EFTA					
Croatia	-	-	<i>IC, EC</i>	<i>Fast train</i>	<i>R</i>
FYR Macedonia	-	-	<i>Fast train with restaurant</i>	<i>Fast train</i>	<i>R</i>
Norway	-	-	<i>IC</i>	<i>Fast train</i>	<i>R</i>
Serbia	-	-	<i>Fast train with restaurant</i>	<i>Fast train</i>	<i>R</i>
Switzerland	-	<i>ICE, TGV, RJ</i>	<i>RJ, IC, EC, ICN, EN, CNL</i>	<i>IR</i>	<i>REX, RE, R, S</i>
Turkey	<i>YHT</i>	-	<i>Fast train with restaurant</i>	<i>Fast train</i>	<i>R</i>
Neighbouring countries					
Belarus	-	-	<i>Fast train with restaurant</i>	<i>Fast train</i>	<i>R</i>
Bosnia and Herzegovina	-	-			<i>R</i>
Moldova	-	-	<i>Fast train with restaurant</i>	<i>Fast train</i>	<i>R</i>
Russia	-	<i>Sapsan</i>	<i>Fast train with restaurant</i>	<i>Fast train</i>	<i>R</i>
Ukraine	-	-	<i>Fast train with restaurant</i>	<i>Fast train</i>	<i>R</i>
	-		<i>Fast train with restaurant</i>	<i>Fast train</i>	

Regarding the demand side, the trip's purpose can be used for the segmentation, since the reasons for travelling can be assumed to influence both the choice of the wagon class, booking patterns and the needed flexibility of a purchased ticket. Here, the demand side is segmented by two trip purposes, business and non-business:

- business travellers use first class, buy a flexible ticket and do not buy the ticket in advance;
- non-business travellers use second class and are able to buy a ticket a minimum of three days in advance.

16.2.8 Methodology

Based on market segments depicted above, the tariff of the ten possible combinations can be expressed as a function of the distance travelled. The task of computing the tariff matrix can be split up into three steps:

- generation of regression functions per demand/ supply segment and country;
- application of a rail network model in order to determine the applicable distances for each O/D relation individually;
- combination of the two estimates.

Since a comprehensive database of European passenger rail tariffs is not available, tariff information was collected for sets of sample relations. These sample O/D relations are defined for each country individually, taking into account country-specific level-of-service patterns and covering a reasonable range and distribution of trip lengths. The distances for the selected O/D relations were obtained from the respective rail timetable. The samples for each demand/supply segment include at least 15 relations; however, this depended on the number of different connections available for a certain supply segment¹. In the next step, the respective regression models were applied for each demand/supply segment.

In order to identify each O/D relation for the distances travelled per country and train category, the ETISplus rail network model has been used as a basis. The ETISplus rail network has been implemented into the VACLAV model to provide for each O/D relation the train type used on the longest stage of the journey² and the distances per country³. The distance information is used in the corresponding regression functions to estimate the fares. International trips were split at the borders – i.e. the fare for a trip from country A to country B is the sum of the fare in country A from the origin to the border of country B, and the fare in country B from the border to the destination.

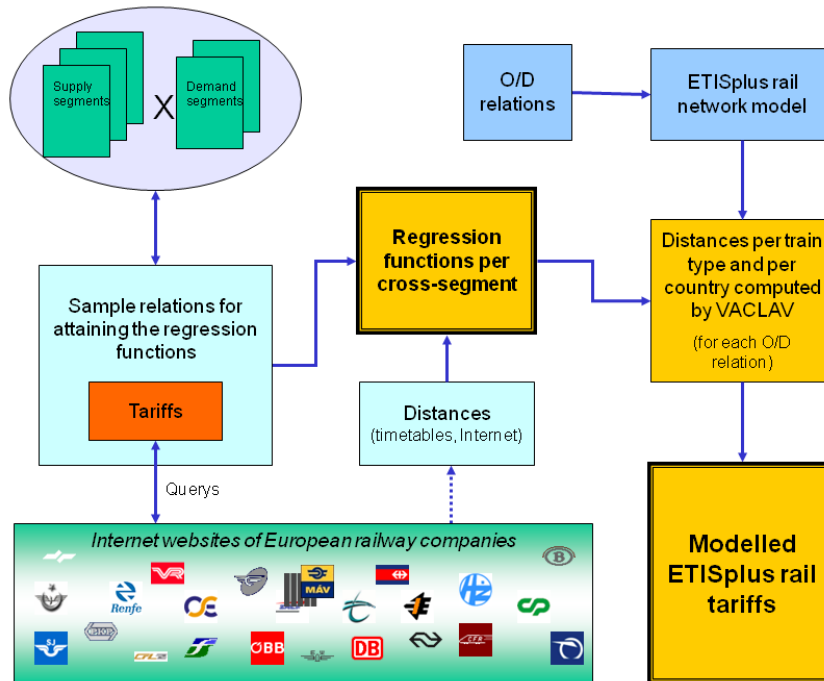
Figure 16-8 gives an overview on the developed methodology. Sample relations are defined, and tariff information is collected for each segment and each country, mainly by searching the railway companies' websites. Each segment is treated individually, together with information on trip lengths, in order to generate regression functions, which estimate the tariff as a function of the travelled distance. For each O/D relation in Europe, distances per country and train type are computed under application of the VACLAV model and on the basis of the ETISplus rail network model 2010. These trip lengths are entered into the estimated regression functions to calculate the fares.

¹ Particularly for the service segment "high-speed rail services on high-speed rail infrastructure" the availability of relations is limited.

² In some countries such as Germany, the fare is determined by the highest train type used, independently of its share during the whole journey. Such peculiarities have been considered by the computations.

³ The route has been determined on the basis of the fastest route within the ETISplus rail network model. It does not embrace a timetable based search.

Figure 16-8: Overview of the applied method



16.2.9 Regional daily accessibility

The attribute “RegionalDailyAccessibility” informs on the number of inhabitants which can be reached by rail within three hours. The regional daily accessibility of a traffic zone i , RDA_i , is determined by following equation:

$$RDA_i = \sum_{j=1}^n \text{Inh}_j \cdot \beta_{ij}$$

with

$$\beta_{ij} = \begin{cases} 1, & \text{if } t_{ij} \leq 180 \text{ minutes} \\ 0, & \text{else} \end{cases}$$

Inh_j Number of inhabitants of region j

t_{ij} Rail travel time between i and j

The data on number of inhabitants applied for the computation of the daily accessibility values stem from the ETISplus socio-economic database module (Siegele et al. 2012).

16.3 Data sources

The current chapter gives an overview of the key data sources applied in order to compile the values of the rail passenger impedance database.

16.3.1 Travel time and frequency

For the computation of travel times and frequencies, the key resource has been the "HaCon Fahrplan-Auskunfts-System" (HAFAS) software published by Deutsche Bahn (HAFAS 2011):

<http://www.bahn.de/p/view/buchung/karten/dbfahrplanbest.shtml>

Version 5.29w Rev. 16

Furthermore, for domestic relations in Greece, timetable data provided by the ETISplus project partner NTUA has been incorporated.

In order to establish links to islands, impedances on ferry links have been obtained from Thomas Cook timetables (Thomas Cook Publishing, 2010).

16.3.2 Travel distance

The main data source for the computation of travel distances is the ETISplus rail network model 2005 (see Szimba and Kraft 2012).

16.3.3 User costs

Empirical data on rail fares have been the basis for the estimation of regression functions. Rail tariffs have mainly been collected from websites of railway operating companies whose url links are listed in Table 16-8.

Table 16-8: Data sources for the estimation of regression functions for the computation of rail passenger tariffs

NUTS 0	Country	Data source
	EU27	
AT	Austria	http://www.oebb.at/en/index.jsp
BE	Belgium	http://hari.b-holding.be/ http://www.b-rail.be/
BG	Bulgaria	http://www.bdz.bg/
CZ	Czech Republic	https://www.cd.cz/eshop/
DK	Denmark	http://www.dsb.dk/
EE	Estonia	http://www.edel.ee/ http://www.elektriraudtee.ee/
FI	Finland	http://www.vr.fi/
FR	France	http://www.ter-sncf.com/ http://www.tgv-europe.com/ http://www.sncf.com/ http://www.voyages-sncf.com/
DE	Germany	http://www.bahn.de/
GR	Greece	http://jizdnirady.idnes.cz/

NUTS 0	Country	Data source
HU	Hungary	http://elvira.mav-start.hu/
IE	Ireland	http://www.irishrail.ie/
IT	Italy	http://www.trenitalia.com/
LV	Latvia	http://www.ldz.lv/
LT	Lithuania	http://www.litrail.lt/
NL	Netherlands	http://www.ns.nl/
PL	Poland	http://rozklad-pkp.pl/
PT	Portugal	http://www.cp.pt/
RO	Romania	http://www.mersultrenurilorcfr.ro/
SK	Slovakia	http://www.slovakrail.sk/zs/
SI	Slovenia	http://www.slo-zeleznice.si/
ES	Spain	http://www.renfe.es/
SE	Sweden	http://www.sj.se/
UK	United Kingdom	http://www.nationalrail.co.uk/
Candidate countries & EFTA		
HR	Croatia	http://www.hznet.hr/
NO	Norway	http://www.nsb.no/
CH	Switzerland	http://www.sbb.ch/ http://www.railaway.com/ http://www.swisstravelsystem.ch/
TR	Turkey	http://www.tcdd.gov.tr/home/detail/?id=599 https://etcdd.tcdd.gov.tr/tcddrezwebaproot/danismanetcddservlet?ulkeid=E NG
Neighbouring countries		
AL	Albania	http://www.mpptt.gov.al/
RU	Russia	http://www.russianrailways.com/
UA	Ukraine	http://www.e-kvytok.com.ua/ http://ticket.dprc.gov.ua/
TRACECA		
GE	Georgia	http://tickets.railway.ge/ http://www.railway.ge/samg/searchTrains.aspx?lang=en-US

16.3.4 Regional daily accessibility

The values for regional daily accessibility have been computed under application of ETISplus data (rail passenger travel time and inhabitants per zone).

16.4 Results

The current chapter intends to give a rough overview of the scope and selected contents of the ETISplus rail passenger impedance data.

Table 16-9: Rail passenger impedances, key results

Access via	Collection	Group	Description
ETIS View	Observed Data	Passenger	Service Frequencies and Travel Times
2010	http://viewer.etisplus.net/ select collection: ETISplus-2010-Observed highlight: Passenger		

Access via	Collection	Group	Description
	open table: Rail Impedances - Passenger Further estimated indicators are available in: select collection: ETISplus-2010-Modelled highlight: Passenger open table: Rail Impedances - Passenger		
2005	http://viewer.etisplus.net/ select collection: ETISplus-2005-Observed highlight: Passenger open table: Rail Impedances – Passenger Further estimated indicators are available in: select collection: ETISplus-2005-Modelled highlight: Passenger open table: Rail Impedances - Passenger		

Figure 16-9 and Figure 16-10 represent visualisations of the rail passenger impedances. Figure 16-9 displays the travel time impedance matrix, whereas Figure 16-10 shows average speeds. Along the x-axis and the y-axis all traffic zones are depicted in alphabetical order. Each grid represents an O/D relation. The different colours give an overview of the performance of these two indicators.

Figure 16-11 and Figure 16-12 illustrate the applied regression functions for a selected number of countries (business trips). Austria and Belgium have a uniform tariff system which does not distinguish between different train types – thus only one regression function has been required. The length of a plotted tariff function depends on the modelled maximum length of a train journey using the respective service segment.

Figure 16-13 shows a map for the regional daily accessibility for rail for Europe and neighbouring countries.

Figure 16-9: Visualisation of the travel time matrix.



Figure 16-10: Visualisation of the travel speed matrix.

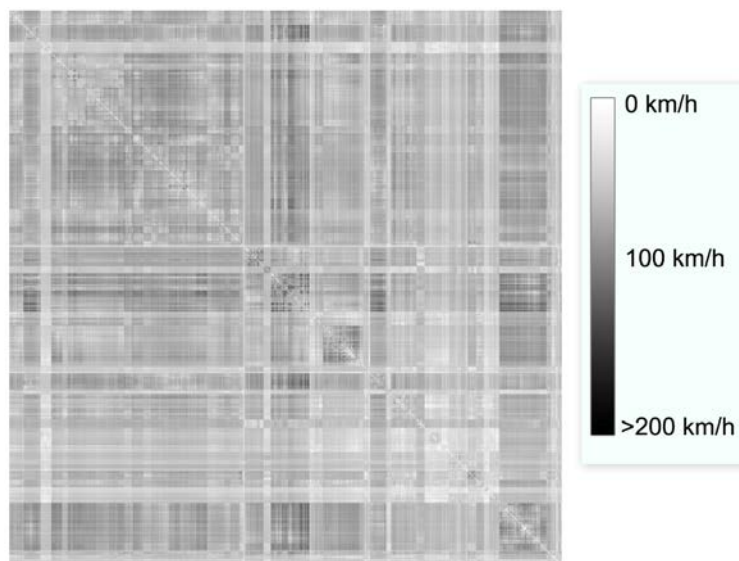
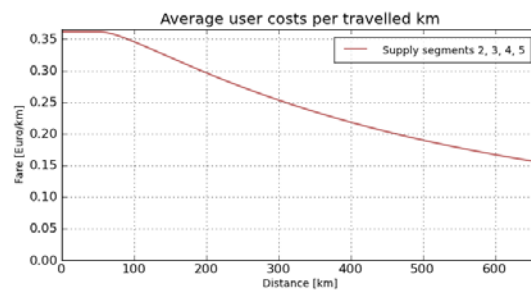
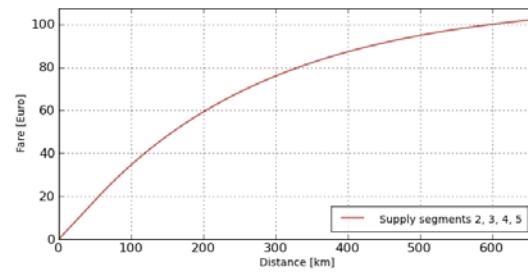


Figure 16-11: Applied regression functions for selected countries (I)

Regression function (Austria, business)



Regression function (Belgium, business)

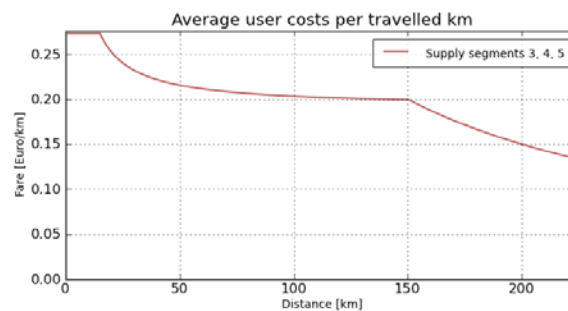
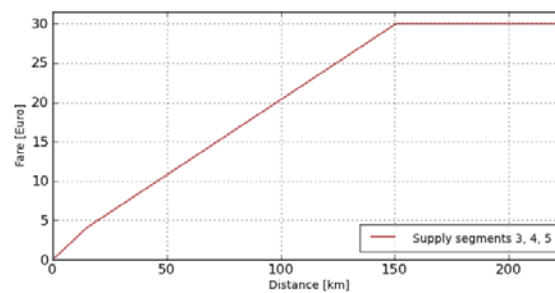
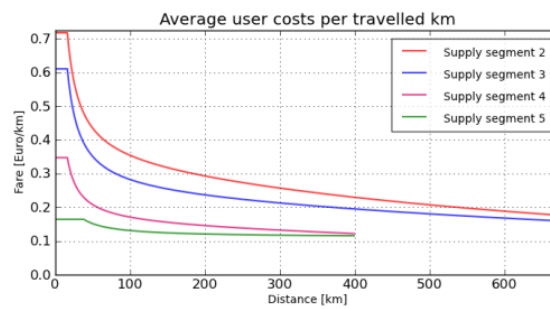
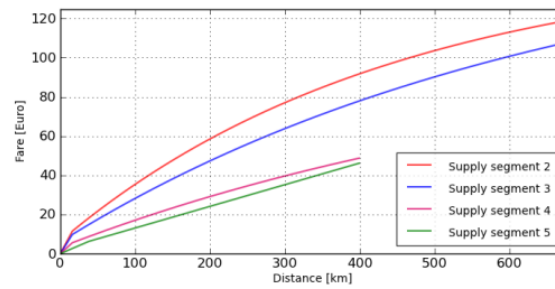


Figure 16-12: Applied regression functions for selected countries (II)

Regression functions (Finland, business)



Regression functions (Poland, business)

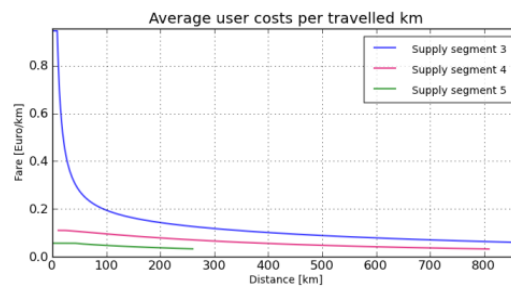
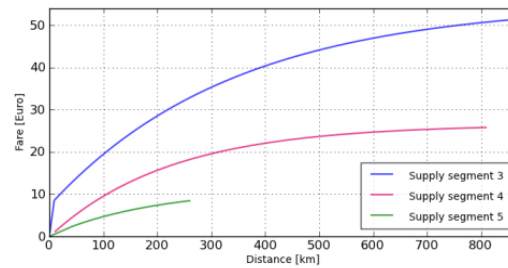
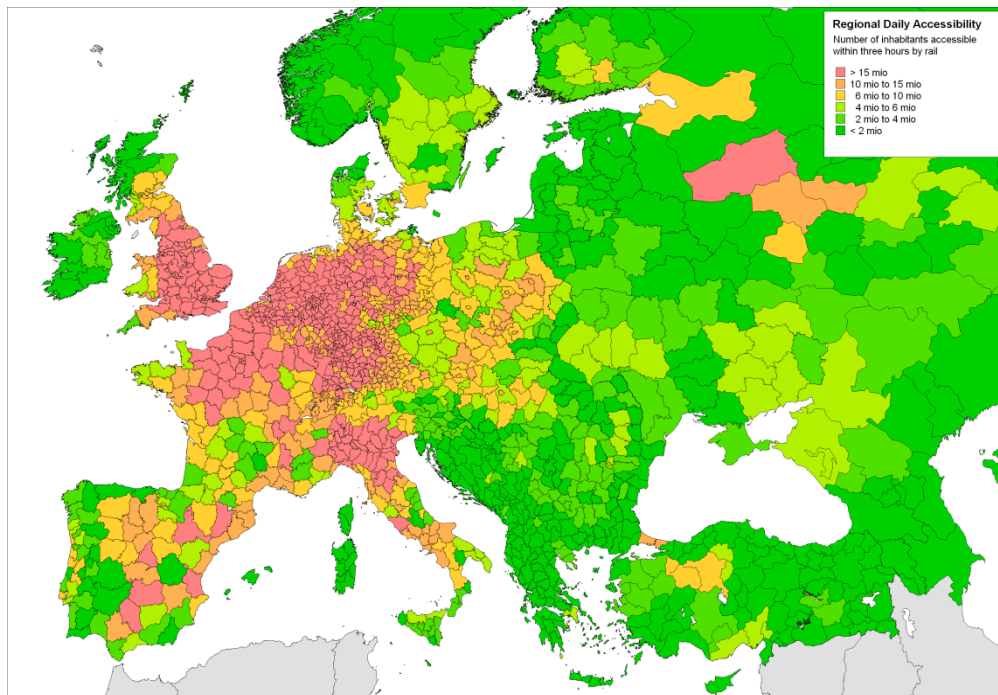


Figure 16-13: Regional daily accessibility: inhabitants accessible within three hours by rail



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17 Impedances for Freight Transport

17.1 Scope of the Database

Freight impedances have been calculated using the ETISplus road, rail and waterway networks. Region to region distances and times are calculated at the NUTS3 level, and stored as data tables which can be downloaded from ETIS-VIEW. Each of the three inland modes is calculated as a separate table. Their scope depends upon the coverage of the underlying networks.

17.1.1 Road Freight

Table 17-1: Overview of main characteristics of the data set

Road freight impedances							
Data feature	Data specification					Remarks	
Base year	2010						
Scope of data	Link	Terminal	O/D relation	Region	Other		
	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
GIS data	Yes	No					
	<input type="checkbox"/>	<input checked="" type="checkbox"/>					
Country coverage					Com-pletely	Par-tially	Within EFTA: IS is not included.
	EU 27				<input checked="" type="checkbox"/>	<input type="checkbox"/>	
	Candidate countries & EFTA				<input checked="" type="checkbox"/>	<input type="checkbox"/>	
	Neighbouring countries				<input type="checkbox"/>	<input checked="" type="checkbox"/>	
	TRACECA				<input type="checkbox"/>	<input checked="" type="checkbox"/>	
	MEDA				<input type="checkbox"/>	<input checked="" type="checkbox"/>	
	Other countries				<input type="checkbox"/>	<input checked="" type="checkbox"/>	
	Total number of countries covered:				65		
Main data sources	ETISplus Road Network, base year 2010 EZ2006_3 (ETISplus Zoning 2006, Level 3, NUTS3 equivalent)						
Main type of data generation	Observed	<input type="checkbox"/>					
	Harmonised	<input type="checkbox"/>					
	Modelled	<input checked="" type="checkbox"/>					

Table 17-2: Data structure of the road freight impedances data set

Indicator	Description of indicator	Unit
Origin zone	Origin zone, NUTS3 equivalent, ETISplus Zoning 2003, Level 3	EZ2006_3
Destination zone	Destination zone, NUTS3 equivalent, ETISplus Zoning 2003, Level 3	EZ2006_3
Distance	Distance from origin to destination in km	Km
Time	Journey time from origin to destination in minutes	Min

17.1.2 Rail Freight

Table 17-3: Overview of main characteristics of the data set

Rail freight impedances																														
Data feature	Data specification					Remarks																								
Base year	2010																													
Scope of data	Link	Terminal	O/D relation	Region	Other																									
	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>																									
GIS data	Yes	No																												
	<input type="checkbox"/>	<input checked="" type="checkbox"/>																												
Country coverage	<table><thead><tr><th></th><th>Com-pletely</th><th>Par-tially</th></tr></thead><tbody><tr><td>EU 27</td><td><input checked="" type="checkbox"/></td><td><input type="checkbox"/></td></tr><tr><td>Candidate countries & EFTA</td><td><input checked="" type="checkbox"/></td><td><input type="checkbox"/></td></tr><tr><td>Neighbouring countries</td><td><input type="checkbox"/></td><td><input checked="" type="checkbox"/></td></tr><tr><td>TRACECA</td><td><input type="checkbox"/></td><td><input checked="" type="checkbox"/></td></tr><tr><td>MEDA</td><td><input type="checkbox"/></td><td><input checked="" type="checkbox"/></td></tr><tr><td>Other countries</td><td><input type="checkbox"/></td><td><input checked="" type="checkbox"/></td></tr><tr><td>Total number of countries covered:</td><td colspan="2">50</td></tr></tbody></table>						Com-pletely	Par-tially	EU 27	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Candidate countries & EFTA	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Neighbouring countries	<input type="checkbox"/>	<input checked="" type="checkbox"/>	TRACECA	<input type="checkbox"/>	<input checked="" type="checkbox"/>	MEDA	<input type="checkbox"/>	<input checked="" type="checkbox"/>	Other countries	<input type="checkbox"/>	<input checked="" type="checkbox"/>	Total number of countries covered:	50		Within EU27: CY and MT have no railway system. Within EFTA: IS has no railway system.
	Com-pletely	Par-tially																												
EU 27	<input checked="" type="checkbox"/>	<input type="checkbox"/>																												
Candidate countries & EFTA	<input checked="" type="checkbox"/>	<input type="checkbox"/>																												
Neighbouring countries	<input type="checkbox"/>	<input checked="" type="checkbox"/>																												
TRACECA	<input type="checkbox"/>	<input checked="" type="checkbox"/>																												
MEDA	<input type="checkbox"/>	<input checked="" type="checkbox"/>																												
Other countries	<input type="checkbox"/>	<input checked="" type="checkbox"/>																												
Total number of countries covered:	50																													
Main data sources	ETISplus Rail Network, base year 2010 EZ2006_3 (ETISplus Zoning 2006, Level 3, NUTS3 equivalent)																													
Main type of data generation	Observed	<input type="checkbox"/>																												
	Harmonised	<input type="checkbox"/>																												
	Modelled	<input checked="" type="checkbox"/>																												

Table 17-4: Data structure of the rail freight impedances data set

Indicator	Description of indicator	Unit
Origin zone	Origin zone, NUTS3 equivalent, ETISplus Zoning 2003, Level 3	EZ2006_3
Destination zone	Destination zone, NUTS3 equivalent, ETISplus Zoning 2003, Level 3	EZ2006_3
Distance	Distance from origin to destination in km	km
Time	Journey time from origin to destination in minutes	min

17.1.3 Waterway

Table 17-5: Overview of main characteristics of the data set

Inland waterways freight impedances																														
Data feature	Data specification					Remarks																								
Base year	2010																													
Scope of data	Link	Terminal	O/D relation	Region	Other																									
	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>																									
GIS data	Yes	No																												
	<input type="checkbox"/>	<input checked="" type="checkbox"/>																												
Country coverage	<table><thead><tr><th></th><th>Com-pletely</th><th>Par-tially</th></tr></thead><tbody><tr><td>EU 27</td><td><input checked="" type="checkbox"/></td><td><input type="checkbox"/></td></tr><tr><td>Candidate countries & EFTA</td><td><input type="checkbox"/></td><td><input checked="" type="checkbox"/></td></tr><tr><td>Neighbouring countries</td><td><input type="checkbox"/></td><td><input checked="" type="checkbox"/></td></tr><tr><td>TRACECA</td><td><input type="checkbox"/></td><td><input checked="" type="checkbox"/></td></tr><tr><td>MEDA</td><td><input type="checkbox"/></td><td><input type="checkbox"/></td></tr><tr><td>Other countries</td><td><input type="checkbox"/></td><td><input type="checkbox"/></td></tr><tr><td>Total number of countries covered:</td><td colspan="2">22</td></tr></tbody></table>						Com-pletely	Par-tially	EU 27	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Candidate countries & EFTA	<input type="checkbox"/>	<input checked="" type="checkbox"/>	Neighbouring countries	<input type="checkbox"/>	<input checked="" type="checkbox"/>	TRACECA	<input type="checkbox"/>	<input checked="" type="checkbox"/>	MEDA	<input type="checkbox"/>	<input type="checkbox"/>	Other countries	<input type="checkbox"/>	<input type="checkbox"/>	Total number of countries covered:	22		
	Com-pletely	Par-tially																												
EU 27	<input checked="" type="checkbox"/>	<input type="checkbox"/>																												
Candidate countries & EFTA	<input type="checkbox"/>	<input checked="" type="checkbox"/>																												
Neighbouring countries	<input type="checkbox"/>	<input checked="" type="checkbox"/>																												
TRACECA	<input type="checkbox"/>	<input checked="" type="checkbox"/>																												
MEDA	<input type="checkbox"/>	<input type="checkbox"/>																												
Other countries	<input type="checkbox"/>	<input type="checkbox"/>																												
Total number of countries covered:	22																													
Main data sources	ETISplus Waterways Network, EZ2006_3 (ETISplus Zoning 2006, Level 3, NUTS3 equivalent)																													
Main type of data generation	Observed	<input type="checkbox"/>																												
	Harmonised	<input type="checkbox"/>																												
	Modelled	<input checked="" type="checkbox"/>																												

Table 17-6: Data structure of the air freight impedances data set

Indicator	Description of indicator	Unit
Origin zone	Origin zone, NUTS3 equivalent, ETISplus Zoning 2006, Level 3	EZ2006_3
Destination zone	Destination zone, NUTS3 equivalent, ETISplus Zoning 2006, Level 3	EZ2006_3
Distance	Distance from origin to destination in km	km
Time	Journey time from origin to destination in minutes	min

17.2 Methodology

One impedance matrix per mode of transport has been calculated. Data formats are as defined in the ETISplus data model, and the zoning for the impedances matrices uses the ETISplus EZ2006_Level3 (incorporating NUTS3 within Europe) definition. The dimensions of the impedance matrices are therefore regions, and the cells contain the distance, the door to door time, between the origin and the destination for the given mode. Costs have not been included because it is not meaningful to define a single cost per O/D for any possible transport movement by any vehicle type between two regions.

ETISplus has updated the networks originally developed in ETIS-Base, Transtools and Worldnet. By analysing paths through the road, rail and waterway networks it has been possible to estimate travel times and distances for freight vehicles. Time and distance data has been estimated and stored on the ETISplus site.

Times and distances are calculated for all connected pairs of origin and destination (EZ3: ETIS Zones Level 3) regions. One time and one distance figure is provided for each O/D combination, even if an administrative region is composed from more than one polygon (e.g. a group of islands).

The calculation procedure selects a node from the given network (e.g. road) as the loading point for the origin region and another as the unloading point in the destination region. A path is selected from the network that provides a balanced optimum of travel time and distance. The distance is calculated by adding the lengths of the links, and the travel time is calculated by dividing the link lengths by the free-flow link speed attributes.

Link distance (but not necessarily O/D distance) can be considered factual. Travel time on a link only requires an estimate of average vehicle speed, which can be estimated from the network attributes by combining free-flow speed, road type and area types. Distances and times per O/D depend upon the selection of loading points and the criteria for choosing from a set of network paths. For any specific O/D there may be a significant relative margin between the shortest and longest possible efficient paths.

The general procedure is:

1. Decompose the set of regions into a set of polygons.

2. For each mode, select one network node inside or close to the polygon.
3. For each pair of polygons, calculate a path using a balance of time and distance to find the optimum path, between the selected loading/unloading points.
4. Calculate the distance by adding the link lengths.
5. Calculate the journey time by applying realistic freight speeds to the link lengths.
6. If an administrative region is composed of more than one polygon, the set of impedances relating to the region is averaged, to give one unique set of impedances per region pair.

For the road network, which is relatively dense (high ratio of road nodes to number of regions) it is almost certain that every region will contain at least one road node. The main problem is which of these internal nodes to select. In ETISplus, the main rule for selecting a loading point is to choose the node closest to the geometric centroid of the region. The procedure therefore picks a starting point close to the middle of the region. In the unlikely case that a region has no road link, the procedure would then look for an adjacent point in the bounding box of the region.

For rail, the network is less dense so it may be the case that the node nearest to the centre of the region is not inside the region. This may also be the case even if rail links pass through the region, because the links' end-points (nodes) might lie outside. A node is defined to be either the starting or ending point on a link.

For rail therefore a loading point may be selected which is in an adjacent region. This is done by looking first inside the region, and failing that by looking inside the bounding box; a rectangle larger than the region.

For waterways, the network is even less dense than rail, and there is a particular issue arising from the fact that rivers frequently form the boundary between administrative regions. Thus it is quite likely that two adjacent regions load traffic at the same waterway node, and also that loading points will be situated by the edges of a region and not the centre. The algorithm for the selection of loading points therefore searches for waterway nodes close to region vertices as well those close to the centroid.

In cases where there is no network node either in a region or adjacent to it, the region is considered to be disconnected from the network and therefore no impedances are calculated for that mode.

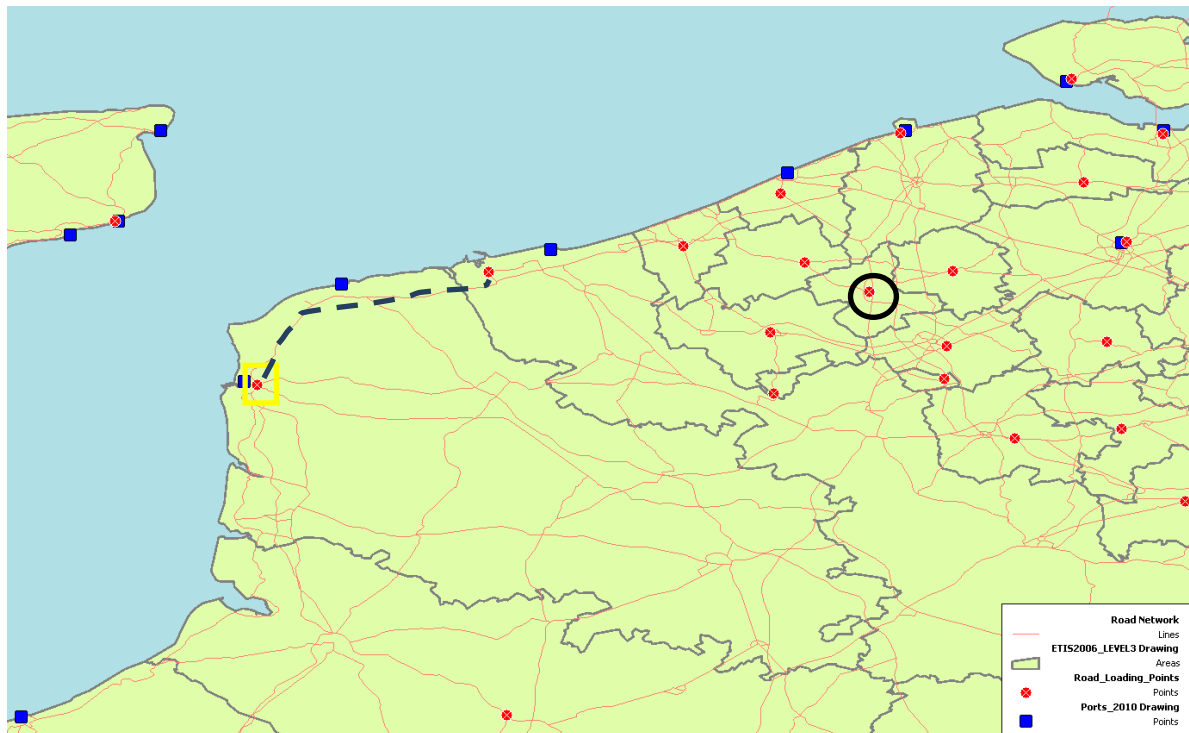
Specific details for each of the modes are set out below.

17.2.1 Road

All EZ3 regions in ETISplus have a loading point connecting to the road network; this will generally be the nearest node to the region's centroid. However, if the region contains a seaport, the nearest node to the seaport node is chosen to be the loading point.

Examples can be seen in the following map.

Figure 17-1: Selection of Loading Points for Road Freight, Calais example



The map shows EZ2006 Level 3 regions close to Calais outlined by grey lines. The blue squares indicate the location of seaports. The light red lines indicate the ETISplus road network links, and the circular red markers are the selected loading points, which are used to calculate impedances.

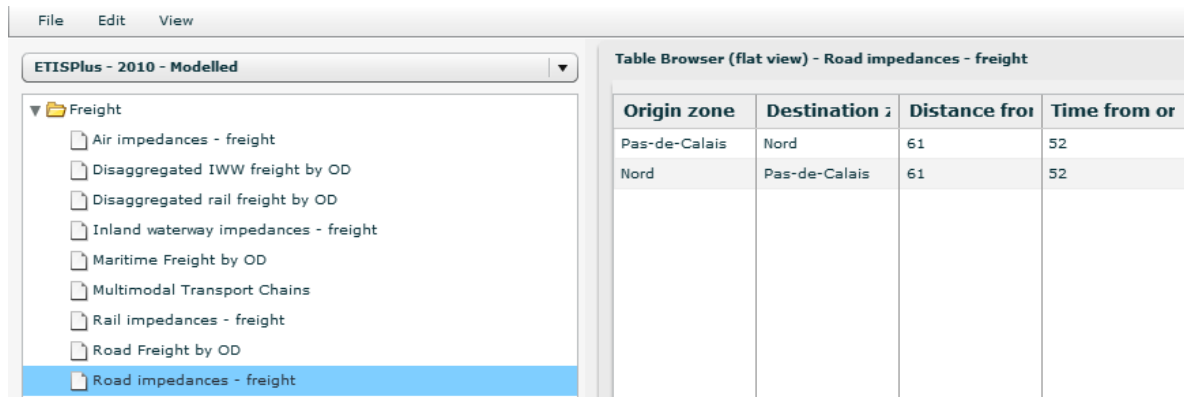
Inland regions (see example circled in black) are connected at road nodes central to the region. Regions containing seaports have loading points close to the ports. See seaport example highlighted with a yellow square.

In regions with more than one port, the choice of loading point is random.

In this example, the distance calculated between the two largest visible regions in the map, regions Nord and Pas-de-Calais, will be based upon the dotted line connecting the Pas-de-Calais loading point (yellow square near Boulogne) to the Nord loading point (just west of Dunkerque). However, given the sizes of these regions there would in reality be a broad range of possible connecting distances.

In this particular case, the impedances between regions Nord and Pas-de-Calais are 61km and 52 minutes. See below.

Figure 17-2: Impedances selected from database



Origin zone	Destination zone	Distance from	Time from or
Pas-de-Calais	Nord	61	52
Nord	Pas-de-Calais	61	52

Google maps, by comparison shows a distance of 57.8km and 44 minutes (assumed to be with car speeds) for a journey between Gravelines (FR) and Boulogne (FR) which is approximately the journey being modelled in ETISplus.

17.2.2 Rail

Each EZ3 region is assigned one loading point connecting to the rail network, provided that the region either contains rail nodes or is adjacent to rail nodes. Either a central point or a seaport will be selected as the loading point. The algorithm is essentially the same as in the case of road.

However, because there are regions of Europe where the rail network density is very low, there are more cases where the point-inside-polygon search may return no nodes. That may lead to anomalies if the procedure is followed too rigidly.

This is exemplified by the following example in Northern Sweden.

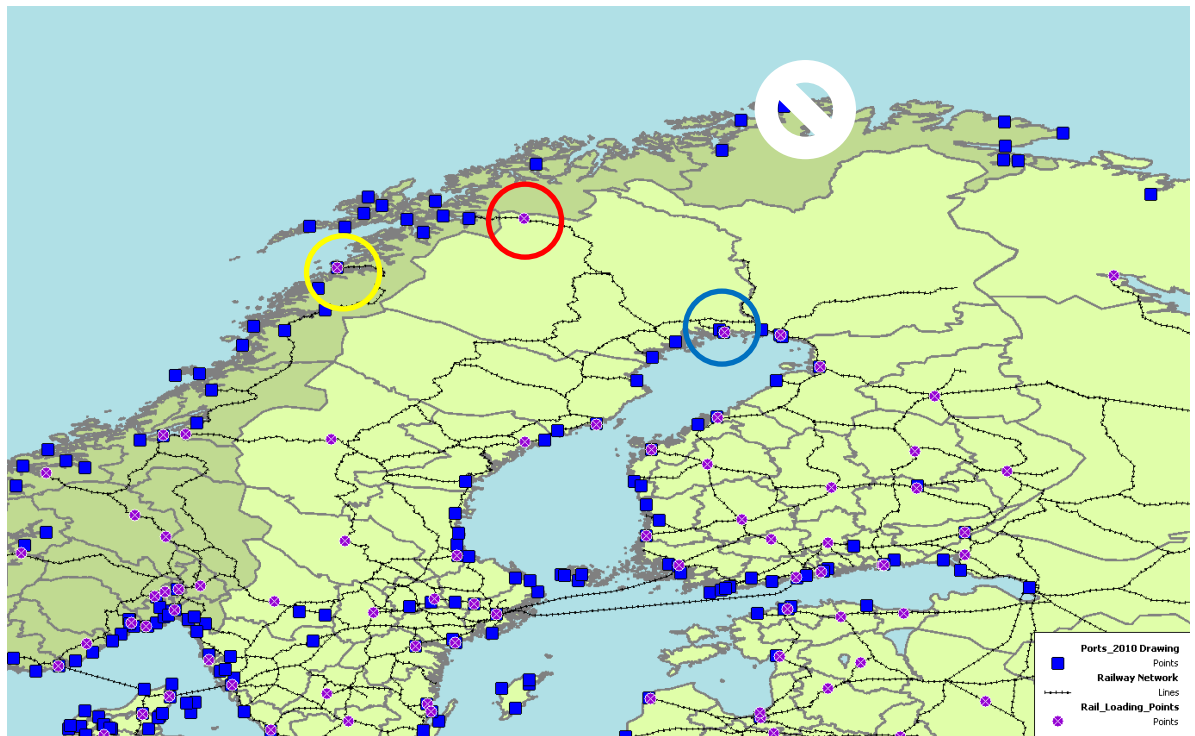
Figure 17-3: ETIS-NETTER map, highlighting rail links near Kiruna



In the map (above) the ETISplus rail network is overlaid via ETIS-NETTER on the Google Maps layer. The EZ3 borders are also shown with thin grey lines.

There is a busy stretch of railway line (highlighted inside the dotted area) which connects the iron ore mining area close to Kiruna (SE) with the port of Narvik (NO). Narvik is at the extreme North of the Norwegian coastal region called Nordland, but is also close to the more Northerly Norwegian region Troms, as well as the large Swedish region, Norrbottens Lan, which contains Kiruna. The Kiruna-Narvik line is not connected to the main coastal route in Norway, so the loading point selection in this area makes a very significant difference to any distances calculated. It might appear, for example that the distance from Kiruna to Narvik is very long because a detour to the South has been picked.

Figure 17-4: Example of Rail Loading Points



The map above shows with purple circles the assigned rail loading points. Seaports are marked with blue squares and railway lines are shown as thin black lines. EZ3 borders are shown with the thicker grey lines. The Norwegian region of Nordland connects to rail at the point highlighted with the yellow circle. The more northerly region Troms has no railway line within its borders, but it is close to the Kiruna-Narvik line, and it has been connected at the point highlighted with the red circle. This loading point however is inside the region Norrbottens Lan in Sweden. The connector for traffic related to Norrbottens Lan itself is on the Swedish coast, highlighted with the blue circle.

The best way to model rail freight flows in this region, as applied in TEN-CONNECT2 is therefore to register the iron ore freight flows as being between Norrbottens Lan (SE) and Troms (NO). The flow will then be routed along the correct stretch.

The most northerly region in Norway (called Finnmark), marked with the white "null" symbol has not been allocated a rail connector. It has no rail nodes either inside its borders, or within the bounding box. The nearest available rail node is considered out of range.

Out of range is defined to be a case where no railway node can be found inside the region itself or inside the rectangle drawn around the region.

The resulting impedances between the example regions are shown in the map and table below. The routes have been superimposed onto the rail network.

Figure 17-5: Loading Points, Routing, and Impedances; Swedish/Norwegian example

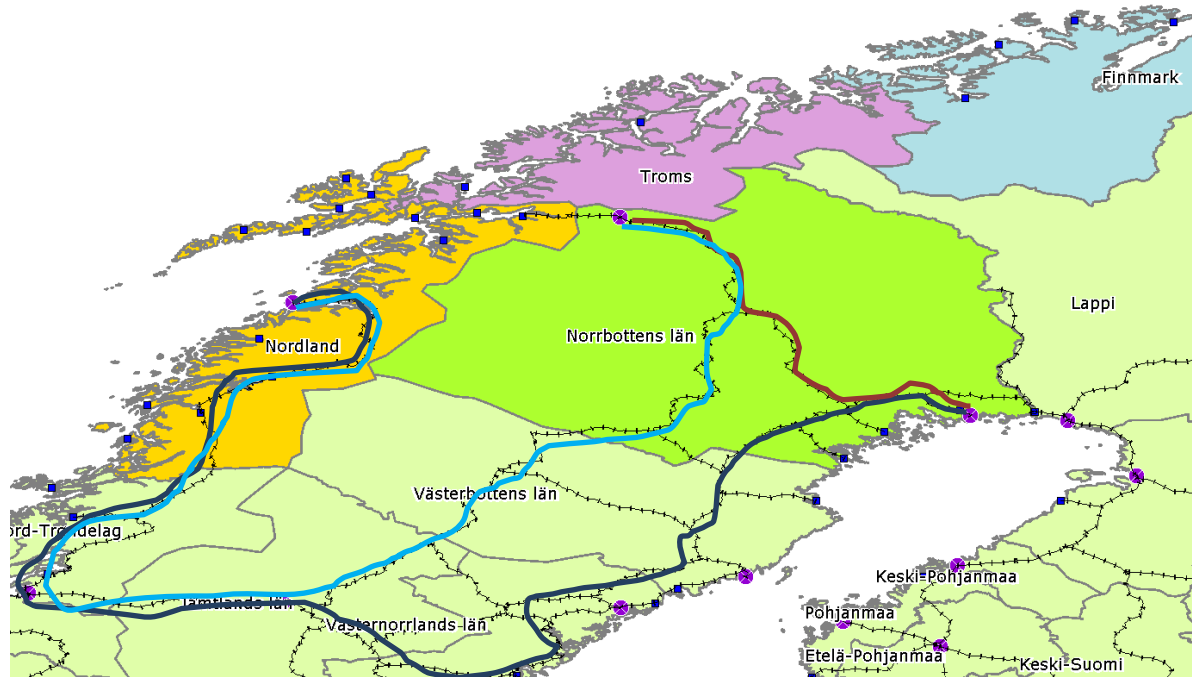


Table 17-7: Estimated impedances

Origin	Destination	Estimated Route	f_imp_rail_distance (km)	f_imp_rail_time (minutes)
Troms	Nordland	Light Blue	1983	1760
Norrbottens län	Nordland	Dark Blue	1734	1579
Norrbottens län	Troms	Dark red	476	555
Finnmark	All		Not connected	

Because of the large regions and the railway connections, this is an exceptional example. In most other cases, a more intuitive loading point can be found at a central point inside each region, and routings will approximate to straight line paths connecting region centroids.

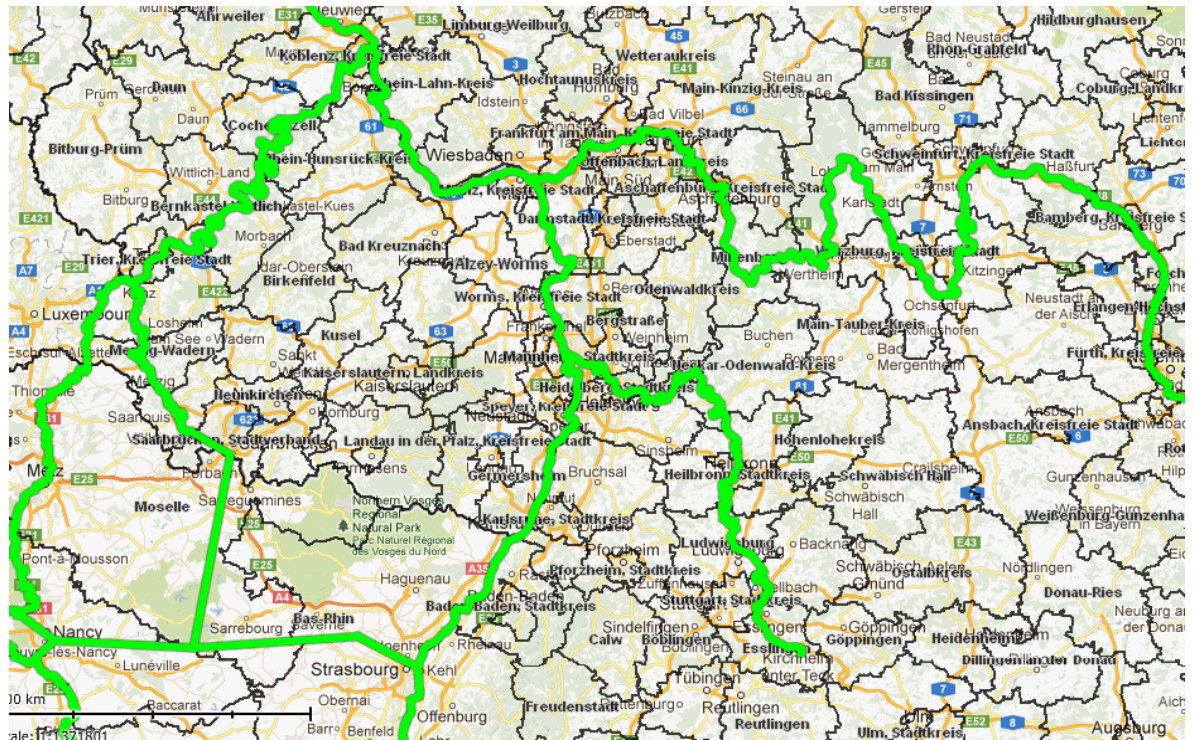
17.2.3 Waterway

For calculating waterway impedances, and therefore for selecting waterway loading points, there are three specific issues. The first is that the waterway network is relatively sparse. The second is that waterways often form a border between regions. The third is that waterway links may be many kilometres long and therefore that there are relatively few nodes in the network to choose from.

If a search for a connector is limited to nodes falling within a region, the result will be that only a few regions appear to be connected to the network.

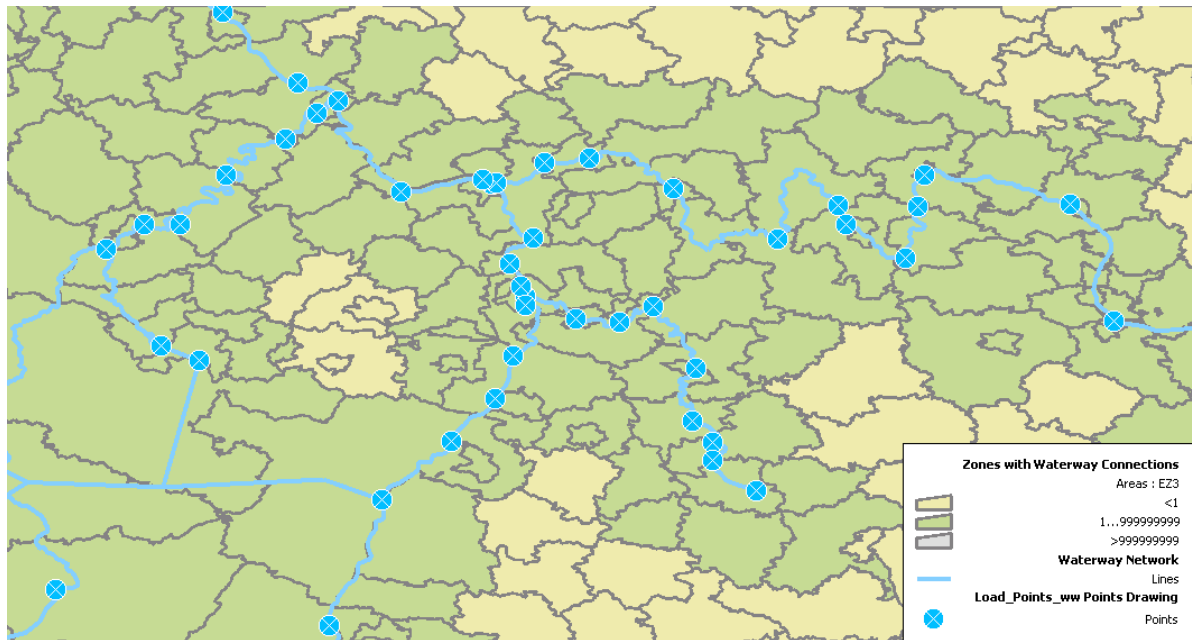
An example has been taken from the region of Western Germany close to Frankfurt. Using ETIS-NETTER, the ETISplus waterway network (green lines) and the EZ3 regions are overlaid onto Google Maps.

Figure 17-6: Example of Waterway Network in Western Germany (ETIS-Netter)



The simplified map below shows the same waterway network over the regions, also indicating the loading points.

Figure 17-7: Waterway Loading Points in Western Germany



Regions are shaded green if they are treated as waterway-connected, and shaded yellow if they are treated as not connected. The loading points are shown as blue circles.

Two rules are applied when connecting a NUTS3 region to the waterways network:

- If the distance of the centroid of a NUTS3 region to the nearest node is less than 40 km
- If the distance from the border of a NUTS3 region to the nearest node is less than 10 km

This is needed in order to take into consideration that a large region bordering a river may show a large geometric distance from centroid to waterway node. Using the distance from the vertices as well as from the centroid ensures that any region bordering a river will appear to be connected. In the above example coverage for both the smaller German regions and the larger French regions is therefore quite balanced. The selection process does nevertheless treat regions which are close but not directly connected to the rivers as being connected.

As with the other modes, if a region contains a port and at least one waterway node, the loading point will be chosen close to the port rather than a centroid.

17.3 Data sources

Impedances are all calculated from other ETISplus resources:

- ETISplus Road network
- ETISplus Rail network
- ETISplus Waterway network
- ETISplus regions (EZ3)
- ETISplus seaports.

17.4 Results

Results for 2010 can be found inside ETIS-VIEW.

Table 17-8: Freight Impedances, surface modes, key results

Access via	Collection	Group	Description
ETIS View	Modelled Data	Freight	Estimated distances and trip times by mode of transport per O/D.
2010	http://viewer.etisplus.net/ select collection: ETISplus-2010-Modelled highlight: Freight open tables: - Road Impedances – freight - Rail Impedances – freight - Inland Waterway Impedances – freight		
2005	http://viewer.etisplus.net/ select collection: ETISplus-2005-Modelled highlight: Freight open tables: - Road Impedances – freight - Rail Impedances – freight - Inland Waterway Impedances – freight		

They are stored in the ETISplus-2010-Modelled collection, labelled:

- Inland Waterway Impedances - Freight
- Rail Impedances – Freight
- Road Impedances – Freight

18 Transport Impacts

18.1 Scope of database

The set of indicators related to transport impacts covers emission volumes per mode (tonnes per year, for CO₂, NO_x and PM), as well as emission factors per unit of transport and data on road accidents and fatalities.

The data source for emission values is the TREMOVE model, developed and maintained by Transport & Mobility Leuven (TML) for the European Commission. It covers all 27 EU countries, plus Switzerland, Croatia, Norway and Turkey.

The main characteristics of this database are summarised by Table 18-1 and the structure is given in Table 18-2 below.

Table 18-1: Overview of main characteristics of the data set

Impacts						
Data feature	Data specification					Remarks
Base year	2010					
Scope of data	Link	Terminal	O/D relation	Region	Other	
	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
GIS data	Yes	No				The level-of-concern data represent GIS data, all other data sets are not GIS-related
	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>				
Country coverage				Com-pletely	Par-tially	
	EU 27			<input checked="" type="checkbox"/>	<input type="checkbox"/>	
	Candidate countries & EFTA			<input type="checkbox"/>	<input checked="" type="checkbox"/>	
	Neighbouring countries			<input type="checkbox"/>	<input checked="" type="checkbox"/>	
	TRACECA			<input type="checkbox"/>	<input type="checkbox"/>	
	MEDA			<input type="checkbox"/>	<input type="checkbox"/>	
	Other countries			<input type="checkbox"/>	<input type="checkbox"/>	
	Total number of countries covered:			31		
Main data sources	TREMOVE 3.5c EUROSTAT					
Main type of data generation	Observed	<input checked="" type="checkbox"/>				
	Harmonised	<input checked="" type="checkbox"/>				
	Modelled	<input checked="" type="checkbox"/>				

Table 18-2: Data structure of the impacts data set

Indicator	Description of indicator	Unit
CO2EmissionsRoadPassenger	CO2 volume emitted by road passenger transport	tonnes/year
CO2EmissionsRoadFreight	CO2 volume emitted by road freight transport	tonnes/year
CO2EmissionsRailPassenger	CO2 volume emitted by rail passenger transport	tonnes/year
CO2EmissionsRailFreight	CO2 volume emitted by rail freight transport	tonnes/year
CO2EmissionsAir	CO2 volume emitted by air transport	tonnes/year
CO2EmissionsIWW	CO2 volume emitted by IWW transport	tonnes/year
NOxEmissionsRoadPassenger	NOx volume emitted by road passenger transport	tonnes/year
NOxEmissionsRoadFreight	NOx volume emitted by road freight transport	tonnes/year
NOxEmissionsRailPassenger	NOx volume emitted by rail passenger transport	tonnes/year
NOxEmissionsRailFreight	NOx volume emitted by rail freight transport	tonnes/year
NOxEmissionsAir	NOx volume emitted by air transport	tonnes/year
NOxEmissionsIWW	NOx volume emitted by IWW transport	tonnes/year
ParticulatesEmissionsRoadPassenger	Emission volume of particulates by road passenger transport	tonnes/year
ParticulatesEmissionsRoadFreight	Emission volume of particulates by road freight transport	tonnes/year
ParticulatesEmissionsRailPassenger	Emission volume of particulates by rail passenger transport	tonnes/year
ParticulatesEmissionsRailFreight	Emission volume of particulates by rail freight transport	tonnes/year
ParticulatesEmissionsAir	Emission volume of particulates by air transport	tonnes/year
ParticulatesEmissionsIWW	Emission volume of particulates by IWW transport	tonnes/year
FatalitiesRoad	Number of road fatalities	fatalities/year
AccidentsRoad	Number of road accidents involving personal injury	accidents/year
FatalitiesRail	Number of rail passengers killed in accidents involving rail	fatalities/year
LevelOfConcernByRoadTransport	Index of level of concern caused by road transport on inhabitants	

18.2 Methodology

18.2.1 Emission data

Emission data were collected from the TREMOVE model.

TREMOVE is a policy assessment model to study the effects of different transport and environment policies on the emissions of the transport sector. The model estimates the transport demand, modal shifts, vehicle stock renewal and scrappage decisions as well as the emissions of air pollutants and the welfare level, for policies as road pricing, public transport pricing, emission standards, subsidies for cleaner cars etc. The model covers passenger and freight transport in 31 countries and covers the period 1995-2030.

The current latest version of the model, version 3.5c, contains updated emission volumes, for CO₂ also calibrated to be in line with EUROSTAT. The main update was done for the assessment of the EC's 2011 Transport White Paper: "Roadmap to a Single European Transport Area - Towards a competitive and resource efficient transport system" (resulting in version 3.4). Later on, a number of unlikely assumptions were removed to create version 3.5c.

Table 18-3 lists the classification of vehicles used by the model.

Table 18-3: TREMOVE vehicle classification

	Vehicle category	Vehicle types	Vehicle stock model
Road transport			
	car (CAR)	10 vehicle types	vehicles
	moped (MOP)	1 vehicle type	vehicles
	motorcycle (MOC)	4 vehicle types	vehicles
	van (VAN)	2 vehicle types	vehicles
	light duty truck (LDT)	2 vehicle types	vehicles
	heavy duty truck < 7.5 ton (HDT1)	1 vehicle type	vehicles
	heavy duty truck 7.5-16 ton (HDT2)	1 vehicle type	vehicles
	heavy duty truck 16-32 ton (HDT3)	1 vehicle type	vehicles
	heavy duty truck > 32 ton (HDT4)	1 vehicle type	vehicles
	bus (BUS)	2 vehicle types	vehicles
Rail transport			
	metro/tram (*) (METRAM)	1 vehicle type	vkm
	passenger train (PTRAIN)	5 train types	vehicles
	freight train (FTRAIN)	4 train types	vehicles
Inland waterways transport			
	inland ship (*) (IS)	21 ship types	vkm
Air transport			
	plane (*) (PLANE)	5 distance classes	pkm

Using a bottom-up approach, total emission volumes are calculated for each country.

18.2.2 Safety data

The indicators "FatalitiesRoad", "AccidentsRoad" and "FatalitiesRail" are the three safety related data elements.

"FatalitiesRoad" indicates fatalities by country caused by road accidents and includes drivers and passengers of motorised vehicles, cyclist and pedestrians, killed within 30 days from the day of the accident.

"AccidentsRoad" are the numbers of accidents by country involving personal injury of drivers and passengers of motorised vehicles, cyclist and pedestrians.

"FatalitiesRail" displays the number of fatalities by country caused accidents involving railway, killed within 30 days from the day of the accident.

18.2.3 Level-of-concern data

The main task of the impact indicator "Level of concern by road transport" is to represent a measurement of inhabitants' level of concern caused by passenger cars' emissions of air pollutants. For this purpose, the level-of-concern indicator applied within the TEN-STAC project (NEA *et al.* 2004; Szimba *et al.* 2004) is used. Information of the CORINE¹ land cover database has been joined with data

¹ CORINE: Co-ordination on Information of the Environment

on number of inhabitants at regional level, in order to be able to assign certain numbers of inhabitants to grids covered by settlement areas.

Figure 18-1 (source: Szimba *et al.* 2004) illustrates this approach by showing a 2000-metres distance band along a road link being crossed with settlement areas. With population spatially distributed to grids the information on spatial vicinity of road links to inhabitants can be measured and by taking into account characteristics of spreading of air emissions by the road mode in the space a risk matrix for exposure of inhabitants to road traffic emissions can be developed (see Table 18-4).

Figure 18-1: Crossing of road infrastructure with settlement areas

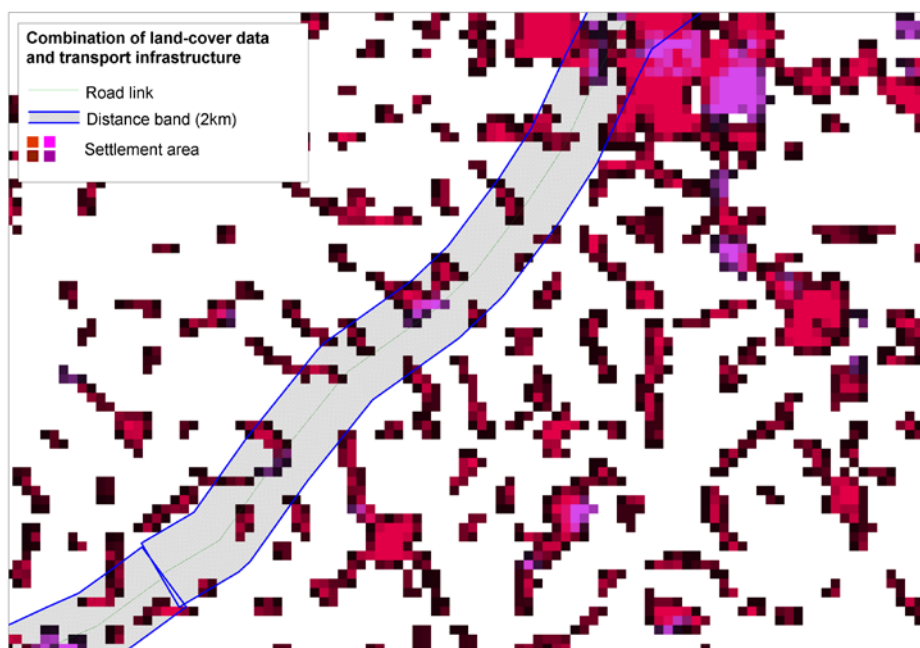


Table 18-4: Risk matrix for exposure of inhabitants to road traffic emissions

Risk class	Distance from the road link	Weight (w)
1	500 metres and less	20
2	500 – 1000 metres	2
3	1000 – 2000 metres	1

Applying this approach, the level of concern on link l $LevelOfConcern_l$ is calculated as follows:

$$LevelOfConcern_l = \sum_k w_k \cdot I_{k,l} \cdot EV_l^w$$

where

W_k	level-of-concern weight associated with distance class k
$I_{k,l}$	number of inhabitants along road link l in distance class k
EV_l^w	emission volume of particulates on link l, caused by inter-zonal passenger cars

The emission volume EV_l^w is estimated on the basis of assigned inter-zonal passenger car flows on the ETISplus road network 2010.

18.3 Data sources

18.3.1 Emission data

TREMOVE 3.5c was calibrated on EUROSTAT data up to 2005.

Road emission factors are based on the COPERT 4¹ methodology. For rail and IWW, emission factors are derived from the EX-TREMIS² project. Air emission data apply emission factors delivered by Eurocontrol.

18.3.2 Safety data

The datasets in this category are taken from the statistics published by the European Commission (2011). Data relating to road accidents and road fatalities are based on the CARE database (DG Mobility and Transport), United Nations (Statistics of road traffic accidents), International Transport Forum and national statistics. Rail fatalities data are based on data from the Union International des Chemins de Fer and national statistics.

18.3.3 Level-of-concern data

The computation of the emissions on link level was based on estimations on diesel shares related to the transport performance of passenger cars taken from TREMOVE. Table 18-5 shows the diesel shares by country.

¹ See <http://www.emisia.com/copert/>

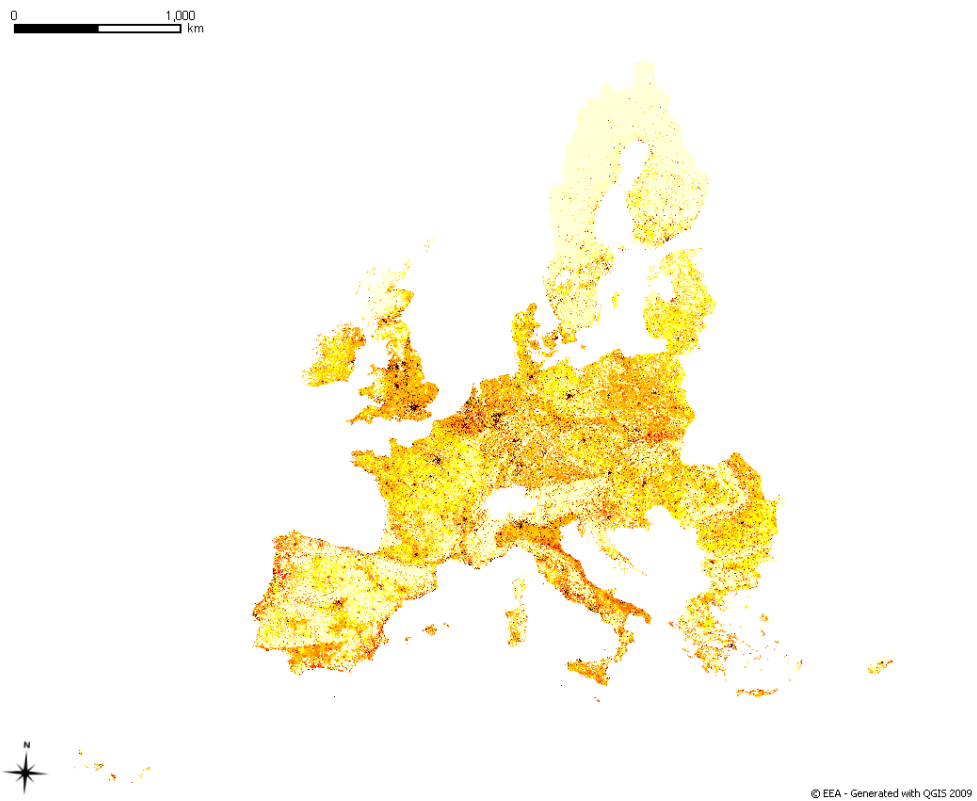
² See <http://www.ex-tremis.eu/>

Table 18-5: Diesel shares related to the transport performance of passenger cars from TREMOVE for 2005

NUTSO	Country	diesel share (%)	Proxy
	EU27		
AT	Austria	69.8	
BE	Belgium	76.8	
BG	Bulgaria	52.2	
CY	Cyprus	20.3	
CZ	Czech Republic	46.2	
DK	Denmark	22.4	
EE	Estonia	26.5	
FI	Finland	33.5	
FR	France	64.9	
DE	Germany	37.6	
GR	Greece	12.4	
HU	Hungary	35.4	
IE	Ireland	21.7	
IT	Italy	48.8	
LV	Latvia	39.6	
LT	Lithuania	46.4	
LU	Luxembourg	76.8	
MT	Malta	40.6	
NL	Netherlands	37.1	
PL	Poland	38.9	
PT	Portugal	44.7	
RO	Romania	35.9	
SK	Slovakia	29.7	
SI	Slovenia	43.3	
ES	Spain	68.1	
SE	Sweden	21.8	
UK	United Kingdom	34.6	
	Candidate countries & EFTA		
HR	Croatia	38.0	
IS	Iceland	22.4	Denmark
LI	Liechtenstein	18.3	Switzerland
MK	FYR Macedonia	38.0	Croatia
ME	Montenegro	38.0	Croatia
NO	Norway	25.4	
RS	Serbia	38.0	Croatia
CH	Switzerland	18.3	
TR	Turkey	19.7	
	Neighbouring countries		
AL	Albania	38.0	Croatia
AD	Andorra	68.1	Spain
BA	Bosnia and Herzegovina	38.0	Croatia
XK	Kosovo	38.0	Croatia

The European Environment Agency (EEA) has published a population density dataset based on the CORINE land cover database containing information. The 100m x 100m dataset for 2000 was used for the computation of the level-of-concern indicator. Figure 18-2 shows a map of the raster dataset (version 5 (09/2009)).

Figure 18-2: Population density disaggregated with Corine land cover 2000



18.4 Results

Table 18-6: Transport Impacts, Key results

Access via	Collection	Group	Description
ETIS View	Modelled Data	Socio-economic	Estimated social impacts from transport (e.g. emissions and accidents)
2010	http://viewer.etisplus.net/ select collection: ETISplus-2010-Modelled highlight: Socio-economic open table: Impacts		
2005	http://viewer.etisplus.net/ select collection: ETISplus-2005-Modelled highlight: Socio-economic open table: Impacts		

18.4.1 Emission data

Table 18-7, Table 18-8 and Table 18-9 below contain the results reported to ETISplus. Emissions on CO₂, NO_x and PM are covered for 2010.

Table 18-7: CO₂ emission data reported by TREMOVE 3.5c

RowDim_Description	CO2 volume emitted by air transport [tonnes/year]	CO2 volume emitted by IWW transport [tonnes/year]	CO2 volume emitted by rail freight transport [tonnes/year]	CO2 volume emitted by rail passenger transport [tonnes/year]	CO2 volume emitted by road freight transport [tonnes/year]	CO2 volume emitted by road passenger transport [tonnes/year]
Austria	1,196,038	169,741	52,368	85,403	3,925,399	9,177,017
Belgium	1,196,344	701,636	58,006	32,640	4,993,554	16,838,006
Bulgaria	623,019	55,935	27,344	39,942	1,903,908	3,104,833
Switzerland	1,322,609		25,560		3,042,697	12,708,158
Cyprus	1,317,756				617,420	735,850
Czech Republic	1,524,561	12,656	65,244	157,326	6,725,130	7,144,665
Germany	11,054,326	3,399,792	339,289	1,089,772	42,362,950	130,928,191
Denmark	1,641,509		24,259	324,268	2,552,420	7,926,738
Estonia	117,834		171,696	21,475	973,663	1,212,754
Spain	16,335,814		99,109	163,247	32,604,545	48,707,730
Finland	1,511,310		92,879	22,827	3,996,749	10,888,920
France	10,811,999	529,308	117,274	460,983	28,825,558	84,305,214
Greece	5,127,559		19,527	120,251	3,739,745	11,081,646
Croatia	385,360		33,197	59,242	1,338,984	2,859,019
Hungary	578,667	53,646	61,092	122,011	4,142,367	4,183,979
Ireland	1,717,394		19,588	101,725	2,144,970	5,004,234
Iceland						
Italy	6,774,312		12,857	278,300	20,495,530	89,221,897
Liechtenstein						
Lithuania	144,650		338,620	47,291	2,860,666	3,557,959
Luxembourg (Grand-Duché)	118,932		5,574	1,939	1,268,526	1,026,053
Latvia	172,194		369,319	36,315	1,511,347	2,116,916
Malta	372,152				42,856	218,266
Netherlands	2,254,312	3,378,118	34,272	73,820	9,704,121	23,201,764
Norway	1,069,541		20,050	23,189	3,335,150	8,106,714
Poland	1,059,923	27,082	230,203	138,736	21,979,823	18,452,031
Portugal	2,794,248		40,401	52,610	5,512,669	9,731,979
Romania	818,340	555,209	215,243	143,265	8,053,260	5,896,376
Sweden	2,446,538		41,716	15,662	4,685,922	16,511,772
Slovenia	76,794		15,954	16,270	2,193,570	2,281,573
Slovakia	224,961	73,676	43,249	53,926	5,452,478	3,046,308
Turkey	1,581,456	259,314	214,617	283,230	26,333,691	17,434,591
United Kingdom	14,391,701		1,126,311	1,091,606	28,025,876	99,672,947

Table 18-8: NOx emission data reported by TREMOVE 3.5c

RowDim_Description	NOx volume emitted by air transport [tonnes/year]	NOx volume emitted by IWW transport [tonnes/year]	NOx volume emitted by rail passenger transport [tonnes/year]	NOx volume emitted by road freight transport [tonnes/year]	NOx volume emitted by road passenger transport [tonnes/year]
Austria	3,553	2,572	33	30,067	25,502
Belgium	3,528	10,846	13	43,429	46,878
Bulgaria	2,096	864	16	19,352	8,207
Switzerland	3,797			24,755	24,127
Cyprus	3,887			6,400	1,436
Czech Republic	4,951	198	61	62,908	18,330
Germany	31,820	51,627	425	311,010	262,928
Denmark	4,707		127	21,433	16,599
Estonia	393		8	8,828	4,328
Spain	49,354		64	301,052	157,766
Finland	4,395		9	40,124	23,201
France	31,397	8,065	180	214,573	248,246
Greece	15,586		47	39,226	25,708
Croatia	1,486		23	12,437	5,434
Hungary	1,946	829	48	33,967	17,994
Ireland	5,238		40	14,115	7,779
Iceland					
Italy	21,103		109	191,797	246,640
Liechtenstein					
Lithuania	482		18	27,593	7,087
Luxembourg (Grand-Duché)	338		1	10,430	2,854
Latvia	574		14	11,276	4,950
Malta	1,159			330	437
Netherlands	6,649	51,770	29	83,209	39,897
Norway	3,068		9	27,786	19,769
Poland	3,534	445	54	174,302	47,161
Portugal	8,236		21	51,364	25,253
Romania	2,753	8,580	56	74,250	15,393
Sweden	7,002		6	38,219	23,042
Slovenia	296		6	15,972	4,993
Slovakia	732	1,131	21	45,497	11,641
Turkey	5,319	4,007	111	241,516	62,719
United Kingdom	43,074		426	202,215	177,763

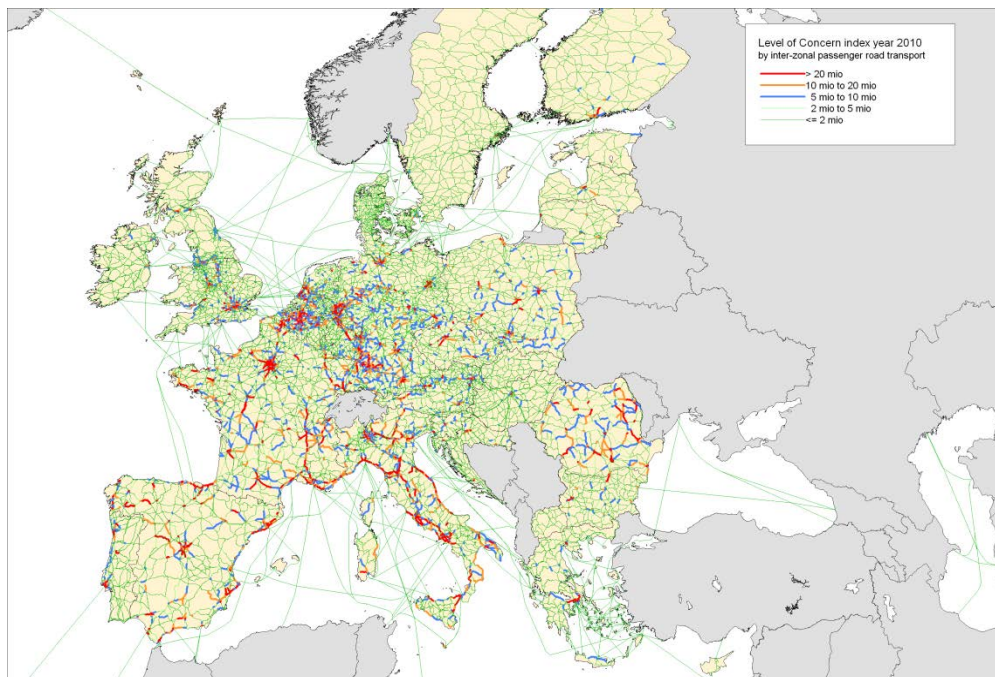
Table 18-9: PM emission data reported by TREMOVE 3.5c

RowDim_Description	Particulate matter volume emitted by IWW transport [tonnes/year]	Particulate matter volume emitted by rail freight transport [tonnes/year]	Particulate matter volume emitted by rail passenger transport [tonnes/year]	Particulate matter volume emitted by road freight transport [tonnes/year]	Particulate matter volume emitted by road passenger transport [tonnes/year]
Austria	76	34	55	359	1,115
Belgium	320	38	21	756	2,214
Bulgaria	25	18	26	474	201
Switzerland		17		405	524
Cyprus				206	78
Czech Republic	6	42	102	1,494	740
Germany	1,531	220	706	3,885	8,720
Denmark		16	210	352	452
Estonia		111	14	158	105
Spain		64	106	5,824	6,501
Finland		60	15	1,029	1,614
France	239	76	299	3,485	13,098
Greece		13	78	917	621
Croatia		22	38	282	560
Hungary	24	40	79	627	459
Ireland		13	66	183	221
Iceland					
Italy		8	180	3,986	13,623
Liechtenstein					
Lithuania		219	31	724	409
Luxembourg (Grand-Duché)		4	1	182	120
Latvia		239	24	151	188
Malta				8	13
Netherlands	1,531	22	48	1,346	1,084
Norway		13	15	523	579
Poland	13	149	90	2,748	1,172
Portugal		26	34	1,115	759
Romania	253	139	93	1,711	404
Sweden		27	10	558	516
Slovenia	33	10	11	236	140
Slovakia	118	28	35	1,108	234
Turkey		139	184	5,437	1,228
United Kingdom		730	707	3,270	6,676

18.4.2 Level-of-concern data

Figure 18-3 shows a map of the level of concern indicator for inter-zonal passenger road transport. Links with a very high level of concern index are depicted in red and denote links with high emissions and a higher number of inhabitants living near these links.

Figure 18-3: Level of concern by inter-zonal passenger road transport (index)



18.5 References

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19 Road Freight Matrix

ETISplus has constructed a series of freight matrices; one for each mode of transport. Since data availability for different transport modes varies and because the relative strengths of national and European sources also vary, a different approach has been undertaken for each mode of transport.

Road data availability from EUROSTAT is relatively strong and published at NUTS3 level, so this has been the main source used in constructing the road matrix. Raw data for 2010 was published in 2011.

One of the most important considerations is that the statistical basis is by vehicle nationality, not territory. Each vehicle is uniquely registered in a single country, whereas any trip can involve border crossing and foreign-flag vehicles, so the collection method means that the data avoids double counting for cross-border traffic.

Simplifying the collection process adds complexity to the interpretation of road tonne kilometres. Tonne kilometres registered under one country may actually take place in another. In 2008, Eurostat made road freight statistics by territory available, so this was used for validation.

National and international data formats also differ. Detail is generally higher for national rather than cross-border traffic, and the relevant sample sizes are much higher. A different matrix building method is needed for national and cross-border streams.

In ETISplus, we have attempted to maintain a link from the original Eurostat data to the final output, so different road freight matrices are stored under the headings; observed, harmonised and modelled. Since the modelled matrix is the most detailed, and involving the greatest number of estimation steps, we concentrate in this section on this end product.

19.1 Scope of the Database

Table 19-1 shows the scope of the modelled road freight matrix, while Table 19-2 shows its structure.

Table 19-1: Scope of Modelled Road Freight Matrix

Road Freight Matrix		
Data feature	Data specification	Remarks
Base year	2010	
Scope of data	<div> <div>Link</div> <div>Terminal</div> <div>O/D relation</div> <div>Region</div> <div>Other</div> </div> <div> <input type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> </div>	Transport data showing journeys made by road.
GIS data	<div> <div>Yes</div> <div>No</div> </div> <div> <input type="checkbox"/> <input checked="" type="checkbox"/> </div>	O/D regions are geo-coded within ETISplus.
Country coverage	<div> <div>Com-pletely</div> <div>Par-tially</div> </div> <hr/> <div> <div>EU 27</div> <div>Candidate countries & EFTA</div> <div>Neighbouring countries</div> <div>TRACECA</div> <div>MEDA</div> <div>Other countries</div> </div> <div> <input checked="" type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> </div> <div> Total number of countries covered: </div> <div> 36 </div>	
Main data sources	Eurostat 2010	
Pedigree	<div> <div>Observed</div> <div>Harmonised</div> <div>Modelled</div> </div> <div> <input type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> </div>	

Table 19-2: Modelled Road Freight Matrix, Structure

Dimensions	Description	Data Type
ID	Unique record ID	Integer
ORIGINZONE_3_ID	EZ3 region of origin	Integer
DEST_ZONE_3_ID	EZ3 region of destination	Integer
NST2_ID	NST2 commodity	Integer
Parameter		
f_transport-road_modelled	Tonnes transported	Floating Point

19.2 Data Sources

Within Eurostat there are a variety of aggregated data concerning road freight transport. Due to confidentiality issues, they are unable to publish their data at the most disaggregate O/D level as required by ETISplus. One of the main tasks in producing the road matrix is therefore to take all of the data that is publicly available, and use it to generate a best possible estimation at the disaggregate level.

The resulting output is a NUTS3-NUTS3 OD matrix, further divided into commodities (NST2). Note that between 2005 and 2010, Eurostat has changed the main commodity classifications. Creating an NST2 matrix therefore requires estimation.

The following Eurostat data is used as input:

Table 19-3: Main Eurostat Data Sources

Eurostat table	ETISplus parameter	Description	Scope
road_go_ia_lgtt road_go_ia7lgtt	f_estat_eu27_road_outgoing	International Road Freight	EU27+NO+CH
road_go_ia_ugtt road_go_ia7ugtt	f_estat_eu27_road_incoming		
road_go_na_rl3g	f_estat_eu27_dom_road_outgoing	Domestic Road Freight	EU27
road_go_na_ru3g	f_estat_eu27_dom_road_incoming		

This is complemented by the following Eurostat data. These are not used directly to construct the final road matrix, but are available as “Observed” data tables in ETISplus.

Table 19-4: Additional Road Freight Sources in ETISplus

Eurostat table	Description	Scope
road_go_ia_tc	Total road freight between country pairs	EU27+NO+CH
road_go_ia_rc	Total road freight between country pairs, by reporting country	EU27
road_go_ta_rl	Total road freight per region of loading	EU27

road_go_ta_ru	Total road freight per region of unloading	EU27
road_go_na_tggt road_go_na7tggt	Domestic road freight, both in tonnes and tkm	EU27
-	Partial NUTS3-NUTS3 road freight matrix for the years 2008 and 2009, as delivered by Eurostat	EU27

The following is a list of countries included in the O/D matrix and the additional non-Eurostat data that was used to make the estimation.

Table 19-5: Sources of 2010 Domestic Road Data

Country	Data source
EU25	Eurostat
Bulgaria	National statistical institute.
Romania	National statistical institute. Data not publicly available.
Croatia	Domestic total from Croatian statistics yearbook.
Serbia	Total per commodity from Serbian statistics yearbook.

Table 19-6: Sources of 2010 International Road Freight Data

Country	Data source
EU25	Eurostat
Bulgaria	Bulgarian customs agency. Detailed enough to be incorporated in methodology as (9) data.
Romania	National statistical institute. Data not publicly available. Total transported to and from partner country by Romanian operators. Complemented by Eurostat data.
Croatia	International total (by Croatian operators) from Croatian statistics yearbook. Partner country shares based on Eurostat 2008 data.
Ukraine	State Statistics Committee of Ukraine. Total transported to and from partner country (all operators). Total transported per commodity.
Serbia, Montenegro, FYR of Macedonia, Moldova, Albania, Bosnia and Herzegovina, Turkey,	Road transport estimated using COMEXT and UN COMTRADE trade data. Only flows between neighbouring countries were taken into account. Road transport between these countries was estimated as
Russia	Road transport estimated using COMEXT and UN COMTRADE trade data. The share of road transport decreases for more distant countries. Commodities that are likely to be transported by pipeline

19.3 Methodology

The complete OD matrix is made with according to the following steps:

- First the domestic OD matrix is calculated for each country, since these each relate to a single data source.
- Then the international O/D matrix is made for all country pairs together.
- The full set is then modelled using O/D distances in order to check consistency with tonne-kilometre flows.

19.3.1 Domestic

For the domestic OD matrices, there is the advantage that a fairly complete domestic NUTS3-NUTS3 matrix already exists for 2008 and 2009, as provided by Eurostat. However, commodity information is not included in this matrix, and some countries lack data altogether. The OD matrices will first be generated for these years, and they will be used as a starting point for the other years.

The following input data is used for the 2008 and 2009 domestic matrices:

- Incoming domestic transport per zone and commodity

- Outgoing domestic transport per zone and commodity
- Domestic transport from loading zone to unloading zone (incomplete)
- Travel distance in km for each zone pair
- Average distance that each domestic tonne travels per country (calculated from road_go_na_tggt)

The actual calculation is the following iterative process:

1. Fill in the empty matrix using a negative exponential distribution function and distance between the zone pairs.
2. For each commodity, use a matrix balancing procedure to set the row and column totals equal to the total transport incoming and outgoing per zone.
3. Where the total transport is known, factor this particular cell in the matrix up or down (for each commodity) so that it agrees with the total.
4. Go back to step 2, unless equilibrium has been reached.
5. Compare the average distance per tonne to the known distance, adjust the parameter of the distribution function and go back to step 1, unless equilibrium has been reached.

For other years (including 2005) the nearest road OD matrix is taken (either 2008 or 2009) as the starting matrix, and then step 2 is performed once so that the row and column totals are equal to the total tonnes incoming and outgoing per zone.

19.3.2 International

The international OD matrix is more complicated. The incoming and outgoing international transport per zone has to be derived from the total transport and domestic transport per zone. By subtracting the domestic from the total, the international part can be estimated.

The following input data is used for the international matrix:

- Incoming domestic transport per zone and commodity (1a)
- Outgoing domestic transport per zone and commodity (1b)
- Total incoming transport per zone (2a)
- Total outgoing transport per zone (2b)
- International transport loaded per country, partner country and commodity (3a)
- International transport unloaded per country, partner country and commodity (3b)
- Total transport between country pairs (both tonnes and tkm) (4)
- Known international transport per zone pair (very incomplete) (5)
- Travel distance in km for each zone pair (6)

From this is derived:

- Total transport between country pairs per commodity (using 3 and 4) (7)
- International transport (un)loaded per zone and commodity (using 1 and 2) (8)

- Known international transport per zone pair and commodity (using 3 and 5) (9)

Then for each commodity the matrix is generated using the following iterative process:

1. Fill in the empty matrix using a negative exponential distribution and distance between the zone pairs
2. For each country pair, calculate the current total in the matrix, compare it to constraining total (7), then factor up or down
3. Use a matrix balancing procedure to set the row and column totals equal to the international transport (un)loaded per zone and commodity (8)
4. Override all of the cells where the transport is known (9)
5. Go back to step 2 unless equilibrium has been reached
6. Calculate the current tkm in the matrix, compare to the known tkm (4), and adjust the country pair specific parameters of the negative exponential distribution accordingly
7. Go back to step 1 unless satisfied with the current matrix (default: adjust parameters 10 times)

The final step is to convert the commodities in both the domestic and international matrices to the desired NST2 commodity classification. In Eurostat, NSTR24 is used in 2007 and earlier, and NST07 in 2008 and later. NSTR24 is based on NST2 codes; some were grouped together by Eurostat to reduce the number of commodities. (See annexes for lists of commodity classifications).

To convert NSTR24 to NST2, COMEXT trade data is used. This means the shares of each NST2 commodity are different for each country pair. For domestic transport, a weighted average of the international trade is used to calculate the shares.

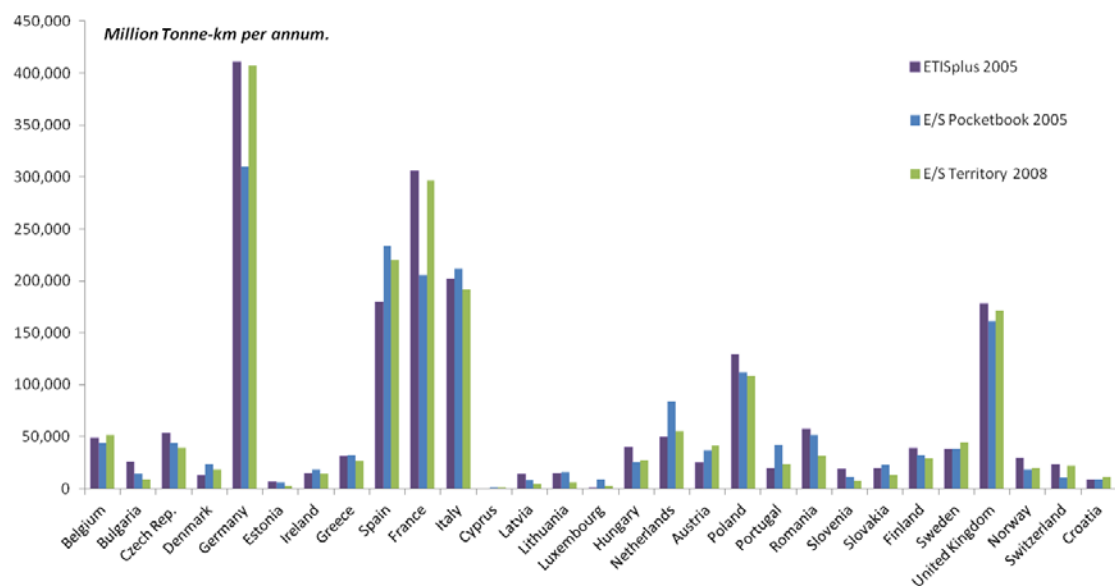
19.4 Results

Since road freight is covered in some detail by European statistics, these sources are also published in ETIS-View as observed and harmonised sets. The result of combining these inputs into a detailed road O/D matrix is stored as a modelled table.

Table 19-7: Road Freight O/D, key results

Access via	Collection	Group	Description
ETIS View	Modelled Data	Freight	Road Freight Tonnages by NUTS3 O/D and NST2 Commodity
2010	http://viewer.etisplus.net/ select collection: ETISplus-2010-Modelled highlight: Freight open table: Road Freight by OD		
2005	http://viewer.etisplus.net/ select collection: ETISplus-2005-Modelled highlight: Freight open table: Road Freight by OD		

The result of assigning the modelled 2005 road matrix is shown below. ETISplus results are compared against the (nationality-based) pocketbook statistics, as well as 2008 territory-based statistics from Eurostat. Although there is no perfect comparison, it is evident e.g. from German and Dutch results that the matrices match closely with the territorial data. In cases such as the UK, where nationality and territory based results only differ by a small margin, there is a closer comparison between pocketbook and ETISplus results.

Figure 19-1: Assigned Road Freight Matrix


20 Rail Freight Matrix

In the following sections we explain the methodologies used for the construction of the Rail Freight Matrix 2010. Like the road freight matrix this was constructed in stages, expanding from a (mainly) observed NUTS2-NUTS2 matrix, then adding NSTR1 commodities, and then finally expanding to NUTS3-NUTS3, with NST2 commodity in order to follow the same structure as other transport modes.

It is important to note that despite the importance of rail freight for transport policy, and despite the fact that full records of train movements are being monitored by the railway authorities, the availability of European rail freight data is weak, compared to other freight modes. It is therefore not possible to adopt the same methods as used for road transport.

As far as possible we have attempted to use Eurostat rail freight data, which is only published in detailed form every five years. During the project, no final version of Eurostat 2010 rail freight data has been officially published. Instead there have been revisions of the 2005 data, carrying on until the summer of 2012, i.e. more than six years after the fact.

The methodology was developed for the 2005 dataset, and the detailed work was applied to that reference year. In the absence of detailed (regional O/D) 2010 data, the 2005 databases and methodologies are key inputs for the 2010 ETISplus rail matrix, as well as some national statistical sources.

20.1 Scope of the Database

The scope of the project is the EU27 countries plus Switzerland, Croatia, Norway and Turkey. In total 29 countries are included: AT, BE, BG, CH, CZ, DE, DK, EE, ES, FI, FR, GR, HR, HU, IE, IT, LT, LU, LV, NL, NO, PL, PT, RO, SE, SI, SK, TR, UK.

Table 20-1: Overview of Rail Freight Database

Rail Freight O/D Matrix																														
Data feature	Data specification					Remarks																								
Base year	2005 and 2010																													
Scope of data	Link	Terminal	O/D relation	Region	Other																									
	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>																									
GIS data	Yes	No																												
	<input type="checkbox"/>	<input checked="" type="checkbox"/>																												
Country coverage	<table><thead><tr><th></th><th>Com-pletely</th><th>Par-tially</th></tr></thead><tbody><tr><td>EU 27</td><td><input checked="" type="checkbox"/></td><td><input type="checkbox"/></td></tr><tr><td>Candidate countries & EFTA</td><td><input type="checkbox"/></td><td><input checked="" type="checkbox"/></td></tr><tr><td>Neighbouring countries</td><td><input type="checkbox"/></td><td><input checked="" type="checkbox"/></td></tr><tr><td>TRACECA</td><td><input type="checkbox"/></td><td><input checked="" type="checkbox"/></td></tr><tr><td>MEDA</td><td><input type="checkbox"/></td><td><input type="checkbox"/></td></tr><tr><td>Other countries</td><td><input type="checkbox"/></td><td><input checked="" type="checkbox"/></td></tr><tr><td>Total number of countries covered:</td><td>49</td><td></td></tr></tbody></table>						Com-pletely	Par-tially	EU 27	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Candidate countries & EFTA	<input type="checkbox"/>	<input checked="" type="checkbox"/>	Neighbouring countries	<input type="checkbox"/>	<input checked="" type="checkbox"/>	TRACECA	<input type="checkbox"/>	<input checked="" type="checkbox"/>	MEDA	<input type="checkbox"/>	<input type="checkbox"/>	Other countries	<input type="checkbox"/>	<input checked="" type="checkbox"/>	Total number of countries covered:	49		From EU 27 countries, CY and MT are not included. In 2010 data, two extra countries are included compared to 2005 data: Liechtenstein and Afghanistan. For 2005 one record refers to Iran.
	Com-pletely	Par-tially																												
EU 27	<input checked="" type="checkbox"/>	<input type="checkbox"/>																												
Candidate countries & EFTA	<input type="checkbox"/>	<input checked="" type="checkbox"/>																												
Neighbouring countries	<input type="checkbox"/>	<input checked="" type="checkbox"/>																												
TRACECA	<input type="checkbox"/>	<input checked="" type="checkbox"/>																												
MEDA	<input type="checkbox"/>	<input type="checkbox"/>																												
Other countries	<input type="checkbox"/>	<input checked="" type="checkbox"/>																												
Total number of countries covered:	49																													
Main data sources	EUROSTAT, Sitram (FR), CBS (NL)																													
Main type of data generation	Observed	<input type="checkbox"/>																												
	Harmonised	<input checked="" type="checkbox"/>																												
	Modelled	<input checked="" type="checkbox"/>																												

For HR, SE and TR national rail flows are not included. The level of detail of the regions in the modelled rail database is ultimately NUTS3, although has to be estimated from data which is recorded at NUTS2.

Data structures are shown below. The harmonised matrix was constructed with EZ – level 2 (NUTS2) and NST1 detail, which follows approximately the detail published by Eurostat. The modelled matrix was further disaggregated to NUTS3, NST2, to become compatible with the other freight matrices.

Table 20-2: Harmonised Rail Freight Matrix, Structure, 2010

Indicator	Description of indicator	Unit 2005	Unit 2010
ORIGINZONE_2_ID	Region of origin, ETISZone2_ID (NUTS2)	EZ2003	EZ2006
DEST_ZONE_2_ID	Region of destination, ETISZone2_ID (NUTS2)	EZ2003	EZ2006
NST1_ID	Commodity group, NST 1 digit	NST 1 digit	NST 1 digit
f_transport_rail	Tonnes	Tonnes	Tonnes

Table 20-3: Modelled Rail Freight Matrix, Structure, 2010

Indicator	Description of indicator	Unit 2005	Unit 2010
ORIGINZONE_3_ID	Region of origin, ETISZone3_ID (NUTS3)	EZ2003	EZ2006
DEST_ZONE_3_ID	Region of destination, ETISZone3_ID (NUTS3)	EZ2003	EZ2006
NST2_ID	Commodity group, NST 2 digit	NST 2 digit	NST 2 digit
f_transport_rail	Tonnes	Tonnes	Tonnes

20.2 Data Sources

There were several dataset from different sources available. The following files were used as input:

- Reporting country
- Region of Origin with finest detail: NUTS2
- Region of Destination with finest detail: NUTS2
- Tonnes

Control table = EUROSTAT rail_go_typeall

- Reporting country
- Direction (domestic, import, export and transit)
- Tonnes

Both rail freight tables tran_r_rago and rail_go_typeall do not contain commodity information.

Data from EUROSTAT

- Annual national and international railway goods transport by region of loading and region of unloading (Eurostat reference: "tran_r_rago"). It contains:
 - Reporting country
 - Region of Origin with detail up to NUTS2
 - Region of Destination with detail up to NUTS2
 - Tonnes
- Rail freight data split by the type of flow, including domestic, international and transit traffic. (Eurostat reference: "rail_go_typeall").

- International annual railway transport from the reporting country to the unloading country (Eurostat reference: "rail_go_intgong").
- International annual railway transport from the loading country to the reporting country (Eurostat reference: "rail_go_intcmgn").
 - INTCMGN and INTGONG contain reporting country, country of loading and unloading, tonnes and tonne kms. There is a commodity dimension, but all flows are coded as "Total".
- Rail freight data per country, showing tonnes and tonne-kms split by 24 NSTR commodities. (Eurostat reference: "rail_go_grpgood").

National data from various countries

Bulgaria

International data only shows flows with neighbouring countries, so this was assumed to be cross-border and not O/D data. For this reason it was not used. National data was used.

International flows (not used)

- Origin (NUTS3)
- Destination (NUTS3)
- Commodity group (NSTR24)
- Tonnes

National flows

- Origin (NUTS3)
- Destination (NUTS3)
- Commodity group (NSTR24)
- Tonnes

Belgium

International flows

- Origin (BE NUTS2, other countries NUTS0)
- Destination (BE NUTS2, other countries NUTS0)
- Commodity group (NSTR1)
- Tonnes

National flows

- Origin (NUTS2)
- Destination (NUTS2)
- Commodity group (NSTR1)
- Tonnes

Germany

The national data from Germany contained regions which are traffic regions, these regions were manually matched with NUTS1 regions. Other countries were translated to NUTS0.

International flows

- Origin (DE NUTS1, other countries NUTS0)
- Destination (DE NUTS1, other countries NUTS0)
- Commodity group (NSTR2)
- Tonnes
-

National flows

- Origin (NUTS1)
- Destination (NUTS1)
- Commodity group (NSTR2)
- Tonnes

France

There was national data only for 2004, since the base year is 2005 the national data was not used. Since the commodity groups of the international flows cannot be translated to NSTR1 or NSTR2 the distribution on commodities was not used.

International flows (2005)

- Origin (FR NUTS2, other countries NUTS0)
- Destination (FR NUTS2, other countries NUTS0)
- Commodity group (NSTR16, not used)
- Tonnes

National flows (2004, not used)

- Origin (NUTS2)
- Destination (NUTS2)
- Commodity group (NSTR1)
- Tonnes

Netherlands

After finding out that the data we received from Eurostat contained errors we received a different data set with adjusted data only for the national flows. Since the international data still contained errors, it was decided to use data from the Netherlands central Bureau of Statistics (CBS) instead.

Dutch CBS data, available dimensions:

International flows

- Origin (NL NUTS2, other countries NUTS0)
- Destination (NL NUTS2, other countries NUTS0)
- Commodity group (NSTR1)
- Tonnes
- Tonne-kilometres

National flows

- Origin (NUTS2)
- Destination (NUTS2)
- Commodity group (NSTR1)
- Tonnes
- Tonne-kilometres

Other countries

Other national statistics were available, however these were on a too aggregated level, such as the total tonnes imported or exported. Additional information per origin-destination relation on NUTS2 level and per commodity group was not available. Also it was too time consuming to convert the data in a usable format.

In 2010, additional data was collected from:

Country ISO	Statistical office	
DE	DESTATIS	Only statistics of the port regions Hamburg and Bremen
UK	DfT	NUTS1 –NUTS1 (no commodity information)

20.3 Methodology

The methodology is constrained to a significant degree by the availability and quality of rail O/D statistics in Europe. Eurostat delivers rail freight O/D data on country level and on regional level. However, the volumes in these sources are not consistent, some of the results are clearly not correct and no information is included about commodities. During the ETISplus project there have been significant data revisions for the year 2005. See examples below.

Table 20-4: Comparison of 2005 and 2010 Data Revisions (TRAN_R_RAGO)

Country	Flow	2005 (v1)	2005 (v2)	2010
Germany	Domestic	191,707,803	201,725,248	0
Netherlands	To Germany	2,654,124	2,763,126	14,733,971
Spain	Domestic	23,961	21,161,816	13,776,410
France	To Italy	4,984,513	4,984,513	2,016,192

Eurostat sources

For example, German domestic traffic does not appear in 2010, despite being one of the most important categories in Europe. Traffic between the Netherlands and Germany, which is one of the most important Dutch freight corridors, appeared to grow by seven times between 2005 and 2010. Spanish domestic traffic increased by a factor of 1000 between the different data releases of 2005 data. French flows to Italy appeared to be halved between 2005 and 2010. Because of the errors and gaps it is difficult to say which of the apparent

changes between 2005 and 2010 are real reflections of the market, or problems with counting.

Besides, only volumes for rail operators above a certain minimum volume are included in statistics. From national statistics of member states only for a number of countries some data is available.

For the construction of the rail O/D freight matrix, different sources have been combined in order to produce a matrix that is as complete and reliable as possible given the limited – and sometimes problematic – data availability.

For constructing the data for the O/D rail matrix 2005, we used the following order for selecting data.

1. For the national flows, national data was used where it was possible.
2. If no national data was available, the data from Eurostat "Tran_r_rago" or the international files, were was used.

Each of the national data files was harmonised to the zoning in ETISplus.

Eurostat data

For each region there were two different values available, for import/export from the Tran_r_rago and the international files (Rail_go_intcmgn, Rail_go_intgong).

The data of Rail_go_intcmgn, Rail_go_intgong, and Tran_r_rago were aggregated to produce the total import/export per country, to make it easy to compare these files. For several countries there are discrepancies between these data files. Therefore it is necessary to determine which files are better or more correct.

It was decided to take the data from the Tran_r_rago file as the leading source, unless there was reason to suspect that the data from the international files was more accurate¹.

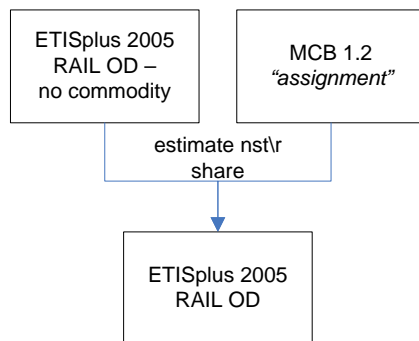
Combination of Data, 2005

The first data combination stage produced a NUTS2-NUTS2 rail O/D matrix with no product definition.

However, as mentioned, Eurostat does produce national level data showing rail freight tonne kilometres per NST24 commodity. A procedure was therefore set up, whereby a synthetic matrix of NUTS3-NUTS3-NST2 rail flows estimated from the WORLDNET mode chain builder (MCB v1.2) was calibrated to the national tonne kilometre data by product. These results were then combined with the harmonised NUTS2 data to produce a consolidated modelled database for 2005.

¹ For Estonia (EE), Finland (FI) and Hungary (HU) the differences were large and it is therefore not easy to decide which file is leading. One of attempts to make this decision was on basis of the Statistical Pocket Book (SPB), this turned out not to be possible since the SPB had values per ton kilometre that included the national flows. By checking the website of Statistics Estonia, e-mailing the Finnish Transport Agency, and e-mailing intrastate Hungary it was determined which file was correct.

Figure 20-1: Commodity estimation



The box on the top left is the ETISplus harmonised matrix (all commodities are set to 9, miscellaneous, in 2005). The modelled matrix is indicated at the bottom.

Estimation of 2010 matrices

The 2010 matrix estimation was carried out in the summer of 2012, but at this point, little or no regional rail data was available for 2010.

Rail 2010 data has been constructed by combining two methods for modelling 2010 flows:

- Part 1: simple upgrade from modelled 2005 Rail matrix using EUROSTAT country totals. This includes changes resulting from the 2005 data revisions, e.g. Spanish domestic traffic.
- Part 2: combine available regional 2010 statistical rail data

Figure 20-2: 2010 matrix estimation, part 1

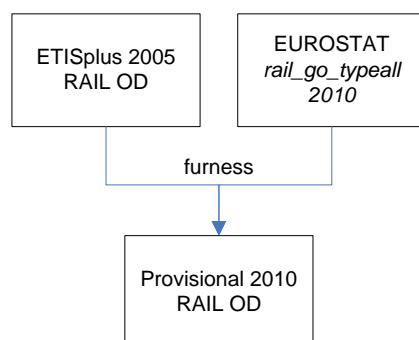
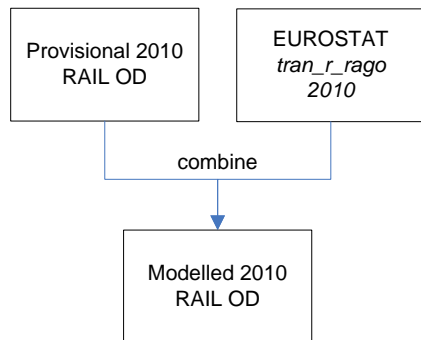


Figure 20-3: 2010 matrix estimation, part 2

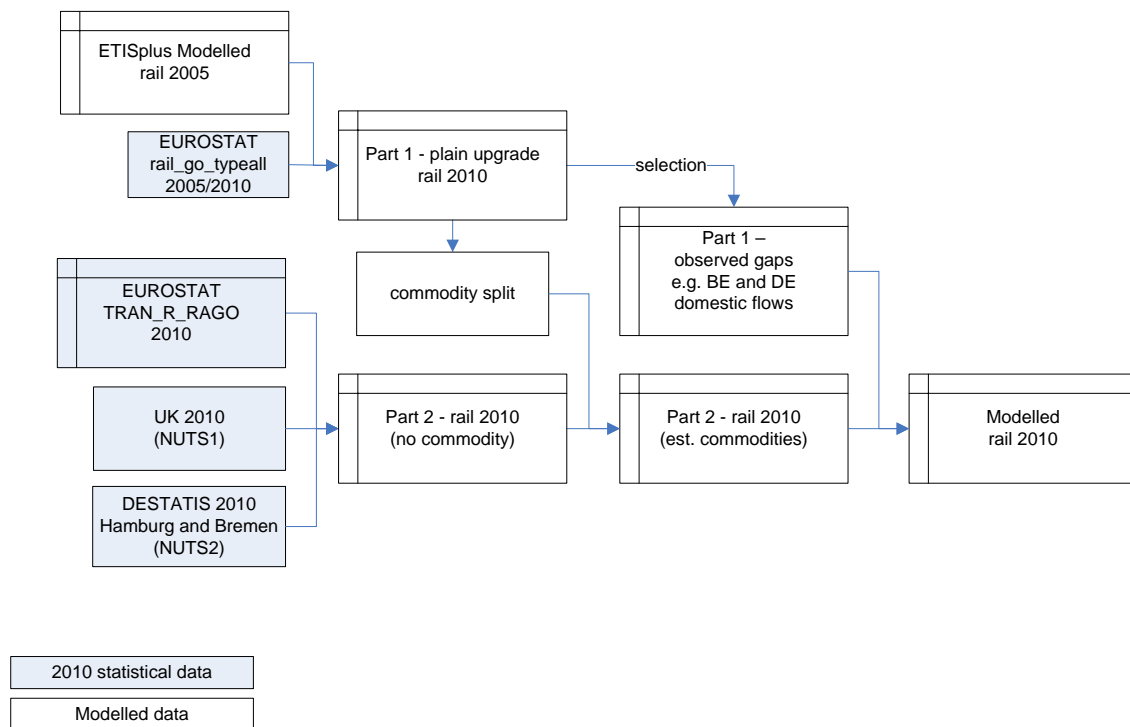
The main goal was to use the real statistical 2010 data as much as possible. However, several data gaps were found in EUROSTAT regional data (*tran_r_rago*). Some countries did not appear as 2010 data reporting country, e.g. BE and DE.

On other hand, for other countries, the total of regional domestic flows shows a perfect match with the EUROSTAT country total. These are: CZ; DK; EE; FI; FR; HR; IE; LT; LV; PT; SI; TR.

Available national statistics were:

- UK statistics available on NUTS1 level – this was important because Eurostat data shows no regional detail inside the UK.
- For Hamburg and Bremen, 2010 DESTATIS data was available on NUTS2 level.

Figure 20-4: Overview of Data Sources and Modelling Steps, 2010



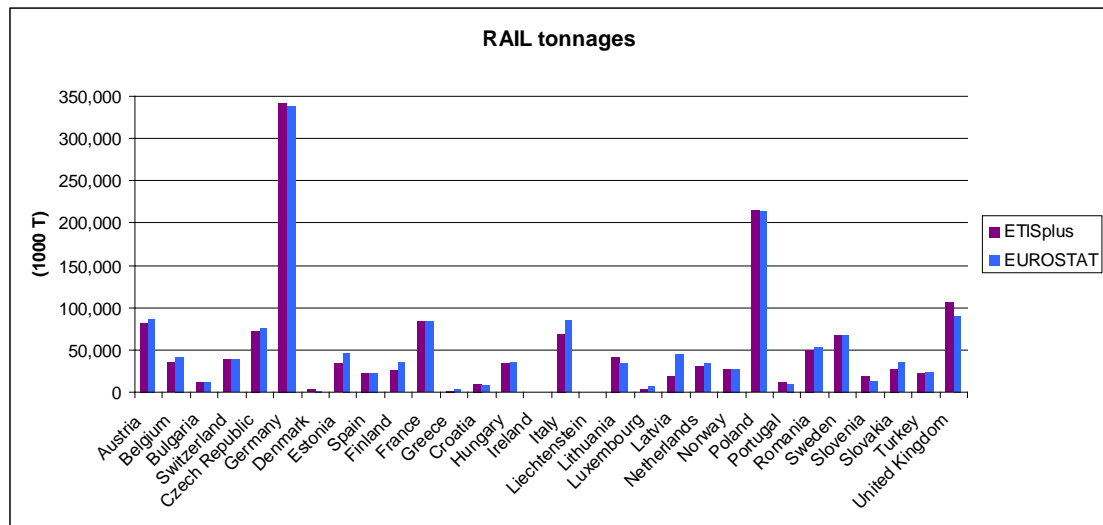
20.4 Results

Table 20-5: Rail Freight Matrix, Key results

Access via	Collection	Group	Description
ETIS View	Modelled Data	Freight	Rail Freight Tonnages by NUTS3 O/D and NST2 Commodity
2010	http://viewer.etisplus.net/ select collection: ETISplus-2010-Modelled highlight: Freight open table: Disaggregated rail freight by OD		
2005	http://viewer.etisplus.net/ select collection: ETISplus-2005-Modelled highlight: Freight open table: Disaggregated rail freight by OD		

A comparison is shown between Eurostat country totals for rail freight and the aggregated figures in the 2010 Modelled ETISplus matrix. Both sets of figures use the territory principle, so they are comparable.

Figure 20-5: rail tonnages comparison Rail Freight EUROSTAT totals, 2010



21 Inland Waterway Freight Matrix

21.1 Scope of the Database

Within Eurostat there exists a variety of aggregated data concerning inland waterways freight transport. One of the goals in ETISplus, under this thematic area, was to take all of the data that is publicly available, and use it to generate a best possible estimation at the disaggregate level. The resulting output for harmonised inland waterways transport data is a NUTS2-NUTS2 OD matrix, further divided into commodities (NST1). This harmonised NUTS2 data has been further disaggregated to determine the split into NUTS3 regional level and NST2 commodities. The NUTS3, NST2 matrix is presented as modelled data.

Table 21-1: Overview of main characteristics of the data set

Inland waterways freight O/D																														
Data feature	Data specification					Remarks																								
Base year	2005 and 2010					2010 data is an upgrade from 2009 statistics																								
Scope of data	Link	Terminal	O/D relation	Region	Other																									
	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>																									
GIS data	Yes	No																												
	<input type="checkbox"/>	<input checked="" type="checkbox"/>																												
Country coverage	<table><thead><tr><th></th><th>Com-pletely</th><th>Par-tially</th></tr></thead><tbody><tr><td>EU 27</td><td><input checked="" type="checkbox"/></td><td><input type="checkbox"/></td></tr><tr><td>Candidate countries & EFTA</td><td><input type="checkbox"/></td><td><input checked="" type="checkbox"/></td></tr><tr><td>Neighbouring countries</td><td><input type="checkbox"/></td><td><input checked="" type="checkbox"/></td></tr><tr><td>TRACECA</td><td><input type="checkbox"/></td><td><input checked="" type="checkbox"/></td></tr><tr><td>MEDA</td><td><input checked="" type="checkbox"/></td><td><input type="checkbox"/></td></tr><tr><td>Other countries</td><td><input type="checkbox"/></td><td><input type="checkbox"/></td></tr><tr><td>Total number of countries covered:</td><td colspan="2">22</td></tr></tbody></table>						Com-pletely	Par-tially	EU 27	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Candidate countries & EFTA	<input type="checkbox"/>	<input checked="" type="checkbox"/>	Neighbouring countries	<input type="checkbox"/>	<input checked="" type="checkbox"/>	TRACECA	<input type="checkbox"/>	<input checked="" type="checkbox"/>	MEDA	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Other countries	<input type="checkbox"/>	<input type="checkbox"/>	Total number of countries covered:	22		16 EU27 countries, 3 candidate & EFTA, 3 Neighbouring / Traceca
	Com-pletely	Par-tially																												
EU 27	<input checked="" type="checkbox"/>	<input type="checkbox"/>																												
Candidate countries & EFTA	<input type="checkbox"/>	<input checked="" type="checkbox"/>																												
Neighbouring countries	<input type="checkbox"/>	<input checked="" type="checkbox"/>																												
TRACECA	<input type="checkbox"/>	<input checked="" type="checkbox"/>																												
MEDA	<input checked="" type="checkbox"/>	<input type="checkbox"/>																												
Other countries	<input type="checkbox"/>	<input type="checkbox"/>																												
Total number of countries covered:	22																													
Main data sources	EUROSTAT, DESTATIS (DE), VNF (FR),CBS (NL)																													
Main type of data generation	Observed	<input type="checkbox"/>																												
	Harmonised	<input checked="" type="checkbox"/>																												
	Modelled	<input checked="" type="checkbox"/>																												

Table 21-2: Data structure of the harmonised inland waterways freight OD

Indicator	Description of indicator	Unit 2005	Unit 2010
ORIGINZONE_2_ID	Region of origin, ETISZone2_ID (NUTS2)	EZ2003	EZ2006
DEST_ZONE_2_ID	Region of destination, ETISZone2_ID (NUTS2)	EZ2003	EZ2006
NST1_ID	Commodity group, NST 1 digit	NST 1 digit	NST 1 digit
f_transport_iww	Tonnes	Tonnes	Tonnes

Table 21-3: Data structure of the modelled inland waterways freight OD

Indicator	Description of indicator	Unit 2005	Unit 2010
ORIGINZONE_3_ID	Region of origin, ETISZone3_ID (NUTS3)	EZ2003	EZ2006
DEST_ZONE_3_ID	Region of destination, ETISZone3_ID (NUTS3)	EZ2003	EZ2006
NST2_ID	Commodity group, NST 2 digit	NST 2 digit	NST 2 digit
f_transport_iww	Tonnes	Tonnes	Tonnes

21.2 Data Sources

Inland waterways data published by Eurostat is limited. For example, regional data for 2005 for the Netherlands is released at NUTS1 level, while the national data source (CBS) contains more regional detail. Moreover the Dutch national statistics is the only data source with the required detail for the final ETISplus database.

In this data theme, the fact that relatively few countries account for the majority of flows, and the fact that national statistics offer greater regional detail than Eurostat are the main reasons that the national statistics are used as main sources.

The following Eurostat data is used:

Table 21-4: Eurostat Sources Used

Eurostat table	ETISplus parameter	Description	Scope
iww_go_atygo07	F_estat_eu27_iww_total	country totals until 2007	EU27+HR [1]
iww_go_atygof07		regional flow data until 2007	[2]
iww_go_atygo		country totals from 2008 to 2010	
iww_go_anavefl		regional flow data from 2008 to 2010	

Several non-Eurostat inland waterways freight data were collected by WP3 for new Member States and Accession countries.

The WP3 datasets used to create the OD matrix are:

Table 21-5: ETISplus WP3 Data Sources

Country ISO	File name
BG	WP8_data_BG.xls (Bulgaria)
RS	WP8_data_RS.xls (Serbia)

Main national statistical sources are shown below. One of the objectives is to match flows between countries by comparing statistics from different countries e.g. Netherlands and Germany. However in 2010, no Dutch (CBS) inland waterway statistics were published, so we have chosen to use 2009 data for all countries in order to allow results to be combined.

Table 21-6: National Sources

Country ISO	Statistical office	Data 2005
DE	DESTATIS	Güterverkehrsstatistik der Binnenschifffahrt 2005
FR	VNF	Statistiques de la Navigation Intérieure 2005 [CDrom]
NL	CBS	Publicatiebestand Binnenvaart 2005

Country ISO	Statistical office	Data 2009
DE	DESTATIS	Güterverkehrsstatistik der Binnenschifffahrt 2009
FR	VNF	Statistiques de la Navigation Intérieure 2009 [web download]
NL	CBS	Publicatiebestand Binnenvaart 2009

21.3 Methodology

To create the OD matrix, the Eurostat data *iww_go_atygo* [1] is used as checklist. This table gives per flow (domestic/import/export) and per country the totals per commodity (NSTR24). First the domestic OD matrix is calculated for each country, followed by the international OD matrix for all country pairs.

21.3.1 Domestic Flows

For the domestic OD matrices, the OD from national statistics are used and complemented by the Eurostat tables *iww_go_atygo* [1] which provides the country totals per commodity and direction of flow and *iww_go_atygo07* [2] which contains regional data for a selection of countries. One of the missing countries in the 2005 Eurostat regional data [2] is the Netherlands.

The following input data is used for the 2005 domestic matrices:

- Domestic transport per country and commodity [1]
- Regional domestic transport per commodity from Eurostat table (incomplete) [2]

- Regional domestic transport per commodity from national sources [3]

Regional domestic transport data was used as distribution key such that the sum per country and commodity agrees with the totals given in table [1]. The German and French national statistics are used as distribution keys for these two countries. The regional information in table [2] for Germany and France are not used.

21.3.2 International Flows

The following input data is used for the international matrix:

- International transport loaded /unloaded per country and commodity [1]
- International transport per region from Eurostat table [2]
- International transport per region from national sources [3]

International flows reported in National statistics

Regarding the international flows, the national statistics give only regional detail for its own country. For example, CBS reports regional detail for the Netherlands but only partly regional detail for Germany and France. Belgium is not regionalised in CBS data.

In order to get the regional detail on both the origin and destination sides, the different data sources are combined:

- 1) CBS and DESTATIS (NL, DE)
- 2) CBS and VNF (NL, FR)
- 3) DESTATIS and VNF (DE, FR)
- 4) combined result from 1) to 3) and EUROSTAT data

The level of detail is different per data source. See below. This requires extra assumptions to harmonise the international flows 1) to 3).

For Belgian domestic flow, the only regional OD information was given in EUROSTAT table, in which all Belgian traffic is assigned to BE21 – Antwerp.

Table 21-7: Levels of Detail for Different Data Sources

Source	Level of detail	Remarks
DESTATIS	NUTS2 – NUTS2 – NST2	NUTS2 in DE; NUTS0 for other countries
VNF	NUTS2 – NUTS2 – NST1	NUTS2 in FR; NUTS0 for other countries
CBS	NUTS3 – NUTS3 – NST2	NUTS3 in NL; NUTS2 partially in DE/BE; NUTS0 for other countries
EUROSTAT		
2005		(ISO country codes, alphabetical order):

Source	Level of detail	Remarks
atygof07	NUTS2 – NUTS2 – NST\R24	AT, BE, BG, CZ, FR, HU, PL and RO
atygo07	NUTS0 – Transport direction (domestic/import/export/transit)	AT, BE, BG, CZ, DE, FR, HR, HU, LU, NL, PL, RO and SK
2010		
anavefl	NUTS2 – NUTS2 – NST2007	AT, BE, BG, CZ, DE, FR, HR, HU, LU, PL, RO and SK
atygo	NUTS0 – Transport direction (domestic/import/export/transit)	AT, BE, BG, CZ, DE, FI, FR, HR, HU, LT, LU, NL, PL, RO and SK

The relationships between data inputs and outputs for the two data years are illustrated below.

Figure 21-1: Compilation of 2005 Inland Waterway O/D Matrix

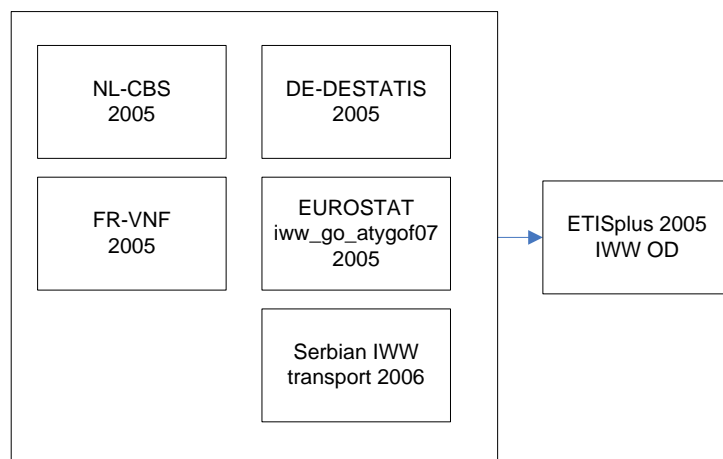
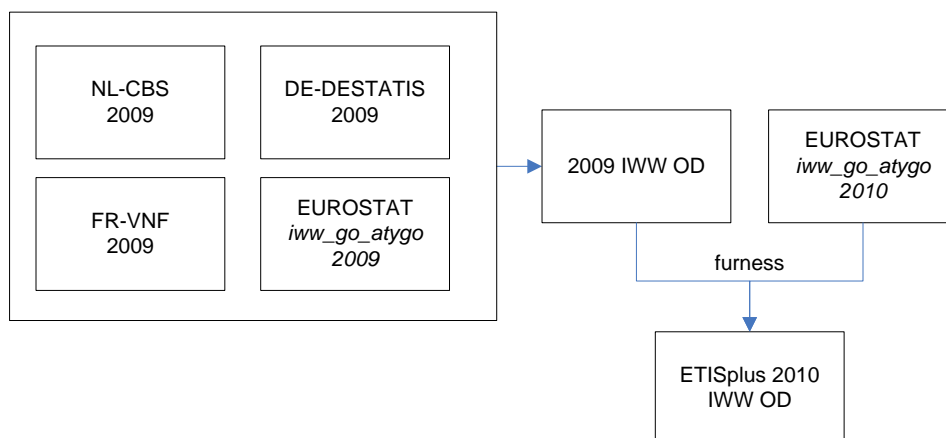


Figure 21-2: Compilation of 2010 Inland Waterway O/D Matrix



Pre-processing steps

Several stages of data manipulation are needed in order to harmonise regional and commodity classification.

Dutch CBS Data:

Conversion has been done for the variable "verkeersgebieden (54 regions)" into ETIS zoning level 3 (NUTS3, 40 regions).

German DESTATIS Data:

Conversion has been done for the commodity code: nst2 = 98 into 99. 98 (= not else specified) a non-official NST2 code.

EUROSTAT Data:

In Eurostat, NSTR24 is used for commodity classification in 2005. These commodities are converted to the NST1 commodity. This conversion is n to 1 translation:

Table 21-8: Conversion from NST24 into NST1

NST24	description NST24	NST1	description NST1
1	Cereals	0	Agricultural products and live animals
2	Potatoes, other fresh or frozen fruits and vegetables		
3	Live animals, sugar beet		
4	Wood and cork		
5	Textiles, textile articles and man-made fibres, other raw animal and vegetable materials		
6	Foodstuff and animal fodder	1	Foodstuffs and animal fodder
7	Oil seeds and oleaginous fruits and fats	2	Solid mineral fuels
8	Solid minerals fuels		
9	Crude petroleum		
10	Petroleum products	3	Petroleum products
11	Iron ore, iron and steel waste and blast furnace dust	4	Ores and metal waste
12	Non-ferrous ores and waste		
13	Metal products	5	Metal products
14	Cement, lime, manufactured building materials	6	Crude and manufactured minerals, building materials
15	Crude and manufactured minerals		
16	Natural and chemical fertilizers	7	Fertilizers
17	Coal chemicals, tar	8	Chemicals
18	Chemicals other than coal chemicals and tar		
19	Paper pulp and waste paper		
20	Transport equipment, machinery, apparatus, engines, whether or not assembled, and parts thereof	9	Machinery, transport equipment, manufactured articles and miscellaneous articles
21	Manufactures of metal		
22	Glass, glassware, ceramic products		
23	Leather, textile, clothing, other manufactured articles		
24	Miscellaneous articles		

If regional details are unknown, Eurostat uses special codes within the region dimensions. Unknown regions are coded 'XX'.

The tonnages with unknown regional code (e.g. CHxx = Switzerland, unknown) were assigned one selected region code. No further disaggregation into different possible regions is considered. The choice has been made based on the total unloaded volume.

Table 21-9: Treatment of unknown regions

EUROSTAT region code	NUTS (2003/2006)	Region name
CHXX	CH03	Nordwestschweiz
CZXX	CZ04	Severozápad
DKXX	DK00 / DK03	Danmark / Syddanmark
HRXX	HR02	Sredisnja i Istocna (Panonska) Hrvatska
IEXX	IE02	Southern and Eastern
NOXX	NO04	Agder og Rogaland
SKXX	SK01	Bratislavský kraj

Combining NL-CBS and DE-DESTATIS data

CBS data is closest in terms of detail to the structure required by ETISplus and therefore this dataset has been taken as the main foundation. Germany related flows are selected from the CBS data and using DESTATIS data as a key, the flow has been sub-divided into German regions.

The matching and combination procedures are shown in the following table:

Table 21-10: Matching flows between Germany and Netherlands

	Origin DE	Destination NL	Commodity
DESTATIS	NUTS2	Country level	NST2
CBS	NUTS1	NUTS3	NST2
Result of combining	NUTS2	NUTS3	NST2

Table 21-11: Matching flows between the Netherlands and Germany

	Origin NL	Destination DE	Commodity
DESTATIS	Country level	NUTS2	NST2
CBS	NUTS3	NUTS1	NST2
Result of combining	NUTS3	NUTS2	NST2

Combining CBS and VNF data

Comparable to the method for combining CBS and DESTATIS data, French VNF data is used as a key to sub-divide the France related flows from CBS.

Table 21-12: Matching flows between France and the Netherlands

	Origin FR	Destination NL	Commodity
VNF	NUTS2	Country level	NST1
CBS	Country level	NUTS3	NST2
Result of combining	NUTS2	NUTS3	NST2

Table 21-13: Matching flows between the Netherlands and France

	Origin NL	Destination FR	Commodity
VNF	Country level	NUTS2	NST1
CBS	NUTS3	Country level	NST2
Result of combining	NUTS3	NUTS2	NST2

Combining DESTATIS and VNF data

DESTATIS data has more detail on commodity compare to VNF data and therefore taken as the 'leading' database. VNF data is used as a key to divide the France related flows from DESTATIS.

Table 21-14: Matching flows between Germany and France

	Origin DE	Destination FR	Commodity
DESTATIS	NUTS2	Country level	NST2
VNF	Country level	NUTS2	NST1
Result of combining	NUTS2	NUTS2	NST2

Table 21-15: Matching flows between France and Germany

	Origin FR	Destination DE	Commodity
DESTATIS	Country level	NUTS2	NST2
VNF	NUTS2	Country level	NST1
Result of combining	NUTS2	NUTS2	NST2

Processing Bulgarian and Serbian data

In the Danube corridor, there are important freight flows on the lower stretched between Serbia and Bulgaria. Bulgarian data has more regional detail compared to Serbian data and therefore taken as the 'leading' database. Serbian data is used as a key to divide the Bulgaria related flows.

Table 21-16: Matching flows between Bulgaria and Serbia

	Origin BG	Destination RS	Commodity
BG data	NUTS3	Country level	NST1
RS data	Country level	NUTS1	NST1
Result of combining	NUTS3	NUTS1	NST1

Table 21-17: Matching flows between Serbia and Bulgaria

	Origin RS	Destination BG	Commodity
BG data	Country level	NUTS3	NST1
RS data	NUTS2	Country level	NST1
Result of combining	NUTS1	NUTS3	NST2

Furthermore, DESTATIS data contains two German NUTS2 regions with flows to Bulgaria (1070202 – Niederbayern and 1070203 - Oberpfalz). In this case the Germany related flows are divided into these two regions using DESTATIS data as key.

Imbalance of different data sources

It is evident that even at aggregate level, differences exist between the various sources. In the following table a comparison is made between two different Eurostat indicators and the equivalent national sources for Germany, France and the Netherlands.

Table 21-18: Imbalance between sources (2005 comparison)

(1000T)	DE			FR			NL		
	<i>E/S Reg</i>	<i>E/S Nat</i>	<i>DE-STATIS</i>	<i>E/S Reg</i>	<i>E/S Nat</i>	<i>VNF</i>	<i>E/S Reg</i>	<i>E/S Nat</i>	<i>CBS</i>
<i>Domestic</i>	54,505	56,663	56,666	14,482	28,938	28,936	<i>missing</i>	92,006	95,003
<i>Export</i>	56,275	53,361	53,343	9,588	16,258	16,257	95,433	123,21	123,408
<i>Import</i>		103,18	103,16					2	
	106,579	1	9	8,509	14,311	14,307	41,870	60,757	60,779

Source: EUROSTAT and National statistics

E/S Reg: (atygo07) regional data from Eurostat; reported in NUTS2 level

E/S Nat: (atygo) national level data from Eurostat

This shows that combining two different sources can cause a contradiction in international flow volumes. For example, comparing international flows between the Netherlands and Germany:

reported by DESTATIS : 60mln

reported by CBS : 40mln

In ETISplus the approach taken to resolve this inconsistency is:

- If two values are given for one flow: take average of the two values.
- If only one value is given: keep this one value.
- If only one value is given for a certain international flow, the reason could be that the flow is zero according to a reporting country, or that there is no reported value from the partner country.
- In such cases, the given value is treated as the real volume, since there is no information to distinguish the different situations.

Regional flow data from EUROSTAT has been combined with the combined data national sources. The flows regarding France, Germany and The Netherlands on both sides of the flow are left out of consideration.

Filling the gaps

After combining the regional statistics to construct the harmonised matrix, further modelling steps were developed in order to estimate the disaggregation to the required level.

- Regions for the Harmonised data: NUTS0/NUTS1 to NUTS2
- Regions for the Modelled data: NUTS2 to NUTS3
- Products for the Modelled data: Commodity split NST1 to NST2

The full O/D data needed to be regionalised to NUTS2 for Harmonised and NUTS3 for Modelled data. The inland waterway transport matrix from the Ten-Connect-II study (Tetraplan et al, 2011) has been used to fill these gaps. This matrix contains origin and destination regions by NUTS3 and commodity in NST1.

First, the shares from NUTS2 regions to NUTS3 regions were calculated using the sum of incoming and outgoing volume per region per commodity. Not all region-commodity pair in the 2005 statistics can be found in the TCII matrix and those cases are disaggregated using the shares based on the region only.

Regarding the Modelled data, the second disaggregation has been applied: commodity group division from NST1 to NST2. This translation was based on shares calculated from the trade data 2005.

Update for 2010

For 2010, one main data source from the 2005 data collection was missing: the Dutch national data from the CBS. The latest available CBS data is from year 2009 and therefore the detailed harmonisation between the three national statistics is done for the year 2009. Then, the Eurostat table `iww_go_atygo`, is used to convert the 2009 estimates to 2010 equivalents.

Product classification is also more complex in 2010 than in previous years. National statistics still report the commodity information with the conventional¹ NST codes, while Eurostat is using NST2007 for its statistics since 2008. In order to use the Eurostat statistics in the ETISplus freight matrices, the translation from NSTR 2007 to NST1 was necessary. This step cannot be made using pre-defined conversion tables.

DESTATIS has published a paper on commodity split NSTR 2007 compared to NST 3 digits 'Verkehr, NST-2007, Einheitliches Güterverzeichnis für die Verkehrsstatistik - 2007'.

<https://www.destatis.de/DE/ZahlenFakten/Wirtschaftsbereiche/TransportVerkehr/Gueterverkehr/Verzeichnisse.html>

¹ NST/R Standard Goods Classification for Transport Statistics/Revised (1967)

The conversion table from NST2007 to NST1 has been calculated combining the shares defined in the DESTATIS paper and the CBS Publicatiebestand Binnenvaart 2009, which contains commodity on NST3 digit level. This conversion has been applied to the EUROSTAT table (iww_go_anavefl).

The final step to construct the 2010 data is a Furness¹ matrix manipulation method to upgrade international flows from 2009 to 2010 volumes. Country totals for 2010 are used, reported in EUROSTAT table (iww_go_atygo). For the domestic flows, one growth rate is calculated per country. This means that the observed flow distribution of 2009 is kept for all countries.

21.4 Results

The final outcome of this task has been the construction of the NUTS3 (EZ-level3) matrix. This can be obtained from the ETIS-View area of the ETIS SITE.

Table 21-19: Inland Waterway O/D, Key results

Access via	Collection	Group	Description
ETIS View	Modelled Data	Freight	Inland Waterway Freight Tonnages by NUTS3 O/D and NST2 Commodity
2010	http://viewer.etisplus.net/ select collection: ETISplus-2010-Modelled highlight: Freight open table: Disaggregated IWW Freight by OD		
2005	http://viewer.etisplus.net/ select collection: ETISplus-2005-Modelled highlight: Freight open table: Disaggregated IWW Freight by OD		

In following figures, a comparison is shown at high level between the original Eurostat volumes, and the re-estimated figures from the study. Finally, a map is shown of assigned 2005 waterway freight flows onto the 2010 waterway network.

¹ Furness K.P., "Time Function Interaction. Traffic Engineering and Control Vol 7", No 7, pp19-36, 1970.

Figure 21-3: ETISplus Inland Waterway Tonnages versus Eurostat Totals, 2005

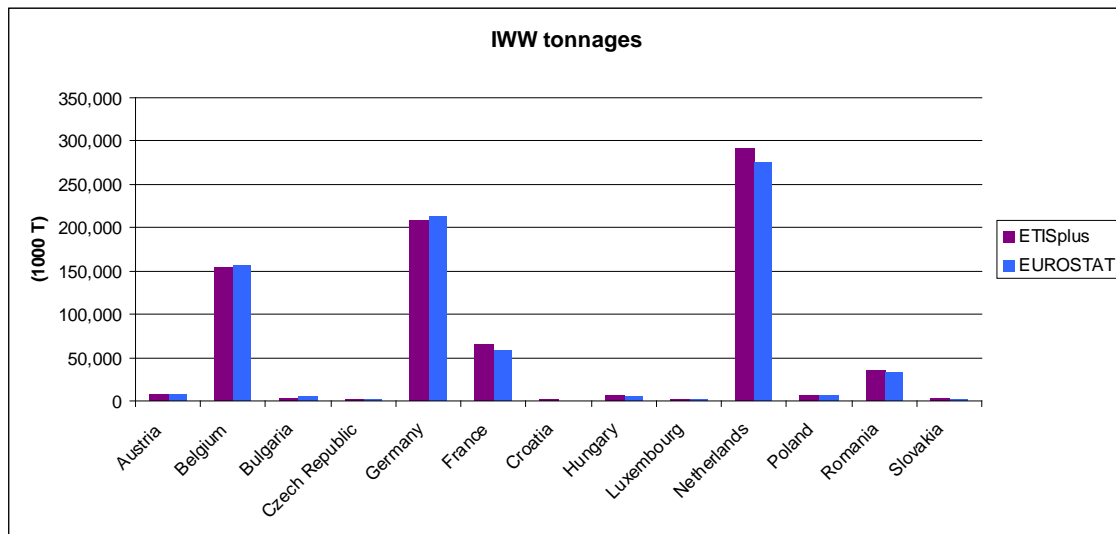


Figure 21-4: ETISplus Inland Waterway Tonnages versus Eurostat Totals, 2010

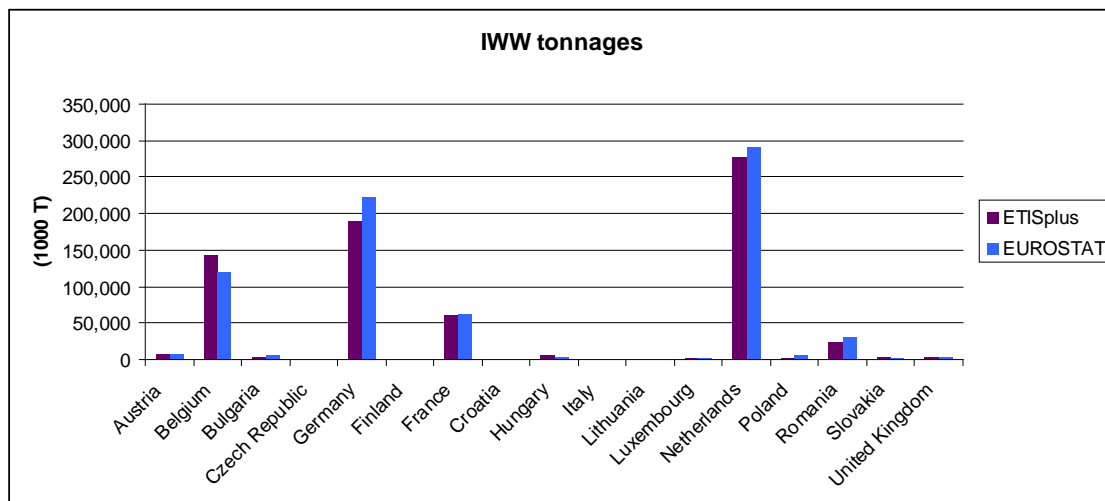
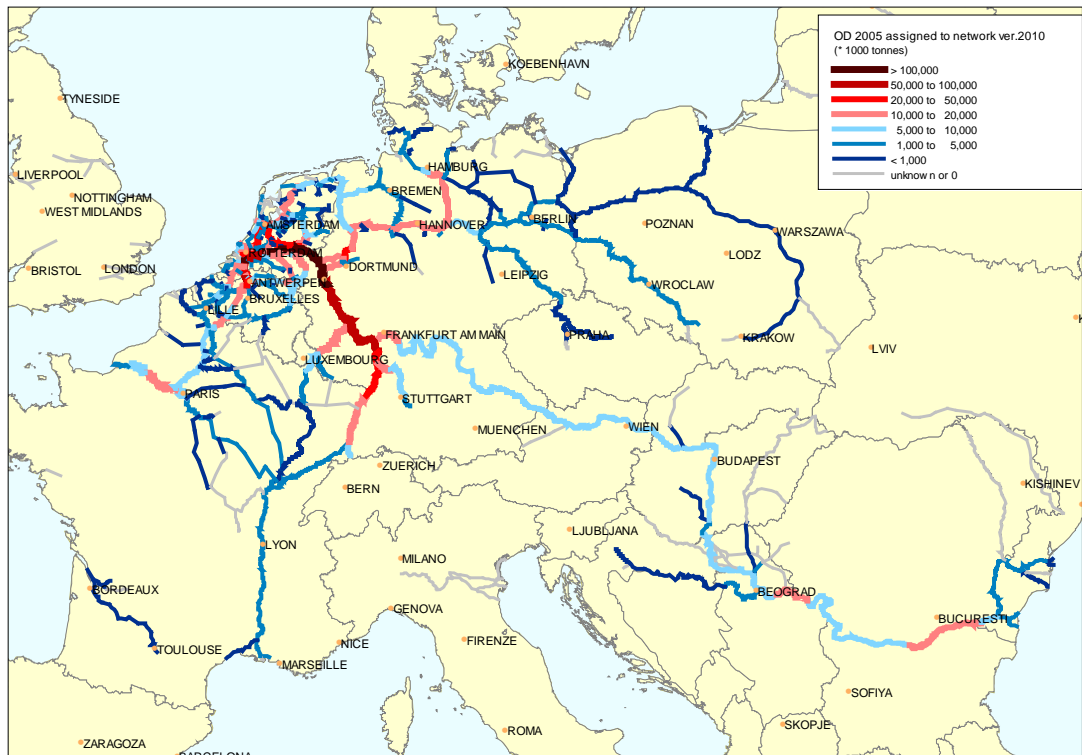


Figure 21-5: Assigned Waterway matrix



21.5 References – Inland Waterway Freight Matrix estimation

List of national data sources:

- NL, CBS: Publicatiebestanden Binnenvaart 2005
- DE, DESTATIS: K.178282-A.235916 - Verflechtung 2005-2010 NUTS-2.zip
- FR, VNF: data CD rom 2005
- ETISplus input from data collection (WP3), Source: ITC, Sofia.
- RS: WP8_data_RS.xls
- BG: WP8_data_BG.xls
- HR: WP8_data_HR.xls

Other national statistics (only country totals - for validation):

- AT, Statistik Austria:
gueterverkehr_auf_der_donau_brjahr_2005_zusammenfassung_014041.pdf
http://sdb.statistik.at/superwebguest/login.do?guest=guest&db=degvd_waren
- BE , Belgium
http://statbel.fgov.be/nl/binaries/p742y2006_nl%5B1%5D_tcm325-33390.pdf
- CH, Port of Switzerland (Basel)
<http://port-of-switzerland.ch/site/images/stories/2005%20Schiffsg%C3%BCterverkehr%20Ankunft.pdf>
<http://port-of-switzerland.ch/site/images/stories/2005%20Schiffsg%C3%BCterverkehr%20Abgang.pdf>

22 Air Freight Matrix

22.1 Scope of the Database

Air cargo, when measured in tonnes, only forms a very minor part of all freight traffic (a thousandth part in total and about 2% of the freight transported globally). Nevertheless it has increased by a third within the last ten years although domestic and intra-European was declining, so that the growth of this transport sector solely comes from intercontinental transport.

For air cargo such a model must cope with the mentioned dominance of intercontinental flow patterns – the underlying regionalisation of ETISplus, with more than 2300 traffic zones representing the world of which more than 1500 cover Europe (NUTS3-level) form the base for an adequate detailing for networks and impedances. Concerning the cargo flows these come aggregated to country level for regions outside Europe, and are assigned for each non-European country to one representative region, in line with the overall regionalisation defined by the project co-ordinator.

So the objective of this part of WP8 is to set up a flow matrix on the given regional level for the years 2005 and 2010 covering air cargo within Europe and as well between Europe and the world.

Table 22-1: Overview of main characteristics of the data set

Air freight flows (tonnage)						
Data feature	Data specification					Remarks
Base year	2010					
Scope of data	Link	Terminal	O/D relation	Region	Other	
	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
GIS data	Yes	No				
	<input type="checkbox"/>	<input checked="" type="checkbox"/>				
Country coverage				Com-pletely	Par-tially	
	EU 27			<input checked="" type="checkbox"/>	<input type="checkbox"/>	
	Candidate countries & EFTA			<input checked="" type="checkbox"/>	<input type="checkbox"/>	
	Neighbouring countries			<input checked="" type="checkbox"/>	<input type="checkbox"/>	
	TRACECA			<input type="checkbox"/>	<input checked="" type="checkbox"/>	
	MEDA			<input type="checkbox"/>	<input checked="" type="checkbox"/>	
	Other countries			<input type="checkbox"/>	<input checked="" type="checkbox"/>	
	Total number of countries covered:			54	155	
Main data sources	Eurostat					
Main type of data generation	Observed	<input type="checkbox"/>				
	Harmonised	<input checked="" type="checkbox"/>				
	Modelled	<input type="checkbox"/>				

22.2 Data Sources

The data sources and procedures used for the preparation of the air cargo matrix are:

- a start-up matrix of air cargo flows derived from the WORLDNET (2005 only) and trade statistics (2005 and 2010)
- an air cargo network (see WP7 report)
- intermodal impedances from region to region including information about the path (see WP7 report)
- air link and airport statistics
- socio-economic data for the underlying traffic zones (from WP7) where existing
- assignment procedures (in house development)
- calibration procedures (in house development)

Unless otherwise noted these sources are described in the following subsections.

22.2.1 Air link and airport statistics

Air link and airport specific information about cargo volumes were taken from EUROSTAT as the most important source. This source in principal should offer data about each air link to or from any airport in Europe, according to EU-regulations. As these regulations imply multiple time limits for compulsory reporting of data by the member states depending on the amount of cargo or passenger volumes for distinct airports, there were a lot of links for which no data has been available for 2005 and to a lesser extend also for 2010. In some cases where member states reported information, it was not published by EUROSTAT, as the volumes were below the limit for compulsory reporting.

We compared the data availability for 2005 with 2006 data and found that the number of routes for which data were available significantly rose within this period of just one year. For this reason we decided to use 2006 data for routes already existing in 2005 but where no data have been reported for that year.

In some cases we had to modify the information from EUROSTAT. This applied for air links where one of the airports is part of a multi-airport-system under a common city code, like Paris Charles de Gaulle (airport code CDG) and Paris Orly airport (airport code ORY) which both belong to the airport system of Paris, France (city code PAR). For some airports there were cargo flows reported to a destination which actually had no flights from the reporting airport but to a destination which is within the same airport system of the outlined destination. This mismatch of airport designators probably already existed in the data reported from a member state to EUROSTAT, so in such cases we adjusted the information to an airport pair which actually has been connected with direct flights.

To fill at least partly the gaps in data available from EUROSTAT we enriched this information by data from several national statistics. Just to name to them: Germany and USA (for air links to/from Europe) statistics, which are available online at www.destatis.de and www.transtats.bts.gov. This helped not only for air links where no data were available from EUROSTAT in line with the regulations or reporting but also for some routes where data should have been available from EUROSTAT, e. g. like Frankfurt, Germany – Buenos Aires, Argentina. Furthermore we received some information for 2005 concerning air transport data of Balkan states from WP3: partly for air links or airport, while some information concerned flows to/from distinct regions.

Finally out of all statistics which could be acquired there remained 4.700 data sets for links of airport pairs actually connected with nonstop or direct flights and for 365 airports for the year 2005. As there are 6,900 links to or from airports situated within continental Europe, of which not all are situated in the European Union, this means a quite good coverage (>50%) of them by transport statistics for air cargo. For 2010 we could acquire more than 6.500 data sets concerning air links and for 427 airports. Although the number of the air links in total is higher for 2010, the degree of coverage is above those for 2005.

22.2.2 Socio-economic data

For the process of matrix calibration one needs to have a kind of “weight” for a traffic zone representing its relevance as an origin or destination for a cargo flow. Our experience in developing procedures for matrix generation in air passenger transport showed that without such a component, algorithms to adjust matrices to measured links loads tend to leave numerous gaps in a matrix, when just focusing on link loads and impedances (transport time etc.).

For this reason socio-economic data for all of the traffic zones of the underlying ETISplus regionalisation were needed.

Concerning the European Union and all other countries within Europe figures for population, gross domestic product (GDP), employment etc. were available from WP7 on the NUTS3-level for 2005. For 2010 we assume that these will be delivered within agreed project schedule.

For countries outside the EU these data were not available from the project in line with the defined regionalisation, so we had to use available data on national level, resulting in flow patterns to be delivered in the same detailing.

So for the countries outside Europe data for population and GDP were derived from the CIA World Fact book (www.cia.gov/library/publications/the-world-factbook). In cases where available data were not for the reference year of the matrix to build (2005 or 2010 respectively), data were taken for the closest available year and extrapolated to 2005 and 2010 by using the annual growth rates for population or GDP stated in this source. GDP values outlined in US\$ were transferred to Euro by exchange rate of June 2005 or June 2010 respectively.

First tests with the calibration algorithms used which were adapted from an existing in-house model for generating passenger flows showed that pure overall GDP values turned out to give best results – prior to any combination of GDP, segment specific GDP, population or employment figures when used as a region specific “weight”.

For this reason we opted for the use of GDP as the only region specific “weight” to be used in the calibration routine described in the following section.

22.3 Methodology

As air cargo is just a small part of all air cargo an approach for modelling the flow patterns just from trade statistics, focusing on distinct commodity groups which qualify due to their value or specific characteristics (e.g. perishables) to be transported by air which is about ten times as expensive as surface transport has been considered as inadequate.

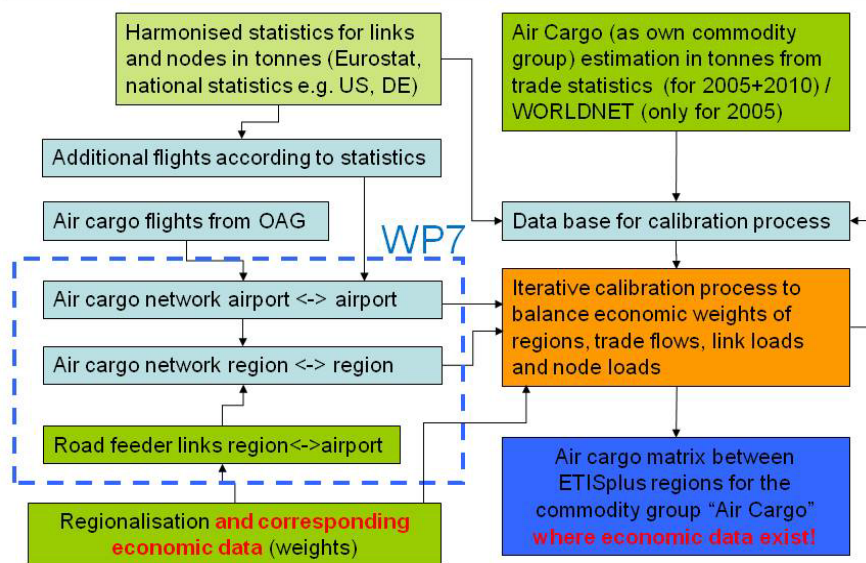
For this reason, actual transport statistics on the air cargo volume transported on specific airport pairs and additional similar information had to be included in the process of modelling air cargo flows on the given level of detailing, taking a

“raw” matrix of air cargo flows derived from the WORLDNET only as a starting point to produce a final matrix.

In brief modelling the air cargo flows was done with the following sequence:

- build up an air cargo network, combining air links between airports and feeder links between regions and airports (see WP7 report)
- enrich those air links and air nodes (airports) of the network with actually measured cargo volumes from statistics
- To build the matrix for the year 2005 we took the aggregated flows (country level) from the WORLDNET project to create a start-up freight matrix for air cargo, which is considered as an own commodity group of all freight
- To build the matrix for the year 2010 we took the matrix for 2005 developed within ETISplus and combine with a “raw” matrix of air cargo flows derived from the latest available trade statistics as input for the calibration process
- Run an iterative calibration process to minimise the total sum of deviations between assigned and measured link loads as well as between start-up cargo-flows and flows adjusted according to the link statistics on country-level.

Figure 22-1: Scheme of approach for constructing the air cargo matrix



External input is coloured in green, resp. in light green when adapted. Calculation procedures are coloured in orange.

Results are coloured in blue, resp. light blue when only intermediate results.

22.3.1 Assignment and calibration routines

First tests in assigning the flows of the start-up matrix to the network just using shortest path algorithms showed results which made obvious the necessity to be

improved. For this reason we implemented a route choice procedure, which splits up a cargo flow between a region of origin and a region of destination to in maximum 16 different routings. These routings may not differ only between different starting or ending airports of a routing, but also if and which intermediate airports may occur. The table below gives an example of 16 different routings between two traffic zones used within ETISplus. "Karlsruhe, Stadt, DE122" and "Japan". The routings differ not only by total traffic time, but also in feeder distance and flight distances, which may represent a kind of cost using a distinct routing and further more in the number of transshipments required, or the number of services offered per week to mention just a few of variables to be considered.

Table 22-2: Example for Route Choice in Air Cargo Karlsruhe – Japan (2005)

Starting Airport	Transfer Airport	Destination Airport	Total Time [minutes]	Connections / week	No. of airside Transshipments	Estimated probability
FRA	---	NRT	1379	22	0	72,4%
ZRH	---	NRT	1518	9	0	14,2%
CDG	---	NRT	1672	25	0	5,0%
MUC	---	NRT	1538	6	0	4,3%
AMS	---	NRT	1693	15	0	2,2%
FRA	PEK	NRT	1759	18	1	0,7%
FRA	PVG	NRT	1838	19	1	0,4%
FRA	LHR	NRT	1851	34	1	0,4%
MUC	PEK	NRT	1838	7	1	0,1%
MLH	ZRH	NRT	1926	7	1	0,1%
FRA	ICN	NRT	1890	24	1	0,1%
MLH	LHR	NRT	1901	7	1	0,1%
ZRH	ICN	NRT	1861	3	1	0,0%
MLH	MUC	NRT	1968	6	1	0,0%
MLH	ICN	NRT	1913	3	1	0,0%
FKB	MUC	NRT	1909	1	1	0,0%

Adapting an existing in-house model for route choice the probability function for air cargo showed reasonable results in assigning the start-up matrix to the network meeting the link loads available from air cargo statistics. In an iterative process the route choice model has been applied and the flows of the start-up matrix have been assigned to minimise the residuum of a linear system of equations.

This linear system of equations consists of one line per air link statistic (see section 'Air link and airport statistics') and one column per origin-destination pair, i. e. its size is about 6500 lines x 20.000.000 columns. The linkage between the lines consists of the up to 16 route alternatives, the flows of the start-up matrix and the 'weights' i. e. the GDP values for each pair of regions.

The iterative process terminated when the deviation between statistics and links loads as well as between start-up-matrix and adapted matrix have come to a minimum. The result, the air cargo matrix, is described in the next section.

22.3.2 Limitations / Lessons learned / possible steps in future

Due to the limited available information on the demand and supply side of air cargo and concerning socio-economy of non-European regions other than on country level, the available air cargo matrix is a result of a combined approach of using trade statistics with measured link loads gained from statistics for flow generation and distribution. In consequence the resulting flows have been checked and adjusted to represent the actual air cargo flows of 2005 much better than it would have been possible just using one of the two components trade statistics and link loads separately.

The quality of this approach improves, when the number of available link statistics will rise as it applies for 2010. Analysing EUROSTAT data shows, that the number of available statistics in 2006 is significantly higher than for 2005 and for 2010 there are even more numbers available. The more the member states of the EU meet the guidelines to report cargo statistics and the more EUROSTAT increases the number of published link loads, the better the data base becomes for the approach used in this project.

A further progress could be made in splitting up air cargo into different commodity groups. To achieve this, it would be necessary to survey air cargo statistics not only by tonnes, but also by the kind of goods carried. When the air cargo reporting within the EU will be well established for all membership countries concerning tonnes, this would be next logical step to improve the statistics.

A second type of intermodality has not been considered within this project now: the combination of the modes shipping and air for cargo. This kind of co-operation applies for some air links where the flow patterns of air cargo are very asymmetric, so that cargo aircrafts have to be flown (nearly) empty in one direction. The idea of this intermodality is to close the performance gap between sea and air (air five times faster, but ten times more expensive than sea), to fill unused air cargo capacities. E.g. for 2006 this kind of intermodal transport sums up to 400.000 tonnes worldwide, which is quite a small amount of all air cargo. Nevertheless it can play a significant role for specific air links (e. g. between airports in the Gulf Area and Europe) so it should be incorporated into the air cargo matrix, by its actual origins and destinations, if information about that form of intermodality is available. For the time being this kind of cargo flows are represented in the available matrix only for the air link and the final road based feeder. E. g. some cargo flows from Far East (China et al) going to ports in the United Arab Emirates and are transhipped there to the airports of Dubai, Abu Dhabi or Sharjah to be flown to their European destinations from there, have their origin in the matrix in the United Arab Emirates and not in China et al.

The last field where an improvement concerning the modelling of air cargo should be taken into account is the introduction of costs for air cargo. For the time being, air cargo is as about ten times as expensive as sea shipping, so that only very specific groups of goods qualify for air cargo due to their value. As the latest trend in worldwide transport is to split up the transportation of a specific good to both, sea transport and air cargo, to bring a (small) part of goods as

soon as possible to the markets for marketing purposes, the biggest part of a delivery will be done by sea transport. So introducing air cargo into a modal split model for distinct commodity groups is a future filed in modelling freight transport. The challenge one faces here is the huge price variation for air cargo transport depending on:

- the relation specific available cargo capacity and demand (e. g. Asia -> Europe vs. Europe – Asia), as carrying even empty aircraft is quite expensive.
- seasonal change of demand
- specific commodity groups of carried cargo (perishables different to spare parts), i.e. to consider air cargo as an own commodity group is not feasible any more when introducing prices in modelling air cargo
- different routings in intercontinental air cargo implies to implement a route choice model which includes prices.

Finally it has to be stated that not all air cargo flights are reported in the published commercial schedules, e.g. cargo charter, so that such supply information gaps are a significant burden for the modelling and validation process. To overcome this unpleasant situation one should quote upon the memorandum concerning cooperation between the European Commission and Eurocontrol to e.g. exchange technical information and data which can be used here for such purposes like the matrix generation. Due to air navigation purposes any flight is monitored at Eurocontrol and is already at hand so that the information (e.g. origin-destination airport, aircraft type, airline, departure time and day, type of flight) could be extracted easily without any major effort whereby the exact flight routings need not to be deployed.

22.4 Results

The air cargo matrix shows the cargo flows in tonnes for each pair of regions covered within ETISplus.

Table 22-3: Air Cargo O/D, key results

Access via	Collection	Group	Description
ETIS View	Harmonised Data	Freight	Air Freight Tonnages by NUTS3 O/D (No Commodity) Additional data is available in Airport database (terminal theme)
2010	http://viewer.etisplus.net/ select collection: ETISplus-2010-Harmonised highlight: Freight open table: Air Freight by OD		
2005	http://viewer.etisplus.net/ select collection: ETISplus-2005-Harmonised highlight: Freight		

open table: Air Freight by OD

In ETISplus datasets, at least one region per flow has to be situated in Europe; i.e. the matrix covers all cargo flows to, from or within Europe. Cargo flows between two regions outside Europe are not covered, irrespective of whether the routing of this cargo touches Europe or not. Furthermore cargo flows within the same NUTS2-region on intra-European relations were omitted, as air cargo on such short distances do not appear in reality.

The flows are shown in tonnes for the specific year. There is no further distinction of these flows in specific commodity groups, as air cargo is considered to be a commodity group of its own.

22.4.1 The matrix for the year 2005

The total flow of air cargo to /from and within Europe including also domestic flows sums up to 11.25 million tonnes for the year 2005. Three fourth of this volume has been carried on intercontinental relations, while 20% were international, intra-European transport and less than 5% were of domestic nature. Flows within or between countries situated in other continents than Europe are not part of the matrix delivered.

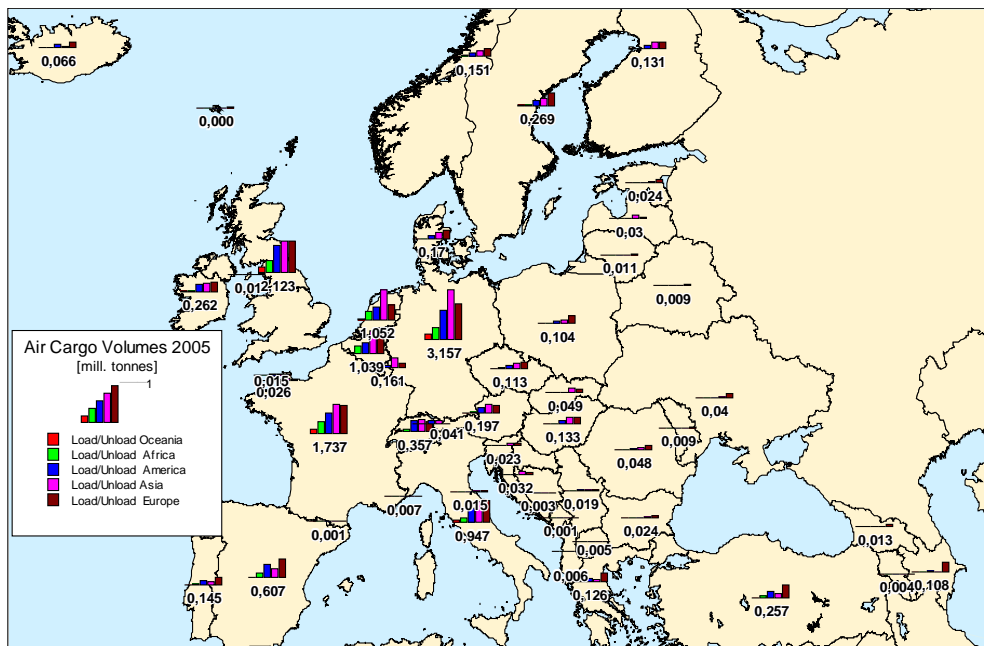
Air cargo to or from Asia forms about 40% of all freight flows of this mode, while cargo to or from America makes about 25% of the total amount. Cargo to from Africa brings another 7% of the cargo volume, while the flows concerning Australia/ Oceania are minor building a share of just 3% of all air cargo flows. The remaining quarter is the intra-European air cargo demand already mentioned. The following table summarises this overall cargo volumes.

Table 22-4: Air cargo volumes 2005 - Overview

ETISplus Air Cargo matrix Overview	Cargo volume [million tonnes]
Within Europe	2.75
Europe to / from Asia	5.0
Europe to / from America	2.6
Europe to / from Africa	0.7
Europe to / from Oceania	0.2
Total Cargo volume	11.25

An overview about the country specific air cargo volumes in Europe is shown on the following map. Please keep in mind that these volumes represent the sum of cargo volume of the region and therefore not necessarily match the cargo volumes loaded and unloaded at the airports of a country. E. g. for Luxembourg the total air cargo volume outlined is at 162,000 tonnes, while the air cargo at Luxembourg's airport Findel is about four times as high.

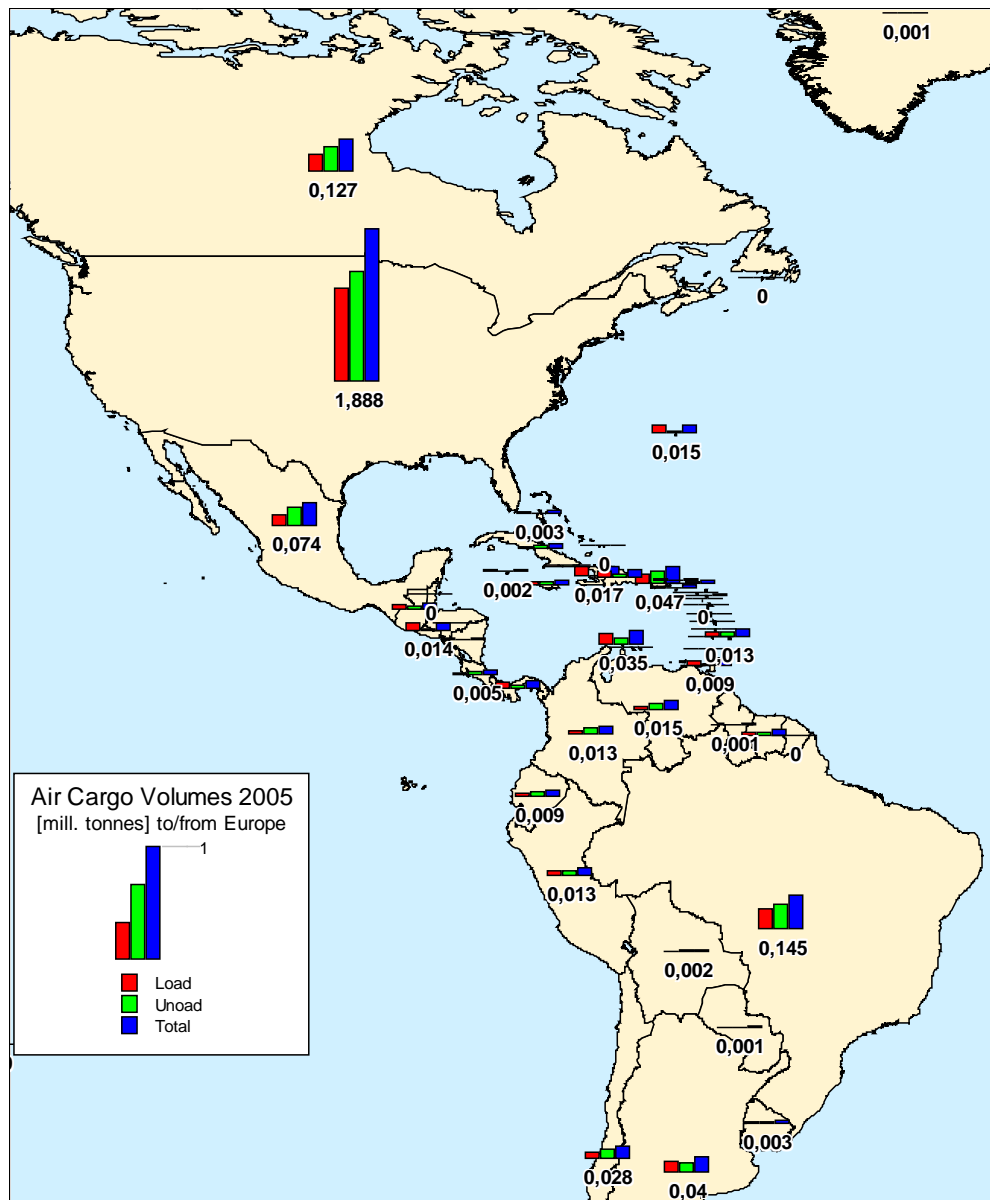
Figure 22-2: Cargo Volumes 2005 by European country



A lot of air cargo is carried from the distinct regions in Europe to the big cargo hubs by surface transport instead of using feeder flights. In many cases this trucking crosses national borders. Another reason for differences in the cargo numbers between a country and its airports lies in the transshipment of cargo between two aircrafts at an airport. Such cargo is counted twice at an airport, similar to passenger figures, where transfer passengers also are counted twice – a first time as an arriving passenger and a second time as a departing passenger.

Considering the country specific volumes, the top five countries in Europe are Germany (3.2 million tonnes), United Kingdom (2.1 million tonnes), France (1.7 million tonnes), The Netherlands (1.1 million tonnes) and Belgium (1.0 million tonnes), which makes about 80% of all air cargo carried to, from or within Europe. Other important countries for air cargo are Italy, and Spain.

Figure 22-3: Cargo Volumes 2005 America

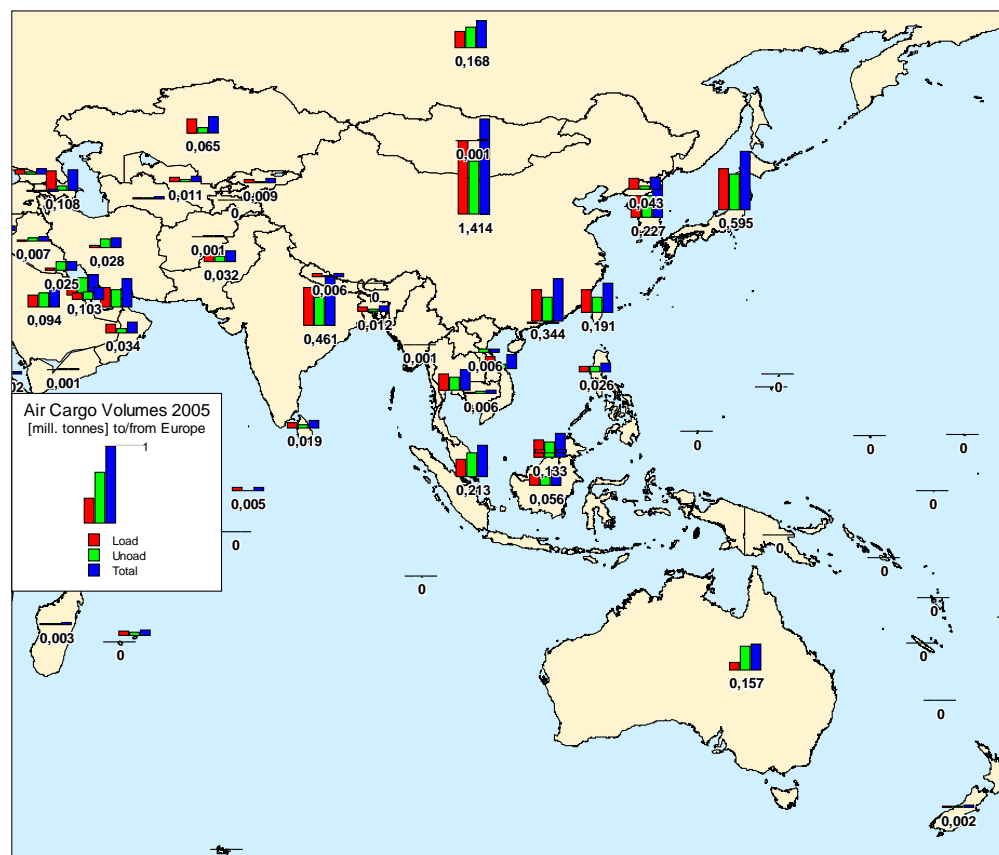


When looking to the American continent, it is obvious that this market is clearly dominated by the United States, which are the origin or destination of more than 70% (1.9 million tonnes) of all air cargo carried to or from Europe (total amount 2.6 million tonnes). The only two other countries with a noteworthy cargo volume with Europe are Brazil and Canada, each exceeding 0.1 million tonnes. Concerning the direction of carriage it has to be stated that air cargo from Europe to America is 0.3 million tonnes higher than in the opposite direction.

Different to America the air cargo relations with Asia (total amount 5.1 million tonnes) have a significant dominance of goods carried to Europe (+0.8 million tonnes) than to Asia. The most important countries in Asia for air cargo are P.R. of China (1.4 million tonnes), Japan (0.6 million tonnes), India (0.5 million

tonnes), Hong Kong (0.3 million tonnes), Korea, Singapore and Taiwan (0.2 million tonnes each). Other important countries for air cargo to or from Europe are United Arab Emirates, Israel, Jordan, Malaysia, Thailand, and Bahrain where more than 100,000 tonnes were carried to or from Europe per each of those countries in 2005. Similar as already stated for Luxembourg, for some countries, the cargo volume from air link statistics to Europe is significantly higher than the outbound or inbound cargo volume in the country. E.g. for the United Arab Emirates the cargo volume reported for air links is seven times higher than the cargo to or from this country, as most of the cargo carried on these flights is transhipped to corresponding flights at the airports of Dubai or Abu Dhabi to or from other airports in Asia. See also section 1.4 for these specific cargo flows.

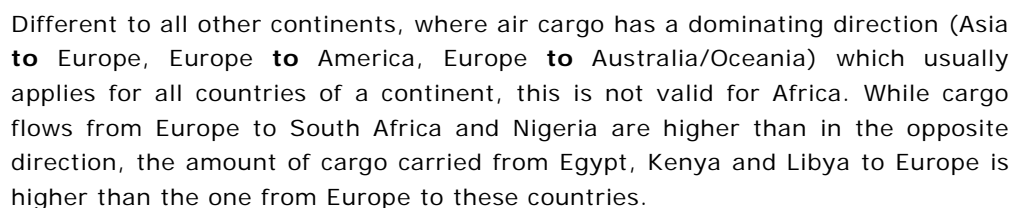
Figure 22-4: Cargo Volumes 2005 Asia and Australia/Oceania



The air cargo volume between Europe and Australia/Oceania is totally different to the one for Asia: First it is just a small amount (less than 0.2 mill tonnes) and as a second point much more cargo is carried from Europe to this continent (140,000 tonnes than the other way round 25,000 tonnes).

The cargo volume to and from Africa is at 0.7 mill tonnes, of which a majority is carried to Europe (0.4 million tonnes), while cargo to Africa has an amount of 0.3 million tonnes. The most important countries are South Africa and Egypt, where the air cargo volume exceeds 100,000 tonnes. Other important countries

Figure 22-5: Cargo Volumes 2005 Africa



22.4.2 The matrix for the year 2010

The total flow of air cargo to, from or within Europe including domestic flows totals 12.46 million tonnes for the year 2010. Some 83% of this volume has been carried on intercontinental relations, while 13.2% were international, intra-European transport and about 4.2% were of domestic nature. Flows within or between countries, situated outside Europe are not part of the matrix delivered.

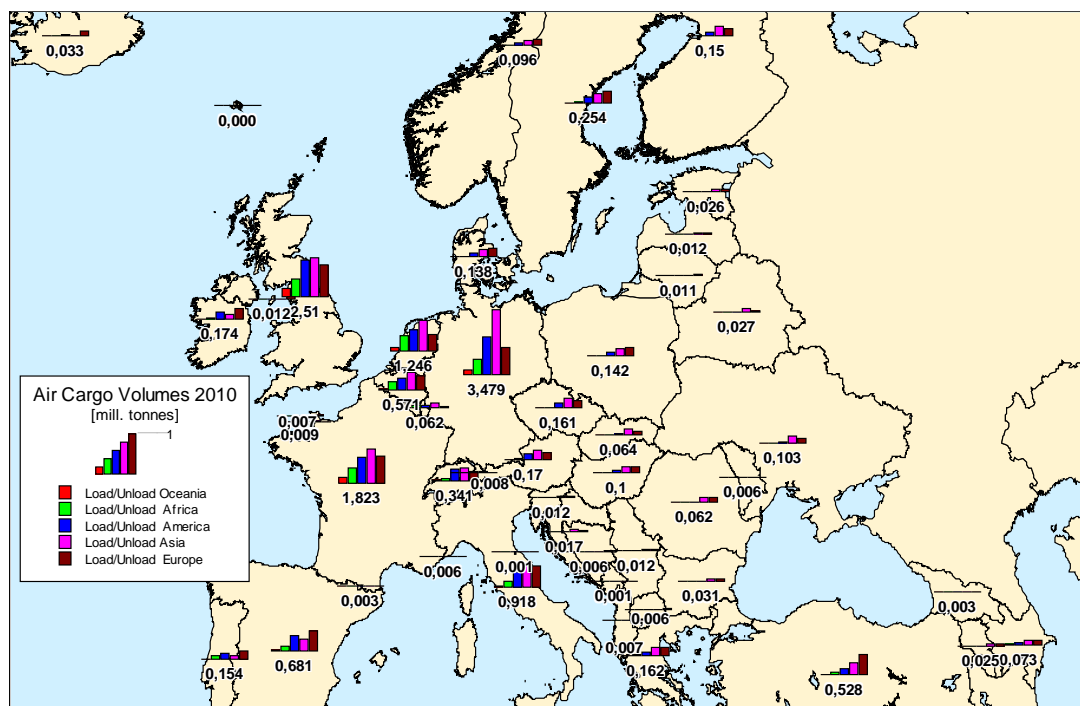
Air cargo to or from Asia forms about 47.3% of all freight flows of this mode, while cargo to or from America makes about 26% of the total amount. Cargo to or from Africa brings another 7.8% of the cargo volume, while the flows concerning Australia/ Oceania are minor building a share of just 1.5% of all air cargo flows. The remaining 17.4% is the intra-European air cargo demand already mentioned. The following table summarises this overall cargo volumes.

Table 22-5: Air cargo volumes 2010 - Overview

ETISplus Air Cargo matrix Overview	Cargo volume [million tonnes]
Within Europe (incl. domestic)	2.17
Europe to / from Asia	5.89
Europe to / from America	3.25
Europe to / from Africa	0.97
Europe to / from Oceania	0.19
Total Cargo volume	12.46

An overview about the country specific air cargo volumes in Europe is shown on the following map. Please keep in mind that these volumes represent the sum of cargo volume of the region and therefore not necessarily match the cargo volumes loaded and unloaded at the airports of a country.

Figure 22-6: Cargo Volumes 2010 by European country

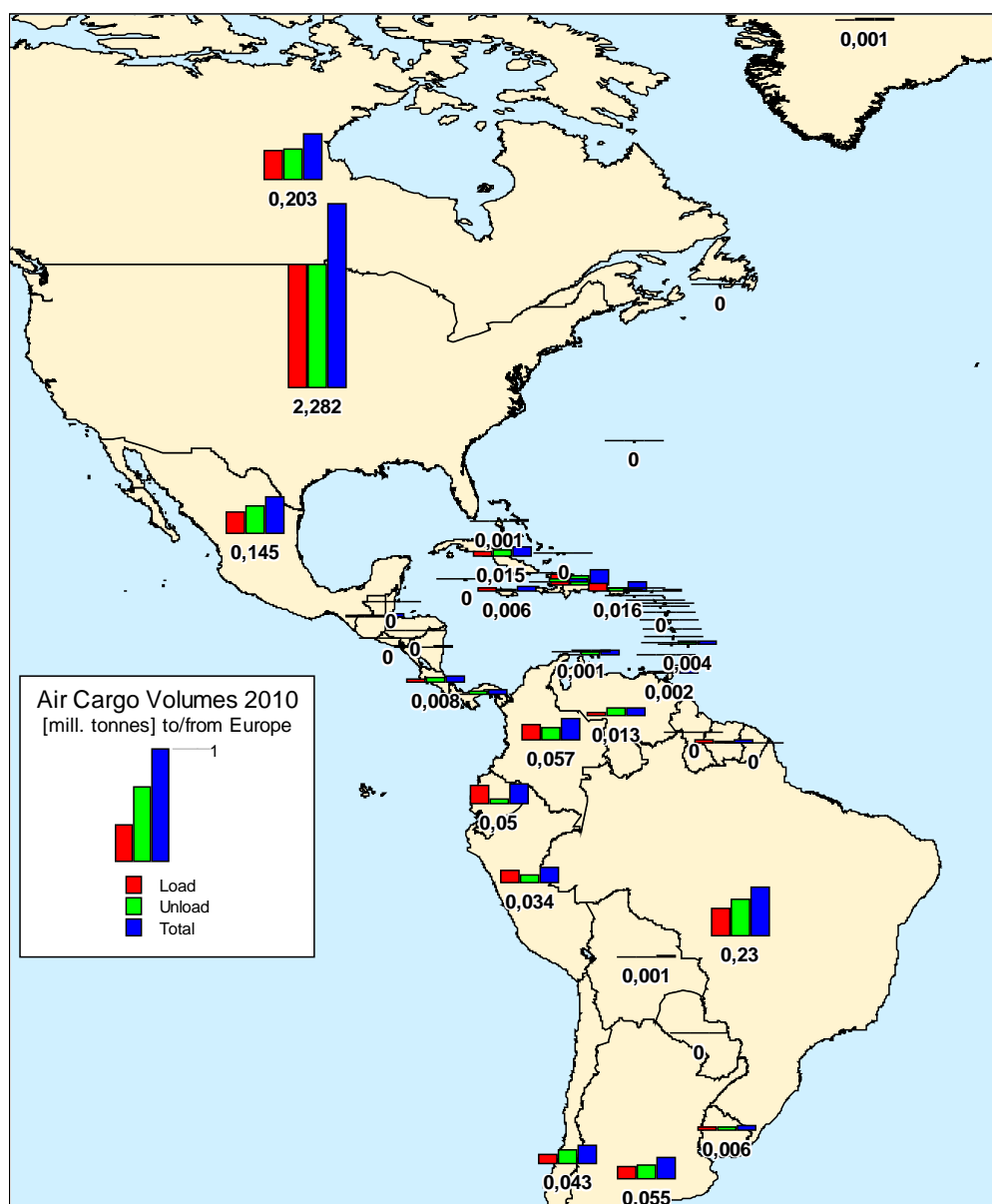


A lot of air cargo is carried from the distinct regions in Europe to the big cargo hubs by surface transport instead of using feeder flights. In many cases this trucking crosses national borders. Another reason for differences in the cargo numbers between a country and its airports lies in the transshipment of cargo

between two aircrafts at an airport. Such cargo is counted twice at an airport, similar to passenger figures, where transfer passengers also are counted twice – a first time as an arriving passenger and a second time as a departing passenger.

Considering the country specific volumes, in 2010 the top five countries in Europe are Germany (3.5 million tonnes), United Kingdom (2.5 million tonnes), France (1.8 million tonnes), The Netherlands (1.2 million tonnes) and Italy (0.92 million tonnes), which makes about 80% of all air cargo carried to, from or within Europe. Other important countries for air cargo in 2010 are Spain, Belgium and Turkey.

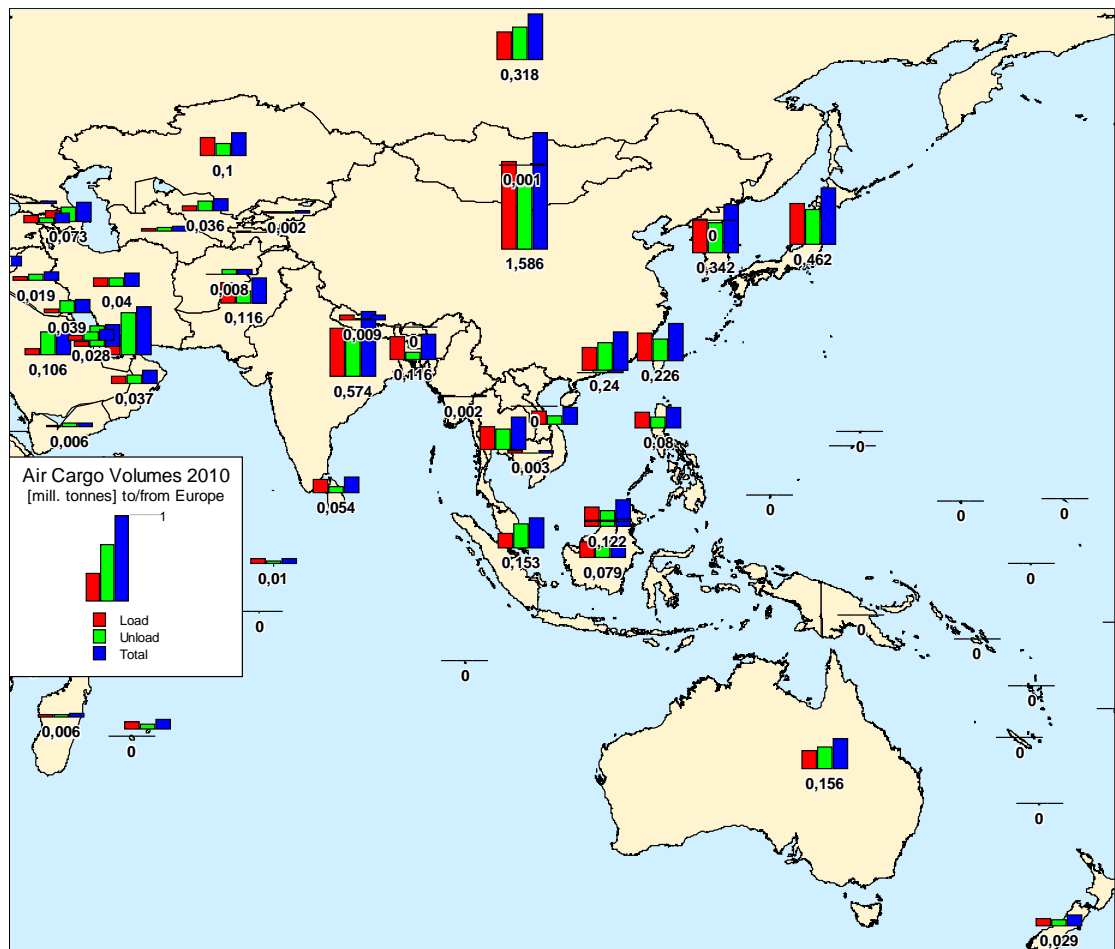
Figure 22-7: Cargo Volumes 2010 America



When looking to the American continent, it is obvious that this market is clearly dominated by the United States, which are the origin or destination of more than 70% (2.3 million tonnes) of all air cargo carried to or from Europe (total amount 3.2 million tonnes). The only two other countries with a noteworthy cargo volume with Europe are Brazil and Canada, each exceeding 0.2 million tonnes and Mexico with nearly 1.5 million tonnes. Concerning the direction of carriage it has to be stated that air cargo from Europe to America is just 0.1 million tonnes higher than in the opposite direction.

Unlike America, air cargo relations between Europe and Asia (total amount 5.9 million tonnes) have a significant dominance of goods carried to Europe (+0.3 million tonnes) than to Asia. The most important countries in Asia for air cargo are P.R. of China (1.6 million tonnes), India (0.6 million tonnes), Japan (0.5 million tonnes), Korea, The United Arab Emirates, Russia (including European part) with each exceeding 0.3 million tonnes), Hong Kong, Taiwan, Thailand and Singapore (0.2 million tonnes each). Similar as already stated for Luxembourg, for some countries, the cargo volume from air link statistics to Europe is significantly higher than the outbound or inbound cargo volume in the country. E.g. for the United Arab Emirates the cargo volume reported for air links is seven times higher than the cargo to or from this country, as most of the cargo carried on these flights is transhipped to corresponding flights at the airports of Dubai or Abu Dhabi to or from other airports in Asia.

Figure 22-8: Cargo Volumes 2010 Asia and Australia/Oceania



Air Cargo Volumes 2010
[mill. tonnes] to/from Europe

Legend:

- Load (Red bar)
- Unload (Green bar)
- Total (Blue bar)

The map shows the following air cargo volumes (in million tonnes) for each country in 2010:

Country	Load	Unload	Total
Algeria	0,042	0,013	0,055
Libya	0,018	0,013	0,031
Egypt	0,169	0,032	0,201
Sudan	0,039	0,028	0,067
Ethiopia	0,106	0,037	0,143
Somalia	0,037	0,006	0,043
Kenya	0,006	0,008	0,014
Tanzania	0,008	0,008	0,016
Uganda	0,008	0,008	0,016
Rwanda	0,008	0,008	0,016
Burundi	0,008	0,008	0,016
DRC	0,008	0,008	0,016
Congo	0,008	0,008	0,016
Angola	0,008	0,008	0,016
Nigeria	0,008	0,008	0,016
Ghana	0,008	0,008	0,016
Sierra Leone	0,008	0,008	0,016
Liberia	0,008	0,008	0,016
Ivory Coast	0,008	0,008	0,016
Senegal	0,008	0,008	0,016
Gambia	0,008	0,008	0,016
Guinea	0,008	0,008	0,016
Sierra Leone	0,008	0,008	0,016
Liberia	0,008	0,008	0,016
Ivory Coast	0,008	0,008	0,016
Senegal	0,008	0,008	0,016
Gambia	0,008	0,008	0,016
Guinea	0,008	0,008	0,016
Sierra Leone	0,008	0,008	0,016
Liberia	0,008	0,008	0,016
Ivory Coast	0,008	0,008	0,016
Senegal	0,008	0,008	0,016
Gambia	0,008	0,008	0,016
Guinea	0,008	0,008	0,016
Sierra Leone	0,008	0,008	0,016
Liberia	0,008	0,008	0,016
Ivory Coast	0,008	0,008	0,016
Senegal	0,008	0,008	0,016
Gambia	0,008	0,008	0,016
Guinea	0,008	0,008	0,016
Sierra Leone	0,008	0,008	0,016
Liberia	0,008	0,008	0,016
Ivory Coast	0,008	0,008	0,016
Senegal	0,008	0,008	0,016
Gambia	0,008	0,008	0,016
Guinea	0,008	0,008	0,016
Sierra Leone	0,008	0,008	0,016
Liberia	0,008	0,008	0,016
Ivory Coast	0,008	0,008	0,016
Senegal	0,008	0,008	0,016
Gambia	0,008	0,008	0,016
Guinea	0,008	0,008	0,016
Sierra Leone	0,008	0,008	0,016
Liberia	0,008	0,008	0,016
Ivory Coast	0,008	0,008	0,016
Senegal	0,008	0,008	0,016
Gambia	0,008	0,008	0,016
Guinea	0,008	0,008	0,016
Sierra Leone	0,008	0,008	0,016
Liberia	0,008	0,008	0,016
Ivory Coast	0,008	0,008	0,016
Senegal	0,008	0,008	0,016
Gambia	0,008	0,008	0,016
Guinea	0,008	0,008	0,016
Sierra Leone	0,008	0,008	0,016
Liberia	0,008	0,008	0,016
Ivory Coast	0,008	0,008	0,016
Senegal	0,008	0,008	0,016
Gambia	0,008	0,008	0,016
Guinea	0,008	0,008	0,016
Sierra Leone	0,008	0,008	0,016
Liberia	0,008	0,008	0,016
Ivory Coast	0,008	0,008	0,016
Senegal	0,008	0,008	0,016
Gambia	0,008	0,008	0,016
Guinea	0,008	0,008	0,016
Sierra Leone	0,008	0,008	0,016
Liberia	0,008	0,008	0,016
Ivory Coast	0,008	0,008	0,016
Senegal	0,008	0,008	0,016
Gambia	0,008	0,008	0,016
Guinea	0,008	0,008	0,016
Sierra Leone	0,008	0,008	0,016
Liberia	0,008	0,008	0,016
Ivory Coast	0,008	0,008	0,016
Senegal	0,008	0,008	0,016
Gambia	0,008	0,008	0,016
Guinea	0,008	0,008	0,016
Sierra Leone	0,008	0,008	0,016
Liberia	0,008	0,008	0,016
Ivory Coast	0,008	0,008	0,016
Senegal	0,008	0,008	0,

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23 Maritime Freight Matrix

23.1 Scope of the Database

Table 23-1: Main characteristics of the dataset, maritime freight O/D

Maritime Freight O/D Matrix						
Data feature	Data specification					Remarks
Base year	2010					
Scope of data	Link	Terminal	O/D relation	Region	Other	
	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
GIS data	Yes	No				
	<input type="checkbox"/>	<input checked="" type="checkbox"/>				
Country coverage				Completely	Partially	
	EU 27			<input checked="" type="checkbox"/>	<input type="checkbox"/>	
	Candidate countries & EFTA			<input type="checkbox"/>	<input checked="" type="checkbox"/>	
	Neighbouring countries			<input type="checkbox"/>	<input checked="" type="checkbox"/>	
	TRACECA			<input type="checkbox"/>	<input checked="" type="checkbox"/>	
	MEDA			<input type="checkbox"/>	<input checked="" type="checkbox"/>	
	Other countries			<input type="checkbox"/>	<input checked="" type="checkbox"/>	
	Total number of countries covered:			29		
Main data sources	EUROSTAT					
Main type of data generation	Observed	<input type="checkbox"/>				
	Harmonised	<input checked="" type="checkbox"/>				
	Modelled	<input checked="" type="checkbox"/>				

23.2 Data Sources

Maritime data is covered in some detail within Eurostat, so this has been the primary data source used.

Data is organised per port, so there is no need for estimation at regional level. For each seaport the ingoing and outgoing transport to trading-partner countries and mode of appearance (containers, dry bulk, liquid bulk, ro-ro) are known.

In ETISplus, the data has been re-organised to create a maritime NUTS3-NUTS3 OD matrix (based on port location), further divided into commodities (NST2).

For this matrix only the "International Maritime Freight" table within ETISplus is used, along with COMEXT trade data (including mode of appearance).

23.3 Methodology

Since the initial raw data is close in content to the format required, the methodology is fairly simple. A record within the raw Eurostat "International Maritime Freight" data has the following fields:

- Reporting port (zones)
- Partner country
- Mode of appearance
- Tonnage

Since each port records all incoming and outgoing flows, and since a high proportion of European maritime trade is between Member States, there is a high degree of double-counting in the data.

In order to make an O/D matrix it is necessary to:

- Avoid double counting (or take it into account)
- Disaggregate the partner countries up into partner ports (zones)
- Estimate the commodity distribution based on mode of appearance and trade data

This means each initial port record is split into potentially dozens of port-to-port records.

23.3.1 Removing double counts

Double counting happens only when the flow is reported twice in Eurostat (by the reporting country and the partner country). If both the reporting and partner country report to Eurostat, only the flow that is reported as IMPORT is taken into account, while EXPORT is ignored.

23.3.2 Disaggregating the partner countries into partner ports

For EU to EU flows, the corresponding EXPORT figures within "International Maritime Freight" can be used to split the flow up into partner ports (zones). For example, suppose Hamburg reports that 10,000 tonnes of a specific dry bulk cargo are imported from the Netherlands. Suppose the Dutch ports reporting the same dry bulk exports to Germany are Rotterdam (6,000 tonnes) and Amsterdam (2,000 tonnes). Altogether, these suggest that 75% of flow would come from Rotterdam and 25% from Amsterdam. This procedure is applied for the full dataset to produce a port-to-port O/D matrix.

It is more difficult to estimate the partner port distribution for flows to and from countries that do not report in Eurostat. In this case a fixed distribution is used based on total throughput (if available) or else it is all assumed to go through the country's largest port.

23.3.3 Estimating the commodity distribution

From COMEXT trade data (see "Trade Matrix" section), a table can be created that shows trade flows between country pairs, including NST2 and mode of appearance. This table was used to split up the maritime flows per mode of appearance into NST2. While maritime transport between countries can be very different from trade between countries (especially if they are near each other), this is the best available estimate.

23.4 Results

Results are published in ETIS-View.

In the Observed (2010) category, there is a matrix, derived from Eurostat (MAR_GO) data called "International Maritime Freight", showing port, partner country, direction, mode of appearance and tonnage. There is a closely related table called "Seaport throughput" which uses the EZ2006 level 3 zoning system to code the ports.

In the Harmonised (2010) category, the matrix, "Maritime Freight by O/D" has been converted into a port-to-port (O/D) format, but the flows are classified by mode of appearance, and not by estimated commodity.

Under the Modelled (2010) category the most detailed version with NST2 products replacing modes of appearance, can be found.

Table 23-2: Maritime Freight, key results

Access via	Collection	Group	Description
ETIS View	Modelled Data	Freight	Maritime Freight Tonnages by NUTS3 O/D and NST2 Commodity
2010	http://viewer.etisplus.net/ select collection: ETISplus-2010-Modelled highlight: Freight open table: Maritime freight by OD		
2005	http://viewer.etisplus.net/ select collection: ETISplus-2005-Modelled highlight: Freight open table: Maritime freight by OD		

24 Input-output Matrix

24.1 Scope

The set of input-output tables, collected within the ETIS-Plus project, represents the description of economic transactions within the countries of EU-27 plus Norway and Switzerland for the year 2005. Input-output tables show the relationships between producing and consuming industries and form the basis for many kinds of economic analysis.

Each input-output table shows the economic structure of one European country and it contains information about production processes of different activities, value added, generated by these activities, domestic use of various products and services, as well international trade flows. The tables are detailed up to level of 59 different production activities, according to NACE classification.

Figure 24-1: Main characteristics of the dataset, Input Output Table

Input-Output Matrix																										
Data feature	Data specification	Remarks																								
Base year	2010	Not possible to update for 2010.																								
Scope of data	<div>Link Terminal O/D relation Region Other</div> <div> <input type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> </div>																									
GIS data	<div>Yes No</div> <div> <input type="checkbox"/> <input checked="" type="checkbox"/> </div>																									
Country coverage	<table border="1"> <thead> <tr> <th></th><th>Completely</th><th>Partially</th></tr> </thead> <tbody> <tr> <td>EU 27</td><td><input checked="" type="checkbox"/></td><td><input type="checkbox"/></td></tr> <tr> <td>Candidate countries & EFTA</td><td><input type="checkbox"/></td><td><input checked="" type="checkbox"/></td></tr> <tr> <td>Neighbouring countries</td><td><input type="checkbox"/></td><td><input type="checkbox"/></td></tr> <tr> <td>TRACECA</td><td><input type="checkbox"/></td><td><input checked="" type="checkbox"/></td></tr> <tr> <td>MEDA</td><td><input type="checkbox"/></td><td><input checked="" type="checkbox"/></td></tr> <tr> <td>Other countries</td><td><input type="checkbox"/></td><td><input checked="" type="checkbox"/></td></tr> <tr> <td>Total number of countries covered:</td><td>29</td><td></td></tr> </tbody> </table>		Completely	Partially	EU 27	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Candidate countries & EFTA	<input type="checkbox"/>	<input checked="" type="checkbox"/>	Neighbouring countries	<input type="checkbox"/>	<input type="checkbox"/>	TRACECA	<input type="checkbox"/>	<input checked="" type="checkbox"/>	MEDA	<input type="checkbox"/>	<input checked="" type="checkbox"/>	Other countries	<input type="checkbox"/>	<input checked="" type="checkbox"/>	Total number of countries covered:	29		
	Completely	Partially																								
EU 27	<input checked="" type="checkbox"/>	<input type="checkbox"/>																								
Candidate countries & EFTA	<input type="checkbox"/>	<input checked="" type="checkbox"/>																								
Neighbouring countries	<input type="checkbox"/>	<input type="checkbox"/>																								
TRACECA	<input type="checkbox"/>	<input checked="" type="checkbox"/>																								
MEDA	<input type="checkbox"/>	<input checked="" type="checkbox"/>																								
Other countries	<input type="checkbox"/>	<input checked="" type="checkbox"/>																								
Total number of countries covered:	29																									
Main data sources	EUROSTAT ETH Zurich (Swiss data)																									
Main type of data generation	<div>Observed <input type="checkbox"/></div> <div>Harmonised <input checked="" type="checkbox"/></div> <div>Modelled <input type="checkbox"/></div>																									

24.2 Data sources

The dataset of European input-output tables represents the data directly collected from Eurostat and for the Switzerland from ETH Zurich (<http://www.input-output.ethz.ch/downloads/index>).

24.3 Methodology

Since most of the Input-output tables were directly downloaded from Eurostat web-site, the dataset follows the methodology established by the European System of Accounts (ESA 1995). For more details we refer to the Eurostat Manual of Supply, Use and Input-Output Tables (2008 edition). According to the ESA 1995 transmission programme all the Member States are supposed to provide Eurostat with the set of supply and use tables annually and with the input-output table every five years. Nevertheless, due to delays and derogation for certain countries, not all the tables were available for the year 2005 and therefore some adjustments were needed.

In order to create the harmonised set of input-output tables we have employed the following rules:

- 1) If the input-output table for 2005 denominated in euros is available, include it in the database as is. These countries are: Austria, Belgium, Czech Republic, Germany, Denmark, Estonia, Spain, Finland, France, Greece, Hungary, Ireland, Italy, Lithuania, Luxembourg, Netherlands, Poland, Portugal, Romania and Sweden.
- 2) If the latest available input-output table is denominated in euros, but for the year before 2005, assume that the structure of economy in 2005 was the same as in the available year. Then the available table is scaled up using the growth rate of nominal GDP expressed in euros from the available year to 2005. These countries are Latvia and United Kingdom.
- 3) If the input-output table for 2005 denominated in national currency is available, convert the table using the yearly average exchange rate for 2005. These countries are Norway, Slovenia and Slovak Republic.
- 4) If the latest available input-output table is for the year before 2005 and denominated in national currency, update the table to 2005, as in (2), and convert to euros, as in (3). These countries are Switzerland and Turkey.

24.4 Results

The final dataset consists of the set of input-output tables for 2005 denominated in Euros for the Member States, Norway and Switzerland.

Table 24-1: Input-Output data, key results

Access via	Collection	Group	Description
ETISplus Sharepoint	ETISplus Public Document Repository	Deliverables Data deliverables Freight	Input-Output Tables per economic sector , per EU country. XLS format.
2010	Not available		
2005	<p>From www.etisplus.eu Click: <u>Deliverables</u> Tab, then <u>Data Deliverables</u> in sidebar, then <u>Freight</u> folder. Item: IOT_Europe2005</p> <p>Or direct: http://www.etisplus.eu/deliverables/Data%20Deliverables/Freight/IOT_Europe2005.xls</p>		

25 Logistics Database

25.1 Scope

The logistic dataset contains information about number of enterprises, employment and value added, created in trade and transport sectors. The dataset covers EU-27 and the Member States separately and is given at a very detailed sector level, the breakdown is according to the 4-digit level of NACE classification.

While the thematic area for this dataset is socio-economic, it has been collected within the freight work-package (WP8) as it is intended to complement the area of freight analysis, showing in detail economic activity in service sectors related to freight transport.

Table 25-1: Scope of Logistics Database

Logistics Database						
Data feature	Data specification					Remarks
Base year	2010					2010 data not available.
Scope of data	Link	Terminal	O/D relation	Region	Other	Number of firms, total wages and number of persons employed per region per NACE sector.
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
GIS data	Yes	No				O/D regions are geo-coded within ETISplus.
	<input type="checkbox"/>	<input checked="" type="checkbox"/>				
Country coverage				Com-pletely	Par-tially	
	EU 27			<input checked="" type="checkbox"/>	<input type="checkbox"/>	
	Candidate countries & EFTA			<input type="checkbox"/>	<input type="checkbox"/>	
	Neighbouring countries			<input type="checkbox"/>	<input type="checkbox"/>	
	TRACECA			<input type="checkbox"/>	<input type="checkbox"/>	
	MEDA			<input type="checkbox"/>	<input type="checkbox"/>	
	Other countries			<input type="checkbox"/>	<input type="checkbox"/>	
	Total number of countries covered:			27		
Main data sources	Eurostat 2010					
Pedigree	Observed	<input type="checkbox"/>				
	Harmonised	<input type="checkbox"/>				
	Modelled	<input checked="" type="checkbox"/>				

Table 25-2: Logistics Database Structure (excerpt)

EZ2003_2_ID	nacerev2	noperson	wages	nofirms
1010101	G461	271	2.3	191
1010101	G462	662	15.6	123
1010101	G463	1081	24.7	158
1010101	G464	471	10.1	92

Table 25-3: Logistics Database Structure (parameters)

ID	Description	Unit	Type
nofirms	Number of firms	Number	DOUBLE
noperson	Number of people employed	Number	DOUBLE
wages	Wages	Euro	DOUBLE

Since the data is 2005 only, the region coding uses the EZ2003 level 2 zoning system. For an explanation of the NACE coding see reference¹.

25.2 Data sources

The dataset is taken from the Structural Business Statistics (SBS) of Eurostat. The SBS describes the structure, conduct and performance of businesses across the European Union on a very detailed level of economic activities (4-digit NACE classification). The SBS covers business demographic variables, 'output related' variables, 'input related' variables. Activities within industry, construction, trade and business services are included.

25.3 Methodology

Since all the data in the dataset are coming directly from the Structural Business Statistics, the methodology completely corresponds with one used by Eurostat. The data given by Eurostat are based on national business registries and surveys of business enterprises or parts of enterprises, such as local units.

25.4 Results

The final dataset represents a subset of economic activities, which are presented in SBS.

¹ EUROSTAT, NACE Rev 2, http://epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-RA-07-015/EN/KS-RA-07-015-EN.PDF

Table 25-4: Logistics Data, key results

Access via	Collection	Group	Description
ETISplus Sharepoint	ETISplus Public Document Repository	Deliverables Data deliverables Freight	Regional socio- economic data related to Logistics Sectors, per NUTS2. MS-Access format
2010	Not available		
2005	From www.etisplus.eu Click: <u>Deliverables</u> Tab, then <u>Data Deliverables</u> in sidebar, then <u>Freight</u> folder. Item: Logistieke data 2005 Or direct: http://www.etisplus.eu/deliverables/Data%20Deliverables/Freight/Logistieke%20data%202005.zip		

The subset includes the activities of transport (4-digit classes within NACE sectors 60, 61, 62), wholesale (4-digit classes within NACE sector 51) and warehousing (4-digit classes within NACE sector 63.1). The data cover all the three groups of variables within SBS: number of enterprises from the business demographics variables, value added from the 'output related' variables and employment from the 'input related' variables. The statistics are given on the level of EU Member States.

Table 25-5: Number of Persons Employed in Logistics Sectors, 2005

NACE-REV2	Description	Number of persons employed
G461	Wholesale on a fee or contract basis	958,404
G462	Wholesale of agricultural raw materials and live animals	340,940
G463	Wholesale of food, beverages and tobacco	1,858,894
G464	Wholesale of household goods	2,250,527
G465	Wholesale of information and communication equipment	611,269
G466	Wholesale of other machinery, equipment and supplies	1,257,096
G467	Other specialised wholesale	2,247,723
G469	Non-specialised wholesale trade	684,852
G471	Retail sale in non-specialised stores	6,403,680
G472	Retail sale of food, beverages and tobacco in specialised stores	1,431,586
G473	Retail sale of automotive fuel in specialised stores	497,719
G474	Retail sale of information and communication equipment in spec stores	537,722
G475	Retail sale of other household equipment in specialised	2,432,463

NACE-REV2	Description	Number of persons employed
	stores	
G476	Retail sale of cultural and recreation goods in specialised stores	1,033,850
G477	Retail sale of other goods in specialised stores	5,307,405
G478	Retail sale via stalls and markets	474,417
G479	Retail trade not in stores, stalls or markets	471,522
H49	Land transport and transport via pipelines	6,007,134
H50	Water transport	224,055
H51	Air transport	378,258
H52	Warehousing and support activities for transportation	2,489,643
H53	Postal and courier activities	1,801,707
TOTAL		39,700,867

26 Trade Matrix

Trade data is a valuable resource, providing useful background and context for transport datasets. Unlike most transport sources it is derived from a full record of international commercial transactions. It is available for all countries worldwide in comparable form, it is timely and it is very detailed by product sectors. In ETISplus the aim has been to combine several sources into a single harmonised 2010 trade matrix, arranged into O/D format.

26.1 Scope of the Database

Table 26-1: Overview of the dataset, Trade Matrices

Trade matrix						
Data feature	Data specification					Remarks
Base year	2010					
Scope of data	Link	Terminal	O/D relation	Region	Other	
	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
GIS data	Yes	No				
	<input type="checkbox"/>	<input checked="" type="checkbox"/>				
Country coverage				Com-pletely	Par-tially	
	EU 27			<input checked="" type="checkbox"/>	<input type="checkbox"/>	
	Candidate countries & EFTA			<input checked="" type="checkbox"/>	<input type="checkbox"/>	
	Neighbouring countries			<input checked="" type="checkbox"/>	<input type="checkbox"/>	
	TRACECA			<input checked="" type="checkbox"/>	<input type="checkbox"/>	
	MEDA			<input checked="" type="checkbox"/>	<input type="checkbox"/>	
	Other countries			<input checked="" type="checkbox"/>	<input type="checkbox"/>	
	Total number of countries covered:			226		
Main data sources	Eurostat COMEXT UN Comtrade					
Main type of data generation	Observed	<input checked="" type="checkbox"/>				
	Harmonised	<input checked="" type="checkbox"/>				
	Modelled	<input type="checkbox"/>				

26.2 Data Structures

Both observed and harmonised datasets are provided through ETIS-View. Under *observed* data, three different sets are shown separately:

1. COMEXT (EU27) Trade Data (intra and extra EU)
2. COMEXT Transport-oriented Trade Data (extra EU only)
3. COMTRADE (non-EU) Trade Data (UN)

Table 26-2: Summarised COMEXT EU27 Trade Data (f_comext_summ), Observed

Dimensions	Description	Type
REPORTINGCOUNTRY_ID	Reporting Country	Integer
PARTNERCOUNTRY_ID	Partner Country	Integer
FLOW_ID	Flow: IMP(import) or EXP(export)	Text
NST2_ID	Commodity NST/R 2 Digit Code	Integer
Parameter	Description	Type
f_comext_summ_tonnes	2010 Tonnage	Double
f_comext_summ_value	2010 Euros (value)	Double

Table 26-3: COMEXT Extra-EU Transport Trade Data (f_comext_transport_summ), Observed

Dimensions	Description	Type
REPORTINGCOUNTRY_ID	Reporting Country	Integer
PARTNERCOUNTRY_ID	Partner Country	Integer
FLOW_ID	Flow: IMP(import) or EXP(export)	Text
NST2_ID	Commodity NST/R 2 Digit Code	Integer
MOA_ID	Mode of Appearance (containerized)	Text
TRAN_TYP_ID	Transport Type (road, rail etc)	Text
Parameter	Description	Type
f_comext_transport_summ_tonnes	2010 Tonnage	Double
f_comext_transport_summ_value	2010 Euros (value)	Double

Table 26-4: COMTRADE Non-EU Trade Data (f_comtrade_summ), Observed

Dimensions	Description	Type
REPORTINGCOUNTRY_ID	Reporting Country	Integer
PARTNERCOUNTRY_ID	Partner Country	Integer
FLOW_ID	Flow: IMP(import) or EXP(export)	Text
NST2_ID	Commodity NST/R 2 Digit Code	Integer

Parameter	Description	Type
f_comtrade_summ_tonnes	2010 Tonnage	Double
f_comtrade_summ_value	2010 Euros (value)	Double

The COMEXT and COMTRADE sources are then combined to create a single harmonised O/D trade matrix in which the mirror-flows¹ are removed. In the O/D format, each flow only exists in one cell of the database.

Table 26-5: Harmonised Trade Data (f_intl_trade_harmonised)

Dimensions	Description	Type
ORIGINCOUNTRY_ID	Reporting Country	Integer
DEST_COUNTRY_ID	Partner Country	Integer
NST2_ID	Commodity NST/R 2 Digit Code	Integer
Parameter	Description	Type
f_intl_trade_harmonised_tonnes	2010 Tonnage	Double
f_intl_trade_harmonised_value_k_eur	2010 '000 Euros (value)	Double
f_intl_trade_harmonised_value_k_usd	2010 '000 USD (value)	Double
f_intl_trade_harmonised_teu	2010 estimated loaded TEU Units	Double

26.3 Data sources

There are four tables with trade data in ETISplus:

- EU Trade (COMEXT)
- EU Detailed Trade (COMEXT Transport)
- Non EU Trade (COMTRADE)
- Harmonised Trade (Combination)

The EU trade comes directly from the COMEXT database. The non EU trade is taken from the UN COMTRADE database. The harmonised trade table reports only one flow of trade from one country to another, based on all the available sources for that particular flow.

26.4 Methodology

The COMEXT and COMTRADE data sets do not require a lot of initial processing. Variables like the direction of trade, reporting and partner country are all in the original source. However, the commodity code was converted into NST2, from

¹ Each country reports all of its own imports and exports. Since one country's imports are another country's exports, each flow is registered twice. However, these mirror flows do not necessarily match in the statistics.

CN8 or SITC5. The correspondence tables for this conversion can be found at Eurostat.

In the harmonised trade table all of the different sources are combined. One particular flow of trade can be reported a maximum of four times: as import or export in COMEXT, and as import or export in COMTRADE. These four values can greatly differ from each other due to time lag, mix-ups in recorded origins and destinations, inconsistent currency conversion, human errors, and so on. The reasons are explained in more detail in the COMEXT manual.

To solve this discrepancy, time series are constructed for each individual reported value. Then the time series are smoothed to fill gaps and/or remove outliers. Lastly, the average of the different time series is taken to create the final time series. The resulting 2005 and 2010 values are inserted in the ETISplus harmonised trade table.

26.5 Results

Table 26-6: Trade data, key results

Access via	Collection	Group	Description
ETIS View	Harmonised Data	Freight	Trade data by Country and NST2 Commodity
2010	http://viewer.etisplus.net/ select collection: ETISplus-2010-Harmonised highlight: Freight open table: Harmonised Trade		
2005	http://viewer.etisplus.net/ select collection: ETISplus-2005-Harmonised highlight: Freight open table: Harmonised Trade		

27 International Freight Chain Matrix

27.1 Scope

ETISplus has collected a range of transport and trade data within the freight work-package. One of the applications of this data has been to combine trade and transport data into international freight chains.

Being able to relate trade and transport flows is useful for many applications, including forecasting. Economic developments generate trade, trade generates transport. A substantial share of hinterland flows are related to maritime flows. For impact analysis within the hinterland, a link with maritime flows is necessary.

The resulting matrix is detailed at NUTS0 (national) level. It contains data in NSTR1 classification in tonnes for the year 2010. The dataset contains information about extra-European and intra-European trade flows in combination with their respective routes. In case of extra-European trade the dataset provides information about the transit country of the flow where the port is located. Further both extra-European and intra-European trade flows follow the same transport routes within Europe. These routes include both one mode routes and multi-mode routes.

Table 27-1: Overview of freight chain matrix, 2010

International freight chain matrix						
Data feature	Data specification					Remarks
Base year	2010					
Scope of data	Link	Terminal	O/D relation	Region	Other	Records are chains with up to two links. O/D flows are disaggregated to include an interchange/transshipment point.
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
GIS data	Yes	No				O/D regions are geo-coded within ETISplus. The finest level of detail is NUTS0.
	<input type="checkbox"/>	<input checked="" type="checkbox"/>				
Country coverage				Com-pletely	Par-tially	Includes intra-European flows, and EU-extra EU flows. Domestic flows and extra-EU-extra-EU are mainly excluded.
	EU 27			<input checked="" type="checkbox"/>	<input type="checkbox"/>	
	Candidate countries & EFTA			<input type="checkbox"/>	<input checked="" type="checkbox"/>	
	Neighbouring countries			<input type="checkbox"/>	<input checked="" type="checkbox"/>	
	TRACECA			<input type="checkbox"/>	<input checked="" type="checkbox"/>	
	MEDA			<input type="checkbox"/>	<input checked="" type="checkbox"/>	
	Other countries			<input type="checkbox"/>	<input checked="" type="checkbox"/>	
	Total number of countries covered:			176		
Main data sources	ETISplus Transport and Trade Matrices Eurostat					
Pedigree	Observed	<input type="checkbox"/>				
	Harmonised	<input type="checkbox"/>				
	Modelled	<input checked="" type="checkbox"/>				

Table 28-2: Structure of freight chain matrix, (Excerpt)

ORIG_EZ2006_0	COMM_NST1	MODE1	TPT_EZ2006_0	MODE2	DEST_EZ2006_0	TONNES_2010
101	0	rail	102	mar	117	0.02
101	0	rail	102	mar	132	26.52
101	0	rail	102	mar	134	0.02
101	0	rail	102	mar	201	109.39

Table 28-3: Structure of freight chain matrix, dimensions and parameter

Dimensions	Description	Type
ORIG_EZ2006_0	Origin Country	Integer
COMM_NST1	Commodity NST/R 1 Digit Code	Integer
MODE1	First Mode of Transport	Text
TPT_EZ2006_0	Interchange/Trans-shipment Country	Integer
MODE2	Second Mode of Transport	Text
DEST_EZ2006_0	Destination Country	Integer
Parameter	Description	Type
TONNES_2010	2010 Tonnage	Double

All geo-coding is at level zero (EZ2006_0).

Modes are enumerated with text fields:

Table 28-4: Mode attributes

Mode ID	Description
iww	Inland waterway transport
mar	Maritime transport
road	Road transport
rail	Rail transport

27.2 Data sources

Multimodal (chain) data is only collected in a few limited corridors in Europe. Furthermore, intra-European trade data containing seaport and mode of transport has not existed since the creation of the Single European Market in 1992. Neither of these is therefore suitable for making a pan-European matrix for 2010.

Dataset on international and European transport chains is based on trade and transport statistics for 2010 collected within the scope of ETIS-Plus project. Besides that we have used information on transport costs by NSTR group and pair of countries based on distance data in combination with TRANSTOOLS cost elements.

27.3 Methodology

As an introduction to methodological description we would like to provide some explanations about the content of existing statistical data on trade and transport and indicate the main difficulties for reconciling the two data sources.

Trade data is commodity-oriented, showing countries of production and consumption:

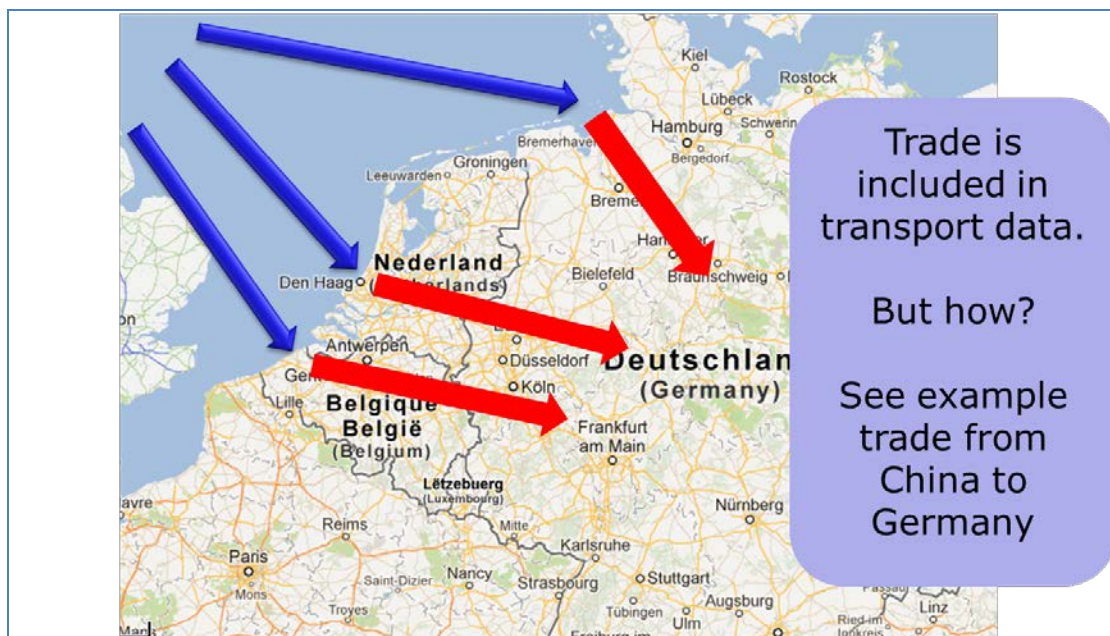
- Country level
- Origin country: production of the goods
- Destination country: consumption of the goods
- **Trade: commodity oriented**

Transport data is oriented towards specific modes of transport, with less commodity information but usually greater spatial detail.

- Regional level (up to NUTS3)
- Origin region: region where goods are loaded on the vehicle
- Destination region: region where goods are unloaded from the vehicle
- **Transport: transport unit oriented**

Ideally what we would like to include in the dataset is the information about trade flow from country A to country B split between different routes that this trade flow follows. Trade data, for example will capture goods flows between China and Germany. These will be picked up in European transport statistics, for example as HGV flows between Continental coastal regions and inland regions, but there is no additional information to distinguish these global streams from other European flows.

Figure 28-1: Linkage between trade and transport data



The freight matrix should in principle be constructed to include multiple modes of transportation. Unfortunately none of the elements of such data is readily available from statistics for reasons that are explained in details below.

Existing trade statistics usually contain, besides pure trade flows between the countries that are of interest for our dataset, also re-exports, which complicates the process of separating real trade flow from an accounting one. In case of European countries, re-exports represent part of the transit of the extra-European trade flows via European countries. Not all transit flows are registered as re-exports but only the part which changes ownership status at the border. Hence even by separating re-exports we will not get information about the total extra-European transit flows through the European countries.

The situation is further complicated by different approaches applied to the collection of trade statistics. Intra-European trade statistics are currently based on surveys which reduce their reliability for the analysis and make them more difficult to use. Extra-European trade statistics are more reliable since they are based on actual customs registrations. However they also include re-exports. In ETISplus, trade flows between non-EU flows are sourced from UN Comtrade databases, which are less detailed than Eurostat sources.

Transport statistics are mainly based on surveys (hence less reliable) and provide data on Loading-Unloading matrices of transport flows between countries. These data sources do not give information about the initial origin and the final destination of transport flows within Europe or worldwide. Instead they provide data on transport flows on various separate parts of the multi-modal routes linking countries.

The first step of our methodological procedure is to estimate the matrix of initial origin to final destination transport flows (called IO-FD matrix) within Europe based on the transport data. This matrix also includes the transit flows from non-European countries.

In order to create the reconciled set of transport and trade data we have followed the steps described below. In our methodology we take transport statistics as given and introduce only minor changes to them. These minor changes are due to substantial inconsistencies between transport and trade data. The trade statistics are adjusted in order to fit the transport-related data. The changes in total amount of trade flows is below 10% overall. However, changes in trade flows of particular commodities or between particular pairs of countries can be much larger.

The estimation steps are shown below:

Table 28-5: Step by Step Chain estimation process

1. Read in ETISplus 2010 transport and trade data and bring it to harmonised dimensions: (1) at the country level and (2) for NSTR1.
2. Check whether transport data allows for generation of two-mode routes between all existing intra-European trade flows. Adjust transport data in case this is not possible.
3. Group European countries into several geographical groups and identify transfer country for each of these groups on the basis of transport statistics. Transit country will have the largest amount of in and out-going transport flows.

- | | |
|----|--|
| 4. | Generate all possible transport routes between European countries on the basis on transport statistics. The routes include one mode routes where from transport statistics we see that there is a direct loading-unloading connection and two-mode routes that combine road, rail, IWW and maritime modes. Besides that we also generate routes that consist of road mode with transit at the countries determined in step 3. |
| 5. | Reduce the number of possible multi-modal routes on the basis of their transport costs to three per each pair of European countries. Leave three cheapest multi-modal routes. |
| 6. | Set-up a <i>nonlinear programming problem</i> for the estimation of total IO-FD matrix transport flows between European countries. The optimization problem consists of several constraints that represent the relationship between transport flows on the routes and total OD matrix, the choice of the share of transport flow to take particular routes (according to logit choice) and the objective function which minimises the difference between the generated IO-FD matrix and the intra-European trade matrix. The difference is measured as an entropy function. |
| 7. | Once we know the IO-FD matrix of transport flows between European countries we can set-up a procedure for the simultaneous estimation of pure intra-European trade and inter-national transit flows. The IO-FD matrix that we have estimated in step 6 on the basis of transport statistics contains pure intra-European trade plus the inter-national transit flows. We use again nonlinear programming approach for the estimation of intra-European trade and extra-European transit flows. The optimization problem includes constraints on non-negativity of trade and transit flows in combination with several identities linking intra-European trade, international transit flows and IO-FD matrix transport matrix. The objective function minimises the difference between the maritime statistics and the resulting extra-European transit flows. The difference is measured as an entropy function. |

27.4 Results

The result of the estimation procedure is the set of transport chains for each PC pair of countries by commodity type, which is based on the following outcomes of methodological procedure:

1. IO-FD matrix of transport flows between European countries, which consists of intra-European trade and inter-national transit flows
2. Transportation flows on the routes which link each pair of European countries. This includes one-mode routes, multi-modal routes and road routes with transit points.
3. Extra-European trade flows between the rest of the world countries and European countries
4. Extra-European transit flows via a particular European country. Upon the entry to Europe these flows follow the same transportation routes as intra-European trade flows.

Finally these results are all combined in a transport chain matrix.

Table 28-6: Transport chain data, key results

Access via	Collection	Group	Description
ETISplus Sharepoint	ETISplus Public Document Repository	Deliverables Data deliverables Freight	Transport Chain Data for 2010 by NUTS0 and NST1 MS-Access Format
2010	<p>From www.etisplus.eu Click: <u>Deliverables</u> Tab, then <u>Data Deliverables</u> in sidebar, then <u>Freight</u> folder. Item: 2010_ETISplus_Transportchains_V21112_FINAL</p> <p>Or direct (MS-Access version): http://www.etisplus.eu/deliverables/Data%20Deliverables/Freight/2010_ETISplus_Transportchains_V21112_FINAL.zip</p> <p>Text Version: http://ftp.demis.nl/Outgoing/ETISplus/DataDeliverables/Additional/Freight-Miscellaneous.zip</p>		
2005	Not available.		

Two examples are shown below. The first shows multimodal flows estimated between the USA and (land-locked) Czech Republic, for commodity NST9, miscellaneous manufactured goods.

Table 28-7: Example of maritime chain, US-CZ, NST9, 2010 database

Origin Country	MODE 1	Interchange (port) Country	MODE2	Destination Country	2010 Tonnage
USA	Sea	Germany	road	Czech Rep.	37,905.07
USA	Sea	Germany	rail	Czech Rep.	16,699.81
USA	Sea	Belgium	road	Czech Rep.	4,758.44
USA	Sea	Italy	road	Czech Rep.	4,558.19
USA	Sea	Other Combinations		Czech Rep.	10,903.58
TOTAL					74,825.09

A second example shows freight flows (commodity 9) between neighbouring Czech Republic and Germany. In this example, Germany is one of the trading countries, and not an intermediate transit point as before. Because the two countries are connected by land, there is no mode interchange. The model system, however, estimates the share of the inland modes

Table 28-8: Example of intra-continental chain, CZ-DE, NST9, 2010 database

Origin Country	MODE 1	Interchange (port) Country	MODE2	Destination Country	2010 Tonnage
Czech Rep.	Road			Germany	4,546,092
Czech Rep.	Rail			Germany	1,671,559
Czech Rep.	Waterway			Germany	151,358

Using this methodology, it is therefore possible to separate the direct and indirect flows between Germany and the Czech Republic. In a forecasting context, they can be treated as two distinct sets reacting differently to economic growth and transport costs.

29 Air Passenger Matrix

The database includes total passenger trips by air in the year 2010, at NUTS3 level differentiated by trip purpose:

- Business (trips for working purposes with different destination than the usual workplace),
- Private (non business related trips with duration of up to 4 days),
- Vacation (non-business trips with duration of more than 4 days),
- Commuting (daily trips for working or studying purposes).

29.1 Scope of the database

Table 29-1: Overview of the dataset, air passenger trips

Passenger trips by air																														
Data feature	Data specification					Remarks																								
Base year	2010																													
Scope of data	Link	Terminal	O/D relation	Region	Other																									
	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>																									
GIS data	Yes	No																												
	<input type="checkbox"/>	<input checked="" type="checkbox"/>																												
Country coverage	<table><thead><tr><th></th><th>Completely</th><th>Partially</th></tr></thead><tbody><tr><td>EU 27</td><td><input checked="" type="checkbox"/></td><td><input type="checkbox"/></td></tr><tr><td>Candidate countries & EFTA</td><td><input checked="" type="checkbox"/></td><td><input type="checkbox"/></td></tr><tr><td>Neighbouring countries</td><td><input checked="" type="checkbox"/></td><td><input type="checkbox"/></td></tr><tr><td>TRACECA</td><td><input type="checkbox"/></td><td><input checked="" type="checkbox"/></td></tr><tr><td>MEDA</td><td><input type="checkbox"/></td><td><input checked="" type="checkbox"/></td></tr><tr><td>Other countries</td><td><input type="checkbox"/></td><td><input checked="" type="checkbox"/></td></tr><tr><td>Total number of countries covered:</td><td>39</td><td></td></tr></tbody></table>						Completely	Partially	EU 27	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Candidate countries & EFTA	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Neighbouring countries	<input checked="" type="checkbox"/>	<input type="checkbox"/>	TRACECA	<input type="checkbox"/>	<input checked="" type="checkbox"/>	MEDA	<input type="checkbox"/>	<input checked="" type="checkbox"/>	Other countries	<input type="checkbox"/>	<input checked="" type="checkbox"/>	Total number of countries covered:	39		
	Completely	Partially																												
EU 27	<input checked="" type="checkbox"/>	<input type="checkbox"/>																												
Candidate countries & EFTA	<input checked="" type="checkbox"/>	<input type="checkbox"/>																												
Neighbouring countries	<input checked="" type="checkbox"/>	<input type="checkbox"/>																												
TRACECA	<input type="checkbox"/>	<input checked="" type="checkbox"/>																												
MEDA	<input type="checkbox"/>	<input checked="" type="checkbox"/>																												
Other countries	<input type="checkbox"/>	<input checked="" type="checkbox"/>																												
Total number of countries covered:	39																													
Main data sources	EUROSTAT air transport statistics, several national air transport statistics					See below for more details																								
Main type of data generation	Observed	<input type="checkbox"/>																												
	Harmonised	<input type="checkbox"/>																												
	Modelled	<input checked="" type="checkbox"/>																												

It is assumed that there are no trips by air for commuting purpose and that there are no intrazonal trips by air; i.e. participants of pleasure, sightseeing or training flights starting and landing at the same airport are not covered.

Trips are between zones and refer to the zoning system of the ETISplus project defined for the year 2010¹. For countries outside geographic Europe air passenger flows have been calculated on country level. "Europe" in this context is considered as consisting of those regions for which the region coding defined within ETIS starts with a "1". As there are some countries outside Europe for which a more detailed regionalisation than country level has been defined (e.g. Brazil) for these countries the flows were assigned to those regions where the country's capital situated (e.g. for Brazil to the region "Distrito Federal", code 617070000), while zero flows have been assigned for all other regions of such countries.

The flow matrix is symmetric, as it is assumed that a passengers' journey always consists of a trip from region A to region B and the trip back from region B to region A. This means the flow indicated in the matrix from a region A to a region B is identical to the flow indicated from region B to region A. There is no distinction if the origin of a traveller is in region A or in region B, so the flows are non-directional.

29.1.1 Data structure of the air passenger trips dataset

Table 29-2: Data structure

Indicator	Description of indicator	Unit
Origin Zone	Origin Zone ID at NUTS3 level	
Destination Zone	Destination Zone ID at NUTS3 level	
Trip Purpose	Trip purpose	
Passenger Trips by air	Yearly trips from Origin Zone to Destination Zone	trips/year

Please note that a trip is different from a journey. A passenger travelling from region A to region B undertakes a trip, while a journey includes the return trip from region B to region A. So the trips per year stated in the table reflect the number of passengers travelling between two regions.

29.2 Methodology

The approach selected to generate an air passenger transport matrix is based on the request using to maximum extent existing information while minimising modelling. So an iterative calibration process was applied where observed values (revealed data) are the benchmark for the reflection of the transport mode situation. Although for aviation statistical data are widespread, some issues required model approaches to determine a true origin – destination matrix comparable with the ones of other transport modes.

¹ The zoning system for the year 2010 differs from that for the year 2005

In general air transport statistics are quite extensive, as travelling by commercial air transport always requires a booking and check in process for each and every passenger belonging to a specific routing with the usage of distinct flights. On the other hand travelling by air in most cases consists of a multimodal transport chain, as usually no trip actually starts or ends at an airport, meaning the true regional zone of origin or destination of these trips is not covered by statistics and is not per definition the region where an airport is situated. Furthermore air transport statistics in many cases just focus on the specific air segments and do not take into account that passengers often have to change planes on an intermediate airport of their trip.

To build a region to region air transport flow matrix an iterative calibration process has been executed. Its working principle is shown in the scheme below. It starts with a bottom-up approach consisting of the collection of statistics for airports, air links, and airport pairs from various sources, forming a data base of harmonised statistics for links and nodes. Data available from Eurostat (table avia_par for passenger data on airports and table avia_paoa for air links) are the backbone of the approach concerning airports in the EU and also air links from, to or between EU airports. The air link data point out the number of passengers transported on a specific link, but do not indicate, if these passengers have actually their true origin at the starting airport or transferred there from another flight. The same is valid concerning the destination airport of such an air link.

These data were supplemented by data from additional national sources, in cases when:

- they provide data for air links not covered by Eurostat, but within the scope of ETISplus (e.g. air links to/from airports situated in EFTA or candidate countries to abroad, e.g. like Oslo – New York, taken from US statistics),
- the air link should be covered by Eurostat, but has not been reported to it by the responsible EU member state (e.g. Athens - Atlanta, taken from US statistics),
- they provide additional information on passenger figures to final or last known destination (the German National Statistic Office, Destatis, points out passenger figures from Frankfurt to Cameroon, although there are no direct flights to Yaoundé, Cameroon's international airport from Frankfurt),
- three-point-statistics (from airport – via airport – to airport) are provided like from Austria's statistic office (but on commercial base, so these data were not imported into the database but used as external benchmarks),
- information of true origin of passengers is given like from the Swiss Bundesamt für Verkehr (BAS) which provides e.g. not only the number of passengers for the link Zurich – Agadir, Morocco, which includes transfers at Zurich, but also the number of passengers starting their trip to Agadir, Morocco at Zurich, or finally
- provide information on the total number of transfer passenger at airports (like from the Norwegian operator of airports, AVINOR).

In addition, for air links where no statistics were available (e.g. as they are not reported by member states due to data safety reasons), out of the capacity offered on the flights serving a link (calculated from carrier specific schedules, the aircraft used and the carrier specific seat configuration and general load

factors applying) artificial statistics were constructed. Finally, all statistics, collected and estimated had to be harmonised² brought together to form a common, consistent database for the calibration process.

As second input the region to region impedances for up to 16 different routings for each pair of regions had to be computed on base of an air network consisting of airports, air links and feeder links connecting regions with airports. These different routings for each region pair are evaluated by an in-house route choice algorithm developed by MKmetric, resulting in trip purpose specific route choice probabilities for each of them. For details on that process we refer to the WP7 report.

As a third prerequisite the shares of the distinct trip purposes (business, private, vacation) on the total demand for distinct destination airports or regions were derived from existing passenger surveys (dateline, KONTIV, passenger surveys on airports). The airport related sources were furthermore used to set up the airport choice / route choice algorithms mentioned above.

Finally the regionalisation defined within ETISplus for the year 2010 and the corresponding socio-economic data collected / estimated within WP7 have been used to compute a start-up passenger flow matrix. For countries outside Europe these data were not available from the project in line with the defined regionalisation, so within the project it was decided to use available data on national level, resulting in flow pattern to be delivered in the same detailing. For the countries outside Europe data for population and GDP were derived from public sources like the CIA World Fact book, UN or national data.

The start up matrix was built by assigning the statistical data for air links between airports to region pairs, using the airports' geographic latitude/longitude information. This approach leaves all regions in which no airport is situated without any demand for air transport. It furthermore implies, that for all region pairs, equipped with airports only those have a passenger flows, where direct flights existed between the corresponding airports or where final destination information from statistics was available.

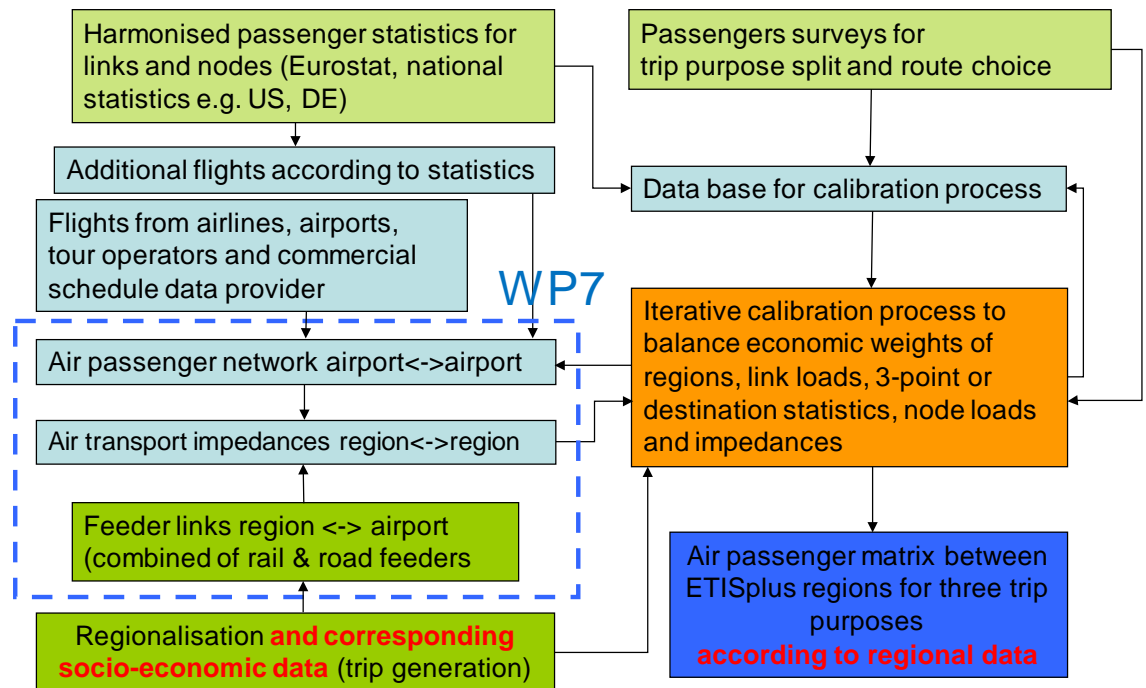
For that reason in a second step these flows between region pairs were distributed among all NUTS3 region pairs within the same NUTS1 pair of regions, by using the regions' socio-economic weights (GDP, population and other attractors).

Finally in a third step all region pairs without any start-up flow received a preliminary flow of passengers > 0 , reflecting socio-economic weights of origin and destination region and impedances between them reflecting the relative accessibility, so that the iterative calibration process can deal as well with such region pairs.

² E.g. in some cases for an air link from A to B airport A reported a passenger figure for departing passengers different from the one reported by airport B on passengers arriving from A.

The following scheme summarises the approach of data processing.

Figure 29-1: Data processing steps



The calibration depicted in the next scheme is an iterative process where data from various sources and model results are assessed to detect irregularities, inconsistencies and errors. The arrows symbolise the principle process flow but due to the complexity the recursive parts and their nesting cannot be displayed.

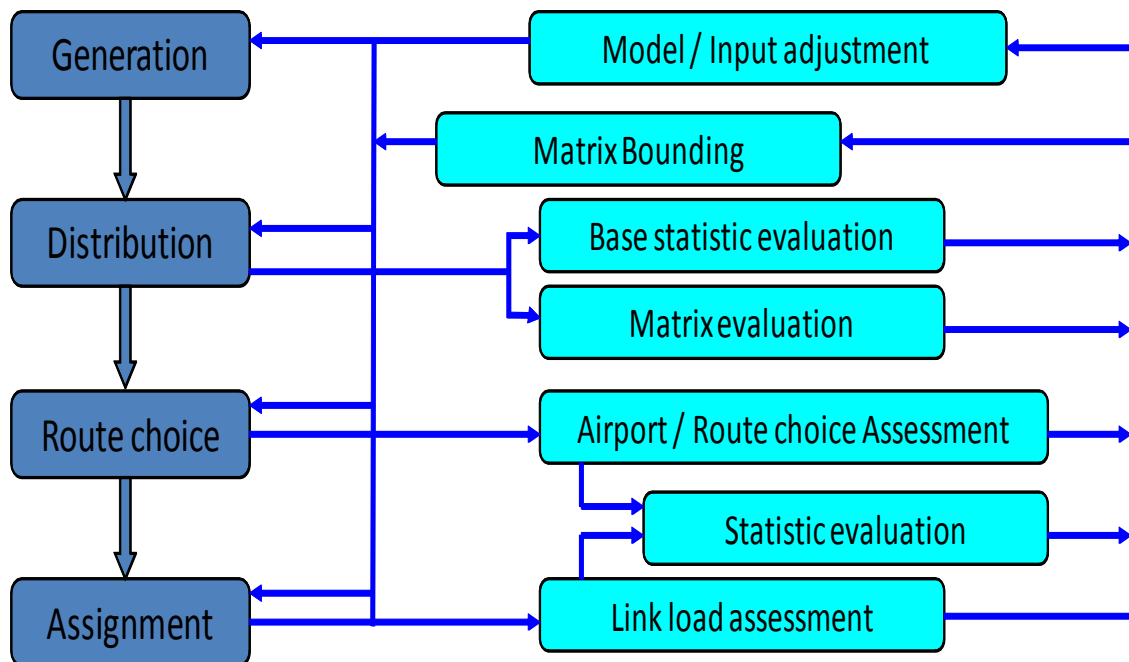
The matrix received from the previous iteration (or in the beginning, the start-up matrix) is assigned to the air network according to the route choice probabilities for all region pairs. The link load assessment (comparison with link statistics) then leads to a variation of the flow matrix, by redoing trip generation and distribution (matrix bounding). This process targets in minimising the deviation of link loads and statistics. It should be noted that inconsistencies in the statistic database (e.g. the sum of link loads to and from an airport is not in line with statistic of total passengers at an airport) detected within this calibration process are also corrected within each iteration step leading to an input adjustment.

For example this may occur when contradictory volumes of passengers are reported for an air link from different sources. An input adjustment may also occur, if further minimising deviations from assigned link loads and link statistics requires a recalculation of transport alternative specific characteristics applying for air links or combination of air links which are part of the routings for regions pairs. Such deviations in e.g. applicable costs for distinct air connections may especially apply on air links, which are run by an airline under a very competitive environment (e.g. multiple airlines operate flights on a distinct city pair, especially to/from multi airport cities like London), when transfer connections compete with nonstop-flights, to and from airports which are slot-constrained or

between countries where capacities provided by the airlines depend on bilateral agreements, so that the supplied capacity is not in line with the existing demand.

The following scheme summarises the calibration process:

Figure 29-2: Calibration process.



In parallel throughout the iteration process the socioeconomic relationships are checked and compared with each other detecting outliers or inconsistencies of travel flows and trip purpose specific mobility pattern.

The iterative process of building the passenger matrix ends when variations of the matrix or an input adjustment do not lead to a further reduction of the overall deviation between link loads and corresponding statistics and the consistency of data structure can't be improved. At the process end the resulting air passenger matrix is reflecting the travel flows between two regions consistently by depicting the number of air passengers. As deliverable this air passenger matrix is uploaded to the ETISplus database.

29.3 Data Sources

The list below shows the major data sources for statistics considered for modelling the air passenger flows (information concerning socio-economic data and networks can be found in the dedicated reports).

Note: If a country is not listed, this does not mean, that there are no national sources concerning air transport available at all, but that there were no sources which provided additional information complementing existing Eurostat data. As well it has to be noted that international airports have web sites with plenty of

information concerning schedules, destinations, transport figures and all kind of news. The web sites can be found easily by searching in the internet for the airport name.

The following table provides the most important data sources used.

Table 29-3: Data sources

Country	Data source
International database	http://epp.eurostat.ec.europa.eu (tables avia par and avia paqa)
	www.cia.gov/library/publications/the-world-factbook
	http://www.aci-europe.org/
	www.iata.org/
EU27	
Austria	http://www.statistik.at/web_de/statistiken/verkehr/luftfahrt/index.html
Denmark	http://www.slv.dk/Dokumenter/dscgi/ds.py/View/Collection-70
France	http://www.aeroport.fr/ http://www.developpement-durable.gouv.fr/Note-trimestrielle-de-l.html http://www.data.gouv.fr/ http://www.aerobuzz.fr/ http://www.dgac.fr/ http://www.developpement-durable.gouv.fr/Bulletin-statistique.html
Germany	https://www.destatis.de/DE/Publikationen/Thematisch/TransportVerkehr/ThemaVerkehr.html http://www.adv.aero/verkehrszahlen/
Hungary	http://portal.ksh.hu/pls/ksh/docs/eng/xstadat/xstadat_infra/e_odmj001.html http://www.bud.hu/?tPath=/english/business-and-partners/aviation/aviation_databank/documents_for_all_airlines
Ireland	http://www.cso.ie/px/pxeirestat/Database/Eirestat/Eirestat.asp
Italy	http://www.enac-italia.it/index.htm http://www.enac-italia.it/La_Regolazione_Economica/Statistiche/index.html http://simonas.bartkus.it/blog/
Lithuania	http://statline.cbs.nl/StatWeb/selection/?DM=SLNL&PA=37570HVV&VW=T
Netherlands	http://www.ulc.gov.pl/index.php?option=com_content&task=view&id=324&Itemid=466
Poland	http://www.airport.com.pl/en/show/flight-statistics/year/2010
Spain	http://estadisticas.aena.es/
Sweden	http://www.swedavia.se/sv/Swedavia/press/Trafikstatistik/Utforsligare-flygplatsstatistik1/
United Kingdom	http://www.caa.co.uk/statistics
Candidate countries & EFTA	
Norway	http://www.avinor.no/
Switzerland	http://www.bfs.admin.ch/
Turkey	http://www.turkstat.gov.tr/VeriBilgi.do?tb_id=52&ust_id=15 http://www.turkstat.gov.tr/PrelstatistikTablo.do?istab_id=376
Neighbouring countries	
Serbia	http://webzrs.stat.gov.rs/WebSite/Public/PageView.aspx?pKey=62
Other countries	
Australia	http://www.btre.gov.au/
Russia	http://www.gks.ru/
USA	http://www.transtats.bts.gov/

The following table provides the national statistical services available.

Table 29-4: Availability of national statistics

Country	Organisation	Website
Afghanistan	Central Statistics Office	cso.gov.af
Albania	Institute of Statistics	instat.gov.al
Algeria	Office National de Statistiques	ons.dz
Angola	Instituto Nacional de Estatística (Angola)	ine-ao.com
Anguilla	Statistics Unit	gov.ai
Argentina	Instituto Nacional de Estadística y Censos (INDEC)	indec.gov.ar
Armenia	National Statistical Service of the Republic of Armenia	armstat.am
Australia	Australian Bureau of Statistics (ABS)	abs.gov.au
Austria	Statistics Austria	statistik.at
Azerbaijan	State Statistical Committee of the Azerbaijan Republic	azstat.org
Bahamas	Financial Services Board	bfsb-bahamas.com
Bahrain	Bahrain Monetary Agency	cbb.gov.bh
Bangladesh	Bangladesh Bureau of Statistics	bbs.gov.bd
Barbados	Barbados Statistical Service	barstats.gov.bb
Belarus	National Statistical Committee of the Republic of Belarus	belstat.gov.by
Belize	Belize Central Statistical Office	cso.gov.bz
Benin	Institut national de la statistique et de l'analyse économique French (INSAE)	insae-bj.org
Bhutan	Department of Planning	www.nsb.gov.bt
Bolivia	Instituto Nacional de Estadística	ine.gov.bo
Bosnia	Statistical Institute of Republika Srpska	rzs.rs.ba
Botswana	Central Statistics Office of Botswana	cso.gov.bw
Brazil	Brazilian Institute of Geography and Statistics (IBGE)	ibge.gov.br
Belgium	Statistics Belgium	statbel.fgov.be
Bulgaria	National Statistical Institute of Bulgaria	nsi.bg
Burkina Faso	Institut national de la statistique et de la démographie French (INSD)	insd.bf
Burma	Central Statistical Organization (Burma)	www.csostat.gov.mm
Burundi	Institut de la Statistique et des Études Économiques du Burundi (ISEEBU)	isteebu.bi
Cameroon	Institut national de la statistique French (INS)	statistics-cameroon.org
Cambodia	National Institute of Statistics of Cambodia	nis.gov.kh
Canada	Statistics Canada	statcan.ca
Central African Republic	Institut centrafricain des statistiques, des études économiques et sociales (ICASEES)	stat-centrafrique.com
Cape Verde	Instituto Nacional de Estatística (Cape Verde)	ine.cv
Chad	Institut national de la statistique, des études économiques et démographiques French (INSEED)	inseed-tchad.org
Chile	Instituto Nacional de Estadísticas	ine.cl
China	National Bureau of Statistics of China	stats.gov.cn
Colombia	National Administrative Department of Statistics (Departamento Administrativo Nacional de Estadística) (DANE)-	dane.gov.co
Comoros	Direction de la Statistique	no website
Costa Rica	Instituto Nacional de Estadística y Censos	www.inec.go.cr
Côte d'Ivoire	Institut national de la statistique French (INS)	www.ins.ci

Country	Organisation	Website
Croatia	Central Bureau of Statistics	dzs.hr
Cyprus	Statistical Service of the Republic of Cyprus	www.mof.gov.cy
Czech Republic	Czech Statistical Office	czso.cz
Congo	Centre national de la statistique et des études économiques French (CNSEE)	cnsee.org
Denmark	Statistics Denmark	dst.dk
Djibouti	Direction des statistiques et des études démographiques (DISED)	ministere-finances.dj
Dominican Republic	Oficina Nacional de Estadística	one.gob.do
Ecuador	Instituto Nacional de Estadística y Censos	www.inec.gov.ec
Egypt	Egypt State Information Service	sis.gov.eg
Egypt	CAPMAS	capmas.gov.eg
El Salvador	Dirección General de Estadística y Censos	www.digestyc.gob.sv
Equatorial Guinea	Direction Générale des Statistiques	dgecnstat-ge.org
Eritrea	National Statistics Office	no website
Estonia	Statistics Estonia	stat.ee
Ethiopia	Central Statistical Agency (CSA)	www.csa.gov.et
Finland	Statistics Finland	stat.fi
Fiji	Fiji Islands Bureau of Statistics	www.statsfiji.gov.fj
France	National Institute for Statistics and Economic Studies (INSEE)	insee.fr
France	Institut National d'Études Démographiques (INED)	statistique-publique.fr
Gabon	Direction générale de la statistique et des études économiques French (DGSEE)	www.stat-gabon.ga
Gambia	Central Statistics Department	www.csd.gm
Georgia	National Statistics Office (GeoStat)	geostat.ge
Germany	Statistisches Bundesamt	destatis.de
Ghana	Ghana Statistical Services	statsghana.gov.gh
Greece	National Statistical Service of Greece	statistics.gr
Guatemala	Instituto Nacional de Estadística	ine.gob.gt
Guinea	Direction nationale de la statistique French (DNS)	stat-guinee.org
Guinea-Bissau	Instituto Nacional de Estadística e Censos	stat-guinebissau.com
Guyana	Guyana Bureau of Statistics	statisticsguyana.gov.gy
Honduras	Instituto Nacional de Estadística y Censos	ine-hn.org
Hong Kong	Census and Statistics Department	censtatd.gov.hk
Hungary	Hungarian Central Statistical Office - Központi Statisztikai Hivatal	portal.ksh.hu
Iceland	Statistics Iceland	Statice.is
India	Indian Statistical Institute	mospi.nic.in
India	Indian Agricultural Statistics Research Institute,	censusindia.gov.in
Indonesia	Statistics Indonesia	bps.go.id
Iran	Statistical Centre of Iran	www.sci.org.ir
Ireland	Central Statistics Office of Ireland	cso.ie
Israel	Israel Central Bureau of Statistics	cbs.gov.il
Italy	Istituto Nazionale di Statistica (ISTAT)	istat.it
Jamaica	Statistical Institute of Jamaica	statinja.com
Japan	Bureau of Statistics	stat.go.jp
Jordan	The Hashemite Kingdom of Jordan-Department of Statistics	www.dos.gov.jo

Country	Organisation	Website
Kazakhstan	Agency of the Republic of Kazakhstan on statistics	eng.stat.kz
Kenya	Kenya national bureau of statistics(KNBS)	cbs.go.ke
Kiribati	Kiribati Statistics Office	www.spc.int
Kosovo	Statistical Office of Kosovo	esk.rks-gov.net
Kyrgyzstan	National Statistical Committee of Kyrgyz Republic	stat.kg
Laos	National Statistical Centre	nsc.gov.la
Latvia	Central Statistical Bureau of Latvia	www.csb.gov.lv
Lebanon	Central Administration for Statistics (CAS)	www.cas.gov.lb
Lesotho	Bureau of Statistics	www.bos.gov.ls
Liberia	Liberia Institute of Statistics and Geo-Information Services (LISGIS)	lisgis.gov.lr
Lithuania	Department of Statistics of Lithuania	www.stat.gov.lt
Macedonia	Statistical Office of Macedonia	www.stat.gov.mk
Madagascar	Institut National de la Statistique French (INSTAT)	instat.mg
Malawi	National Statistical Office	nso.malawi.net
Malaysia	Department of Statistics-Malaysia	statistics.gov.my
Maldives	Ministry of Planning and National Development	planning.gov.mv
Mali	Institut national de la statistique French (INSTAT)	instat.gov.ml
Malta	National Statistics Office (NSO)	nso.gov.mt
Marshall Islands	Office of Management and Statistics	www.spc.int
Mauritania	Office national de la statistique French (ONS)	ons.mr
Mauritius	Central Statistical Office	statsmauritius.gov.mu
Federated States of Micronesia	Federated States of Micronesia Division of Statistics	www.spc.int
Mexico	National Institute of Statistics, Geography and Data Processing (INEGI)	www.inegi.org.mx
Moldova	National Bureau of Statistics of the Republic of Moldova	statistica.md
Monaco	Institut Monégasque de la Statistique et des Etudes Economiques	gouv.mc
Mongolia	National Statistical Office	www.nso.mn
Montenegro	Statistical Office of Montenegro	monstat.org
Morocco	Direction de la Statistique	www.insea.ac.ma
Mozambique	Instituto Nacional de Estatística (Moçambique)	www.ine.gov.mz
Namibia	Central Bureau of Statistics National Planning Commission	www.mpc.gov.na
Nepal	Central Bureau of Statistics	cbs.gov.np
The Netherlands	Centraal Bureau voor de Statistiek	cbs.nl
New Zealand	Statistics New Zealand	stats.govt.nz
Nicaragua	Instituto Nacional de Estadística y Censos	www.inec.gob.ni
Niger	Institut national de la statistique French (INS)	www.stat-niger.org
Nigeria	National Bureau of Statistics (Nigeria)	nigerianstat.gov.ng
Norway	Statistics Norway	ssb.no
Oman	Ministry of National Economy	mone.gov.om
Palestinian Authority	Palestinian Central Bureau of Statistics	pcbs.gov.ps
Pakistan	Statistics Division - Government of Pakistan	statpak.gov.pk
Panama	Dirección de Estadística y Censo	contraloria.gob.pa
Papua New Guinea	National Statistical Office of Papua New Guinea	www.spc.int

Country	Organisation	Website
Paraguay	Dirección General de Estadísticas, Encuestas y Censos	www.dgeec.gov.py
Peru	Instituto Nacional de Estadística e Informática	www.inei.gob.pe
Philippines	National Statistics Office (NSO)	www.census.gov.ph
Philippines	National Statistical Coordination Board (NSCB)	www.nscb.gov.ph
Poland	Central Statistical Office (GUS)	stat.gov.pl
Portugal	Instituto Nacional de Estatística (INE)	ine.pt
Romania	National Institute of Statistics	insse.ro
Russia	Federal State Statistics Service	gks.ru
Rwanda	National institute of statistics of Rwanda (NISR)	statistics.gov.rw
Samoa	Statistical Services Division	www.spc.int
San Marino	Ufficio Programmazione Economica Centro Elaborazione Dati e Statistica (UPECEDS)	statistica.sm
Sao Tome and Principe	Instituto Nacional de Estatística (São Tomé e Príncipe)	ine.st
Saudi Arabia	Central Department of Statistics	planning.gov.sa
Senegal	Agence nationale de la statistique et de la démographie (French) (ANSI)	ansd.sn
Serbia	Statistical office of the Republic of Serbia	webzrs.stat.gov.rs/axd/en/
Seychelles	National Statistics Bureau	nsb.gov.sc
Sierra Leone	Statistics Sierra Leone	statistics.sl
Slovakia	Statistical Office of the Slovak Republic	statistics.sk
Slovenia	Statistical Office of the Republic of Slovenia	www.stat.si
Solomon Islands	Solomon Islands Statistics	www.spc.int
South Africa	Statistics South Africa	www.statssa.gov.za
South Korea	Statistics Korea (KOSTAT)	kostat.go.kr
Sri Lanka	Department of Census and Statistics	www.statistics.gov.lk
Saint Lucia	Government Statistics Department	stats.gov.lc
Spain	National Statistics Institute (INE)	ine.es
Sudan	Central Bureau of Statistics of Sudan	cbs.gov.sd
Swaziland	Central Statistics Office of Swaziland	www.gov.sz
Sweden	Statistics Sweden	scb.se
Switzerland	Swiss Federal Statistical Office FSO	bfs.admin.ch
Syria	Central Bureau of Statistics in Syria	cbssyr.org
Tajikistan	State Committee on Statistics of Tajikistan	stat.tj
Tanzania	Bureau of Statistics (Tanzania)	nbs.go.tz
Thailand	National Statistical Office of Thailand (NSO)	web.nso.go.th
Togo	Direction générale de la statistique et de la comptabilité nationale French (DGSCN)	stat-togo.org
Tonga	Government of Tonga-Statistics Department	www.spc.int
Trinidad and Tobago	Central Statistical Office	cso.gov.tt
Tunisia	Institut National de la Statistique of Tunisia (INS)	www.ins.nat.tn
Turkey	Turkish Statistical Institute	www.turkstat.gov.tr
Turkmenistan	State Committee of Turkmenistan on Statistics	stat.gov.tm
Uganda	Uganda Bureau of Statistics	www.ubos.org
Ukraine	State Statistics Committee of Ukraine	ukrstat.gov.ua
United Arab	United Arab Emirates Ministry of Economy Statistic Reports	economy.ae

Country	Organisation	Website
Emirates		
Uruguay	Instituto Nacional de Estadística	www.ine.gub.uy
Uzbekistan	State Committee of the Republic of Uzbekistan on Statistics	stat.uz
United Kingdom	Office for National Statistics (ONS)	www.statistics.gov.uk
United States	United States Census Bureau	census.gov
United States	Bureau of Labor Statistics (BLS)	bls.gov
United States	National Center for Education Statistics (NCES)	nces.ed.gov
United States	Energy Information Administration (EIA)	eia.doe.gov
United States	National Agricultural Statistics Service (NASS)	www.nass.usda.gov
United States	Bureau of Justice Statistics (BJS)	ojp.usdoj.gov/bjs
United States	Bureau of Economic Analysis (BEA)	bea.gov
United States	National Center for Health Statistics (NCHS)	cdc.gov/nchs
Vanuatu	Vanuatu national Statistics Office (VNSO)	www.spc.int
Venezuela	Oficina Central de Estadística e Informática	www.ine.gov.ve
Vietnam	General Statistics Office	www.gso.gov.vn
Zambia	Central Statistical Office of Zambia	www.zamstats.gov.zm
Zimbabwe	Central Statistical Office of Zimbabwe	www.zimstat.co.zw

Please note that the collection of national statistical services is maintained on the following web site http://en.wikipedia.org/wiki/List_of_national_and_international_statistical_services and we recommend checking the latest updates as internet addresses change from time to time.

29.4 Results

Table 29-5: Air passenger trips, key results

Access via	Collection	Group	Description
ETIS View	Modelled Data	Passenger	Air passengers by O/D and trip purpose. Flows by airport also available in airport database (see Airports, Ports, Terminals theme)
2010	http://viewer.etisplus.net/ select collection: ETISplus-2010-Modelled highlight: Passenger open table: Passenger transport by air at regional level		
2005	http://viewer.etisplus.net/ select collection: ETISplus-2005-Modelled highlight: Passenger open table: Passenger transport by air at regional level		

The following table summarises the passenger flows by air **departing** per country, differentiated by areas of destination for the year 2010. Figures are given in million passengers. For the opposite direction flows are identical.

Note that these flows are according to true origin and true destination, i.e. a passenger who has travelled from Brussels to India is counted just once in the field Belgium to Asia, irrespective if travelling to India from Brussels airport by a direct flight, using a flight connection via an intermediate airport (e.g. Frankfurt or London) or first travelled by train to Paris airport and then by a nonstop flight to India from there. In consequence, a passenger originating in Alsace (France), travelling to Hamburg by taking a flight from the airport of Karlsruhe in Germany, which is situated just across the border from France, is counted as a trip from France to Germany, although the traveller has used a domestic flight within Germany.

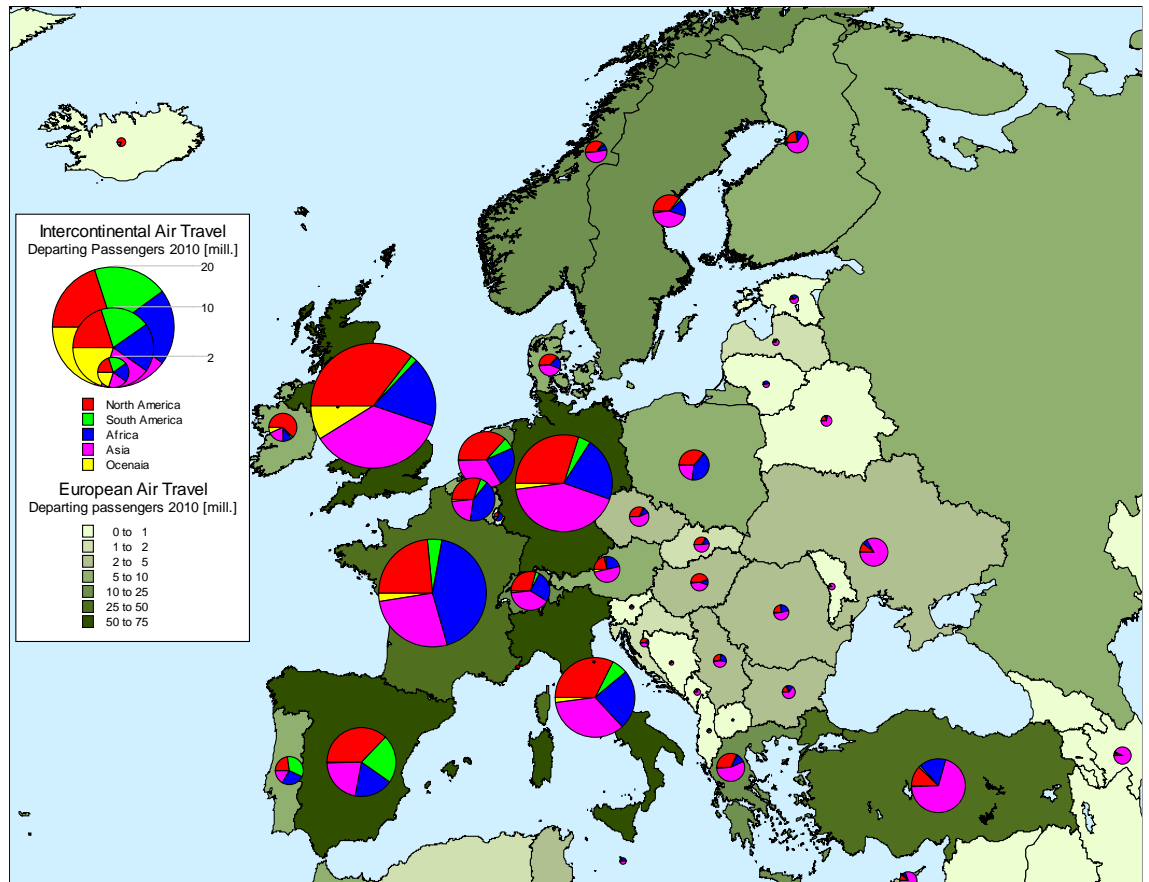
Table 29-6: 2010 passenger flows by air to selected destinations (million)

Country Name	domestic	Europe (incl. Domestic)	Africa	Asia	Oceania	North America	South America	Total
Austria	0.393	6.100	0.326	0.692	0.057	0.297	0.031	7.503
Belgium	0.029	7.231	1.371	0.695	0.055	1.013	0.170	10.535
Bulgaria	0.138	2.077	0.062	0.243	0.004	0.070	0.005	2.462
Switzerland	0.085	10.070	0.725	1.113	0.036	0.820	0.085	12.849
Cyprus	0.000	3.498	0.042	0.528	0.006	0.075	0.013	4.162
Czech Republic	0.071	3.870	0.087	0.445	0.003	0.256	0.005	4.666
Germany	16.506	56.911	2.858	5.695	0.274	4.007	0.534	70.279
Denmark	0.943	7.210	0.173	0.444	0.022	0.386	0.022	8.256
Estonia	0.000	0.605	0.044	0.098	0.001	0.020	0.003	0.770
Spain	26.981	74.244	1.357	1.616	0.049	2.798	1.699	81.763
Finland	1.312	5.458	0.094	0.637	0.012	0.221	0.020	6.442
France	20.061	45.746	6.920	4.342	0.426	3.789	0.693	61.917
Greece	4.502	14.843	0.158	0.895	0.016	0.511	0.031	16.454
Croatia	0.254	1.616	0.025	0.073	0.007	0.073	0.003	1.797
Hungary	0.001	3.385	0.064	0.284	0.009	0.285	0.006	4.033
Ireland	0.227	9.689	0.151	0.263	0.100	0.936	0.033	11.172
Iceland	0.000	0.623	0.007	0.023	0.002	0.146	0.004	0.806
Italy	24.185	52.478	2.290	3.335	0.216	3.106	0.641	62.065
Liechtenstein	0.000	0.034	0.003	0.005	0.001	0.007	0.001	0.051
Lithuania	0.000	0.974	0.039	0.059	0.001	0.010	0.002	1.085
Luxembourg (Grand-Duché)	0.000	0.476	0.116	0.028	0.003	0.049	0.010	0.682
Latvia	0.000	1.430	0.020	0.102	0.001	0.021	0.003	1.576
Malta	0.000	1.270	0.035	0.045	0.002	0.013	0.003	1.368
Netherlands	0.006	12.757	1.201	1.760	0.038	1.930	0.367	18.054
Norway	10.318	17.362	0.084	0.474	0.015	0.329	0.034	18.298
Poland	0.671	8.751	0.653	0.369	0.008	0.587	0.016	10.384
Portugal	1.526	9.388	0.397	0.245	0.008	0.336	0.522	10.898
Romania	0.729	4.390	0.102	0.246	0.006	0.108	0.007	4.860
Sweden	3.967	14.049	0.328	0.818	0.033	0.679	0.047	15.953

Country Name	domestic	Europe (incl. Domestic)	Africa	Asia	Oceania	North America	South America	Total
Slovenia	0.001	0.577	0.016	0.038	0.004	0.020	0.002	0.657
Slovakia	0.058	1.660	0.054	0.238	0.003	0.150	0.015	2.120
Turkey	12.935	28.801	0.743	3.274	0.018	0.573	0.049	33.459
United Kingdom	12.552	67.838	3.737	7.434	1.803	7.306	0.379	88.496
Azerbaijan	0.000	0.399	0.010	0.560	0.001	0.026	0.002	0.998
Guernsey	0.000	0.457	0.003	0.013	0.002	0.007	0.001	0.483
Jersey	0.000	0.501	0.007	0.015	0.002	0.006	0.001	0.531
Bosnia and Herzegovina	0.007	0.346	0.009	0.037	0.002	0.016	0.001	0.411
Gibraltar (UK)	0.000	0.067	0.002	0.002	0.000	0.002	0.000	0.074
Greenland (DK)	0.000	0.051	0.001	0.002	0.000	0.001	0.000	0.056
Faroe Islands (DK)	0.000	0.083	0.001	0.002	0.000	0.001	0.000	0.088
Jan Mayen	0.000	0.021	0.001	0.001	0.000	0.000	0.000	0.024
Isle of Man	0.000	0.342	0.002	0.004	0.001	0.002	0.001	0.351
Andorra	0.000	0.012	0.001	0.002	0.000	0.001	0.000	0.017
Monaco	0.000	0.098	0.004	0.007	0.001	0.027	0.001	0.137
Albania	0.001	0.806	0.009	0.028	0.001	0.015	0.002	0.861
Armenia	0.000	0.134	0.004	0.394	0.001	0.006	0.001	0.540
San Marino	0.000	0.027	0.002	0.005	0.000	0.001	0.000	0.035
Serbia	0.123	2.129	0.091	0.167	0.010	0.098	0.002	2.497
Montenegro	0.014	0.573	0.008	0.086	0.002	0.024	0.001	0.694
Svalbard	0.000	0.082	0.001	0.001	0.000	0.001	0.000	0.086
Former Yugoslav Republic of Macedonia	0.000	0.176	0.005	0.012	0.001	0.004	0.001	0.199
Belarus	0.000	0.350	0.022	0.203	0.002	0.055	0.003	0.634
Ukraine	0.872	2.549	0.091	1.308	0.007	0.172	0.009	4.136
Moldova, Republic of	0.000	0.264	0.002	0.110	0.000	0.016	0.000	0.393

The following map displays the passenger flows departing from European countries by the area of destination for the year 2010. While the circles per country inform about volume and structure of intercontinental demand in air travel, country specific colouring shows the amount of air travel towards European destinations.

Figure 29-3: Intercontinental Air Travel, 2010



The amount of passenger demand from countries / regions outside Europe and European destinations is shown in the following table.

Figure 29-4: Air passenger Demand, 2010

ETIS ID	Country Name	Departing passengers	ETIS ID	Country Name	Departing passengers
201	Egypt	6.197	216	Swaziland	0.009
202	British Indian Ocean Territory (Chagos Archipelago) (UK)	0.017	217	Angola	0.183
203	Burkina Faso	0.072	218	Benin	0.053
204	Central African Republic	0.015	219	Botswana	0.015
205	Algeria	1.736	220	Burundi	0.027
206	Congo, the Democratic Republic of the	0.106	221	Cameroon	0.140
207	Ethiopia	0.295	222	Cape Verde	0.214
208	Nigeria	0.532	223	Chad	0.029
209	Sao Tome and Principe	0.022	224	Côte d'Ivoire	0.147
211	Gabon	0.083	225	Djibouti	0.016
212	Comoros	0.007	226	Equatorial Guinea	0.059
213	Mauritania	0.105	227	Ghana	0.233
214	Lesotho	0.011	228	Guinea	0.050
215	Morocco	5.291	229	Guinea Bissau	0.017
			230	Kenya	0.668

ETIS ID	Country Name	Departing passengers
231	Liberia	0.045
232	Madagascar	0.162
233	Malawi	0.010
234	Mali	0.128
235	Mauritius	0.725
236	Mozambique	0.055
237	Namibia	0.099
238	Niger	0.031
239	Senegal	0.459
240	Seychelles	0.126
241	Sierra Leone	0.121
242	South Africa	1.487
243	Gambia	0.090
244	Tunisia	3.834
245	Uganda	0.163
246	Congo	0.091
247	Zambia	0.079
248	Zimbabwe	0.041
249	Sudan	0.087
250	Libyan (Arab Jamahiriya)	0.366
251	Rwanda	0.039
252	Somalia	0.067
253	Eritrea	0.054
254	Mayotte (FR)	0.089
255	Togo	0.036
256	Tanzania (United Republic of)	0.272
257	Western Sahara	0.026
301	Korea (Democratic People's Republic of) (North)	0.028
302	Sri Lanka	0.504
303	Georgia	0.297
304	Jordan (Hashemite Kingdom of)	0.487
305	Hong Kong (special administrative region of China)	1.107
306	Papua New Guinea	0.343
307	Iran (Islamic Republic of)	0.665
308	Pakistan	0.885
309	Afghanistan	0.061
310	Japan	2.757
311	Bhutan	0.040
312	Cambodia (Kingdom of)	0.032
313	Nepal	0.491
314	Saudi Arabia	0.674
315	Thailand	2.254
316	Kyrgyzstan	0.092
317	Lao People's Democratic Republic	0.052
318	Lebanon	0.668

ETIS ID	Country Name	Departing passengers
319	Macau (special administrative region of China)	0.044
320	Malaysia	0.495
321	Mongolia	0.029
322	Brunei Darussalam	0.072
324	Bangladesh	0.280
325	Iraq	0.194
326	Korea (Republic of) (South)	0.705
327	Maldives	0.314
328	Singapore	1.281
329	Tajikistan	0.080
330	Uzbekistan	0.230
331	Yemen (Republic of)	0.106
332	Philippines	0.410
333	Vietnam	0.357
334	Spratly Islands	0.000
335	Bahrain	0.302
336	Israel	3.055
337	Kuwait	0.306
338	Qatar	0.681
339	Oman	0.366
340	Syrian Arab Republic	0.446
341	Taiwan	0.323
342	Turkmenistan	0.166
343	Myanmar	0.192
344	United Arab Emirates	3.111
345	China	3.038
346	Indonesia	0.386
347	India	3.033
348	Russian Federation	8.098
349	Kazakhstan	0.472
350	Palestinian Authority	0.198
401	Cook Islands (NZ)	0.015
402	Northern Mariana Islands (US)	0.005
403	Federated States of Micronesia	0.004
404	Independent State of Samoa	0.006
405	Tonga	0.020
406	Montserrat (UK)	0.008
407	New Zealand	0.288
408	Pitcairn (UK)	0.008
409	Kiribati	0.005
410	Nauru	0.003
411	Palau (US)	0.005
412	Vanuatu	0.009
413	Fiji	0.017
414	Marshall Islands (US)	0.003
415	St. Helena (UK)	0.022

ETIS ID	Country Name	Departing passengers
416	Solomon Islands	0.010
417	American Samoa (US)	0.019
418	Cocos (Keeling) Islands (AU)	0.003
419	French Polynesia (FR)	0.037
420	Guam (US)	0.006
421	Heard and McDonald Islands (AU)	0.007
423	Norfolk Island (AU)	0.006
424	Wallis and Futuna Islands (FR)	0.010
425	Tuvalu	0.008
426	Australia	2.495
427	New Caledonia (FR)	0.032
501	Antigua and Barbuda	0.063
502	Belize	0.020
503	Bahamas	0.037
504	Puerto Rico (US)	0.077
505	Dominican Republic	1.155
506	Aruba (NL)	0.091
508	Barbados	0.246
509	Bermuda (UK)	0.062
510	Cayman Islands (UK)	0.024
511	Dominica	0.020
514	St. Christopher (St. Kitts) and Nevis	0.013
515	Grenada	0.040
517	Jamaica	0.300
521	Costa Rica	0.153
522	Cuba	0.764
523	El Salvador	0.023
524	Guatemala	0.141
525	Haiti	0.070
526	Honduras	0.062
527	Nicaragua	0.084
528	Panama	0.157
529	Saint Lucia	0.081
530	Saint Vincent and the Grenadines	0.037
531	St. Pierre and Miquelon (FR)	0.005
532	Anguilla (UK)	0.035
533	Turks and Caicos Islands (UK)	0.009
535	British Virgin islands (UK)	0.019
536	Virgin Islands of the United States (US)	0.030
538	Mexico	1.527
539	Canada	3.688
540	United States	22.277
541	United States Minor Outlying Islands (US)	0.007
601	Argentina	0.798
602	Venezuela	0.388

ETIS ID	Country Name	Departing passengers
603	Guyana	0.063
604	Falkland Islands (Malvinas) (UK)	0.004
607	Uruguay	0.072
608	Bolivia	0.063
609	Colombia	0.401
610	Ecuador	0.269
611	Paraguay	0.087
612	Peru	0.376
613	Suriname	0.101
614	Trinidad and Tobago	0.076
615	South Georgia and the South Sandwichs Islands (UK)	0.005
616	Chile	0.293
617	Brazil	2.112
618	Netherland Antilles (NL)	0.257
701	French southern territories (FR)	0.008
702	Antarctica	0.004

30 Bus and Coach Passenger Matrix

30.1 Scope of the databases

Table 30-1: Overview of the dataset, Bus and Coach Passengers

Bus and Coach Passenger matrix						
Data feature	Data specification					Remarks
Base year	2010					
Scope of data	Link	Terminal	O/D relation	Region	Other	
	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
GIS data	Yes	No				
	<input type="checkbox"/>	<input checked="" type="checkbox"/>				
Country coverage	<div>Completely</div> <div>Partially</div>					
	EU 27		<input checked="" type="checkbox"/>	<input type="checkbox"/>		
	Candidate countries & EFTA		<input checked="" type="checkbox"/>	<input type="checkbox"/>		
	Neighbouring countries		<input checked="" type="checkbox"/>	<input type="checkbox"/>		
	TRACECA		<input type="checkbox"/>	<input type="checkbox"/>		
	MEDA		<input type="checkbox"/>	<input type="checkbox"/>		
	Other countries		<input type="checkbox"/>	<input type="checkbox"/>		
	Total number of countries covered:		42			
Main data sources	See below for more details					
Main type of data generation	Observed	<input type="checkbox"/>				
	Harmonized	<input type="checkbox"/>				
	Modelled	<input checked="" type="checkbox"/>				

30.2 Data structure

30.2.1 Passenger transport by bus dataset

Table 30-2: Data Structure, bus dataset

Indicator	Description of indicator	Unit
Origin Zone	Origin Zone ID at NUTS3 level	
Destination Zone	Destination Zone ID at NUTS3 level	
Trip Purpose	Trip purpose	
Passenger trips by bus	Yearly trips	trips/year

The "Passenger transport by bus" dataset contains the following information:

- Intra-zonal trips by bus (local public transport)
- Inter-zonal trips by regular scheduled national and international long distance coach services.

Demand for non-scheduled long-distance services (e.g. touristic coach services) and short-distance services between ETIS Zoning level 3 regions is not covered.

Data is differentiated by four trip purposes:

- Business (trips for working purposes with different destination than the usual workplace),
- Private (non business related trips with duration of up to 4 days),
- Vacation (non-business trips with duration of more than 4 days),
- Commuting (daily trips for working or studying purposes).

It is assumed that:

- There are no Vacation trips for intra-zonal trips (local demand)
- There are no Business and Commuting trips for long-distance inter-zonal trips

The matrix is not in the GA (Generation Attraction) format, but in the OD (Origin Destination) format.

This implies that:

- the number of trips between zone A and zone B is the total number of trips occurring between the two zones and it is provided regardless of the nationality of travellers;
- the matrix is symmetric.

30.2.2 Passenger trips by coach dataset

Table 30-3: Data Structure, coach dataset

Indicator	Description of indicator	Unit
Origin Zone	Origin Zone ID at NUTS3 level	
Destination Zone	Destination Zone ID at NUTS3 level	
Trip Purpose	Trip purpose	
Passenger trips by regular long distance scheduled coach services	Yearly trips	trips/year

The "Passenger trips by coach" dataset contains only the information on Inter-zonal trips by regular scheduled national and international long distance coach services.

Demand for non-scheduled long-distance services (e.g. touristic coach services) and short-distance services between ETIS Zoning level 3 regions is not covered.

Data is differentiated by four trip purposes:

- Business (trips for working purposes with different destination than the usual workplace),
- Private (non business related trips with duration of up to 4 days),
- Vacation (non-business trips with duration of more than 4 days),
- Commuting (daily trips for working or studying purposes).

It is assumed that:

- There are no Business and Commuting trips by regular long distance scheduled coach services.

The matrix is not in the GA (Generation Attraction) format, but in the OD (Origin Destination) format.

This implies that:

- the number of trips between zone A and zone B is the total number of trips occurring between the two zones and it is provided regardless of the nationality of travellers;
- the matrix is symmetric.

30.3 Methodology - Intra-zonal trips by bus (local public transport)

Two different methodologies are adopted for the production of the information included into these datasets.

A first one is related to the production of a) Intra-zonal trips by bus (local public transport); a second one is used for the modelling of b) Inter-zonal trips by regular scheduled national and international long distance coach services.

Here below the description of both approaches is provided. The estimation of local demand has a general common approach for all considered transport modes (car, rail, bus, tram&metro, walking and cycling) but some differences exist for each transport mode.

The methodology heavily relies on available observed data: EUROSTAT and other international organizations statistics, national statistics, mobility studies, census data, National Travel Surveys, dedicated reports on public transport performances etc.

Here below the main steps of the modelling framework are explained.

30.3.1 Estimation of total trips by bus

The first step for the estimation consisted in collecting available data on transport demand by bus mode both in terms of passengers carried and passenger-km.

Data was gathered from several available sources and it varies from National transport statistics, mobility studies, national travel surveys, census data, dedicated reports etc.

In the most of the cases statistics are available only at national level or at a more aggregate level than the one adopted by the ETIS zoning system. Therefore the methodology deeply focused on assumptions to model traffic data at zone level by starting from more aggregate information.

As far as concerns data on bus and coaches transport, in some cases it is not clear if the collected figures are related to scheduled long-distance services only or include also data on urban public transport performances. In fact, in some cases the analysis of national statistics proved that ETIF figures (in terms of buses and coaches pass-km) don't include urban traffic even though it is not explicitly mentioned in the footnotes.

When local public transport data is provided with some detail, generally a differentiation in Urban and Interurban is given, but it poses some difficulties in the classification of data according to distance bands (see below) and therefore some assumptions were needed for the comparison of estimated vs observed data.

30.3.2 Zones and distance bands

The zoning system adopted for the estimation of 2010 local demand is the ETIS2006_zone_level3. The estimation of local demand is made for 39 countries: EU 27 + Accession + EFTA and the neighbouring countries Albania, Bosnia and Herzegovina, Montenegro, Serbia and Kosovo (1537 zones in total).

Four distance bands have been defined for the estimation of local transport demand:

Distance Band 1: trips between 0 and 3 Km
Distance Band 2: trips between 3 and 25 Km
Distance Band 3: trips between 25 and 50 Km
Distance Band 4: trips > 50 km.

The definition of these bands was made in relation to:

- Dimensions of ETISplus zoning system;
- Classifications currently used in available National Travel Surveys or other existing documentation.

In particular the first distance band is related to very short trips and to trips by slow modes (walking and cycling). Distance bands 1 and 2 can be considered with a certain approximation as representative of urban trips, whereas the distance bands 3 and 4 are representative of interurban trips; particularly, distance band 4 is related to those trips, longer than 50 km, which start and end within the traffic zone.

The first step of the methodology was to identify the distance bands belonging to each zone; this was made by considering the dimension of the zone and in particular a "virtual" diameter derived by approximating the zone to a circle.

All ETIS zones have the first and the second distance bands; 1202 zones have the third distance band and 686 zones have also the fourth distance band.

In several cases the defined distance bands intercept the dimension of the "virtual" diameter. As an example the zone AT111 Mittelburgenland has a virtual diameter of about 30km. This implies that 100% of the trips within the first distance band (between 0 and 3 Km) can be supposed to start and end within the zone; in similar way, 100% of the trips belonging to the second distance band (trips between 3 and 25 Km) can be considered within the zone, but only a certain rate of the trips belonging to the third distance band (between 25 and 50 Km) can be supposed to start and end within the zone. Therefore for the distance bands that cross the virtual dimension of the zone the share of trips supposed to be intra-zonal is computed as a function of the virtual diameter and the upper threshold of the band.

For those zones that have the "virtual" diameter >50 Km (fourth distance band) it is assumed that the share of trips within the Level zone 3 is a function of the ratio between the "virtual" diameter and a fixed threshold of 150Km.

30.3.3 Distribution by distance bands

The distribution of total generated trips within each distance band is made by deriving national coefficients from available sources. For some countries, it is possible to derive the share of trips by transport mode and by the defined distance band from available National Travel Surveys.

As an example from German National Travel Survey it can be derived that 20.6% of trips by bus are within the first distance band; 71.1% of trips are within the

second distance band; 3.3% in the third distance band and the remaining 5% is longer than 50 km. It is assumed that these rates (by mode) apply to all trips generated by each single zone in the country.

From the available National Travel Surveys it is also possible to derive information on the average trip length within each distance band by transport mode. As an example from German National Travel Survey it can be derived that the average distance of the trips between 0 and 3 Km made by bus is 1.97 Km; the average distance of the trips between 3 and 25 Km is 8.8 Km; and the average distance of the trips between 25 and 50 Km is 32.7.

For those countries where no national travel survey is available, similar rates have been estimated and further refined on the basis of additional information when available (e.g. comparison of observed urban trips with total trips within the two first distance bands).

30.3.4 Distribution by Trip Purpose

The last step of the estimation consisted in the distribution of trips by purpose. Based on the information provided by several national travel surveys, the shares of trips by bus and by purpose have been derived at national level. The distribution covered commuting, business and private trip purposes. Where information was not available, data from similar countries has been used as reference.

An additional step was made to include the different characteristics of zones with regard to the amount of Economically Active population. For this purpose, the shares previously computed at national level have been adjusted according to the characteristics of the zones at Zone3 level: based on the ratio between active and total population by zone, the share of commuting and business trips have been increased/decreased depending on the difference with respect to the average national value.

Additional assumptions were made in order to take into account the additional share of tourists travelling by bus in some attractive zones (e.g. capital or other touristic cities); for these specific zones the share of private trips was adjusted based on the estimated comparison between the potential usage of these services by tourists (assumed to be 3 days/tourist in average) and the potential usage by residents (assumed to be 365 days/resident).

30.3.5 Final comparison

Unlike the other transport modes (car and rail) which provide an overall estimation of both intra and inter-zonal demand, the estimation of local demand by bus is not accompanied by a complete estimation of inter-zonal matrices at Level3 zones since the methodology adopted for the production of inter-zonal car and rail matrices does not cover the bus mode. Therefore all possible comparisons against statistics are not exhaustive and can be made only in terms of the share of estimated intra-zonal demand on total demand by bus.

The final comparison of the estimation of intra-zonal demand by bus (local public transport) in terms of trips is based on statistics collected from national sources when available (EUROSTAT does not provide statistics in terms of total trips by bus).

Collected statistics are available at national level and in some cases provide the detail of Urban Traffic which is compared with the sum of the first and second distance band (0 to 25 km). The final comparison in terms of pass-km is based on EUROSTAT ETIF figures in terms of buses and coaches pass-km. See below for additional comments on data sources.

30.4 Data Sources

The modelling of local passenger demand has benefited from an extensive data collection; data was gathered from several available sources and it varies from transport statistics, mobility studies, national travel surveys, census data, dedicated reports etc.

As a general remark, it has to be stated that usually traffic data are not available at zone level; in the most of the cases statistics are available at national level or at a more aggregate level than the one adopted by the ETIS zoning system. Therefore in the most of the cases assumptions were needed in order to estimate traffic data at zone level by starting from more aggregate information.

Statistics are generally more available for public transport than for private transport.

As far as concerns data on bus and coaches transport, in some cases it is not clear if the provided figures are related to scheduled long-distance services only or include also data on urban public transport performances.

In fact, in some cases the analysis of national statistics proved that ETIF figures (in terms of buses and coaches pass-km) don't include urban traffic even though it is not explicitly mentioned in the footnotes.

When local public transport data is provided with some detail, generally a differentiation in Urban and Interurban is given, but it poses some difficulties in the classification of data according to distance bands and therefore some assumptions were needed for the comparison of estimated vs observed data.

Here below the list of data sources considered for the modelling on intra zone passenger trips by bus mode is reported.

Table 30-4: Data sources

Country	Data source
International database	ec.europa.eu/transport/publications/statistics/pocketbook-2010_en.htm http://stats.oecd.org UNECE Transport Division Database http://w3.unece.org
EU27	
Austria	www.statistik.at
Belgium	http://www.plan.be

Country	Data source
Bulgaria	Data Collected from Bulgarian Ministry of Transport
Czech Republic	www.czso.cz
Denmark	http://www.statbank.dk National Travel Survey
Estonia	www.stat.ee
Finland	www.stat.fi National Travel Survey http://www.hlt.fi
France	www.developpement-durable.gouv.fr www.insee.fr National Travel Survey
Germany	www.destatis.de National Travel Survey
Greece	www.oasa.gr
Hungary	www.ksh.hu
Ireland	http://census.cso.ie
Italy	www.istat.it www.isfort.it
Latvia	www.stat.gov.lt
Netherlands	Mobiliteitsonderzoek Nederland 2007 National Travel Survey
Poland	www.stat.gov.pl
Romania	Data Collected from Romanian Ministry of Transport
Slovakia	www.statistics.sk
Spain	http://www.ine.es
Sweden	www.sl.se National Travel Survey http://www.sika-institute.se/
United Kingdom	www.tfl.gov.uk www.dft.gov.uk/statistics National Travel Survey
Candidate countries & EFTA	
Croatia	Data Collected from Croatian Ministry of Transport
Norway	www.ssb.no
Switzerland	www.bfs.admin.ch
Turkey	www.turkstat.gov.tr
Neighbouring countries	
Bosnia and Herzegovina	Data Collected from Ministry of Transport of Bosnia and Herzegovina
Serbia	Data Collected from Ministry of Transport of Serbia

30.5 Results, bus passengers

Here below the table summarizing the modelled passenger trips by bus (only intra zone trips) by country is provided together with a comparison on available statistics on observed trips by bus at urban level.

Table 30-5: Bus passenger results, 2010, (trips)

Country	Modelled passenger trips by bus (intra-zonal)	Modelled passenger trips by bus (intra-zonal <= 25 km)	Observed passenger trips by bus - Urban
EU27			
Austria	498,703,693	449,059,517	-
Belgium	647,188,018	605,942,781	-
Germany	4,752,381,874	4,665,908,168	-
Denmark	283,568,183	251,266,969	-
Spain	2,159,608,090	1,737,960,357	1,732,632,000
Finland	303,439,043	257,139,523	-
France	3,153,808,711	2,888,549,386	-

Country	Modelled passenger trips by bus (intra-zonal)	Modelled passenger trips by bus (intra-zonal <= 25 km)	Observed passenger trips by bus - Urban
Greece	976,116,484	826,567,714	-
Ireland	258,715,818	217,500,000	-
Italy	5,633,462,492	4,968,615,586	-
Luxembourg (Grand-Duché)	38,051,521	30,960,000	-
Netherlands	871,650,587	808,031,951	-
Portugal	648,447,510	581,417,260	-
Sweden	670,533,490	594,418,716	-
United Kingdom	4,320,824,398	4,229,958,533	-
Bulgaria	479,770,834	412,301,659	-
Cyprus	39,859,681	27,104,583	-
Czech Republic	1,228,749,683	1,082,174,987	-
Estonia	148,045,481	127,720,000	-
Hungary	982,754,629	905,752,004	-
Lithuania	369,225,167	346,200,597	339,232,700
Latvia	150,481,689	140,888,593	-
Malta	35,604,217	35,604,217	-
Poland	3,199,212,717	2,896,241,307	-
Romania	1,101,942,431	1,021,106,642	1,119,862,900
Slovenia	101,375,669	84,222,458	82,789,000
Slovakia	674,963,549	586,581,240	-
Candidate countries & EFTA			
Switzerland	884,598,393	842,752,174	-
Iceland	23,266,871	19,936,044	-
Liechtenstein	1,671,163	1,671,163	-
Norway	311,281,071	274,090,346	-
Croatia	231,297,975	206,856,000	-
Former Yugoslav Republic of Macedonia	72,512,255	63,239,110	-
Turkey	6,524,868,596	5,870,166,341	-
Neighbouring countries			
Albania	20,999,416	18,788,000	19,318,000
Bosnia and Herzegovina	73,968,815	66,277,292	-
Montenegro	4,449,917	2,328,930	-
Serbia	729,088,776	650,146,930	-
Kosovo	71,806,979	64,386,078	-

The table below summarizes the estimated pass-km by bus (only intra-zone) by country and provides a comparison with available statistics on observed pass-km by bus at urban level.

Table 30-6: Bus passenger results, 2010, (passenger-kms)

Country	Modelled pkm by bus (intra-zonal)	Modelled pkm by bus (intra-zonal <= 25 km)	Observed pkm by bus - Urban
EU27			
Austria	5,232,766,787	3,613,327,269	-
Belgium	6,117,721,056	5,070,018,706	4,541,600,000
Germany	33,494,847,170	31,106,783,438	38,929,700,953

Country	Modelled pkm by bus (intra-zonal)	Modelled pkm by bus (intra-zonal <= 25 km)	Observed pkm by bus - Urban
Denmark	3,283,830,881	2,083,640,564	2,850,000,000
Spain	30,106,752,146	13,289,125,871	-
Finland	4,625,917,420	2,477,002,236	-
France	27,816,403,659	19,645,643,593	-
Greece	13,884,923,360	8,051,273,694	-
Ireland	3,634,055,941	1,919,800,000	-
Italy	66,977,413,888	42,412,245,121	-
Luxembourg (Grand-Duché)	524,431,240	255,420,000	-
Netherlands	8,082,793,724	6,282,030,628	-
Portugal	6,953,978,586	4,804,895,367	-
Sweden	7,450,802,786	4,853,809,011	-
United Kingdom	23,346,799,068	20,940,016,734	-
Bulgaria	6,704,765,701	3,828,890,568	-
Cyprus	1,270,547,618	385,841,713	-
Czech Republic	11,863,142,796	7,427,630,349	-
Estonia	1,650,237,929	942,400,000	-
Hungary	6,944,403,568	4,745,361,895	4,218,000,000
Lithuania	2,092,168,061	1,410,672,324	1,398,100,800
Latvia	1,157,952,326	827,323,263	-
Malta	487,203,577	487,203,577	-
Poland	32,785,734,888	21,847,334,403	-
Romania	9,169,402,573	5,988,816,570	6,338,310,900
Slovenia	1,478,957,258	793,281,800	-
Slovakia	4,704,651,211	2,301,772,718	-
Candidate countries & EFTA			
Switzerland	4,468,389,826	3,412,147,325	-
Iceland	317,491,240	197,871,847	-
Liechtenstein	9,035,768	9,035,768	-
Norway	3,413,298,091	2,278,274,789	-
Croatia	2,006,198,643	1,294,942,043	-
Former Yugoslav Republic of Macedonia	841,631,451	516,596,022	-
Turkey	74,729,622,630	48,278,691,064	-
Neighbouring countries			
Albania	208,009,897	138,963,000	135,841,000
Bosnia and Herzegovina	820,392,915	542,573,464	-
Montenegro	79,194,876	16,477,044	-
Serbia	8,128,293,707	5,391,117,532	-
Kosovo	785,269,019	528,101,129	-

Here below a comparison between modelled intra-zonal passenger trips and observed total passenger trips by bus is provided.

Table 30-7: Bus passenger results, 2010, (trips)

Country	Modelled passenger trips by bus (intra-zonal)	Observed total passenger trips by bus	Share of modelled intra-zonal trips on total reference trips
EU27			
Austria	498,703,693	-	-
Belgium	647,188,018	-	-
Germany	4,752,381,874	5,601,072,572	85%
Denmark	283,568,183	-	-
Spain	2,159,608,090	2,410,860,000	90%
Finland	303,439,043	-	-
France	3,153,808,711	-	-
Greece	976,116,484	-	-
Ireland	258,715,818	-	-
Italy	5,633,462,492	-	-
Luxembourg (Grand-Duché)	38,051,521	43,000,000	88%
Netherlands	871,650,587	-	-
Portugal	648,447,510	-	-
Sweden	670,533,490	-	-
United Kingdom	4,320,824,398	-	-
Bulgaria	479,770,834	-	-
Cyprus	39,859,681	-	-
Czech Republic	1,228,749,683	-	-
Estonia	148,045,481	-	-
Hungary	982,754,629	-	-
Lithuania	369,225,167	339,232,700	97%
Latvia	150,481,689	-	-
Malta	35,604,217	-	-
Poland	3,199,212,717	-	-
Romania	1,101,942,431	1,119,862,900	81%
Slovenia	101,375,669	82,789,000	86%
Slovakia	674,963,549	-	-
Candidate countries & EFTA			
Switzerland	884,598,393	-	-
Iceland	23,266,871	-	-
Liechtenstein	1,671,163	-	-
Norway	311,281,071	-	-
Croatia	231,297,975	-	-
Former Yugoslav Republic of Macedonia	72,512,255	-	-
Turkey	6,524,868,596	-	-
Neighbouring countries			
Albania	20,999,416	19,318,000	95%
Bosnia and Herzegovina	73,968,815	-	-
Montenegro	4,449,917	-	-
Serbia	729,088,776	-	-
Kosovo	71,806,979	-	-

Here below the comparison between modelled intra-zonal pass-km and ETIF pass-km by bus and coach is provided together with the share of modelled pkm on ETIF statistics.

Table 30-8: Bus and coach passenger results (passenger-kms)

Country	Modelled pkm by bus (intra-zonal)	ETIF pkm by bus&coaches	Share of modelled intra-zonal pkm on ETIF pkm
EU27			
Austria	5,232,766,787	9,874,000,000	53%
Belgium	6,117,721,056	18,662,900,000	33%
Germany	33,494,847,170	61,766,355,762	54%
Denmark	3,283,830,881	6,965,000,000	47%
Spain	30,106,752,146	50,902,000,000	59%
Finland	4,625,917,420	7,540,000,000	61%
France	27,816,403,659	49,942,395,414	56%
Greece	13,884,923,360	21,100,000,000	66%
Ireland	3,634,055,941	6,890,000,000	53%
Italy	66,977,413,888	103,526,000,000	65%
Luxembourg (Grand-Duché)	524,431,240	940,000,000	56%
Netherlands	8,082,793,724	12,130,000,000	67%
Portugal	6,953,978,586	10,580,000,000	66%
Sweden	7,450,802,786	8,560,000,000	87%
United Kingdom	23,346,799,068	46,500,000,000	50%
Bulgaria	6,704,765,701	10,613,000,000	63%
Cyprus	1,270,547,618	1,290,000,000	98%
Czech Republic	11,863,142,796	17,435,500,000	68%
Estonia	1,650,237,929	2,061,000,000	80%
Hungary	6,944,403,568	15,984,000,000	43%
Lithuania	2,092,168,061	2,693,600,000	78%
Latvia	1,157,952,326	1,976,000,000	59%
Malta	487,203,577	500,000,000	97%
Poland	32,785,734,888	21,600,000,000*	-
Romania	9,169,402,573	11,955,000,000 **	-
Slovenia	1,478,957,258	3,183,000,000	46%
Slovakia	4,704,651,211	5,271,556,900	89%
Candidate countries & EFTA			
Switzerland	4,468,389,826	5,522,300,000	81%
Iceland	317,491,240	-	-
Liechtenstein	9,035,768	-	-
Norway	3,413,298,091	4,506,000,000	76%
Croatia	2,006,198,643	-	-
Former Yugoslav Republic of Macedonia	841,631,451	-	-
Turkey	74,729,622,630	107,580,000,000	69%
Neighbouring countries			
Albania	208,009,897	-	-
Bosnia and Herzegovina	820,392,915	-	-
Montenegro	79,194,876	-	-

Country	Modelled pkm by bus (intra-zonal)	ETIF pkm by bus&coaches	Share of modelled intra-zonal pkm on ETIF pkm
Serbia	8,128,293,707	-	-
Kosovo	785,269,019	-	-

* Poland national statistics indicate that the value reported from ETIF covers only interurban transport

** The value reported from ETIF covers only interurban transport.

30.6 Methodology: Inter-zonal trips by regular scheduled national and international long distance coach services

Within the ETISplus project the first attempt to produce an European matrix of national and international coach transport activity data has been made. In fact, no other attempt was made previously in order to build up a consistent set of data to allow comparisons and further analysis for this particular and often unexplored segment of the passenger transport market.

Besides some necessary preliminary definitions and taking into account the most relevant distinction between regular short (i.e. local public transport) and long distance road passenger transport by buses and coaches, it has to be underlined that for the latter category there is no international legal obligation for the collection of data and provision of official statistics. The result is a total absence of figures for some countries or the availability of aggregated bus and coach data for the majority of the cases with only some exceptional countries reporting detailed statistics for long distance coach transport (e.g. Germany).

In addition to that and despite the efforts made at UNECE level in recent years, there is still a need for more common definitions, harmonisation and standards.

There is not a common definition of long distance coach services from country to country. Distance is often the main element used to distinguish between short and long distance collective road transport but distance bands vary a lot among countries: over 15 miles in Britain, 50 km in Germany or over 100 km in Sweden. This is also the main reason for which also existing detailed statistics are not directly usable for the purposes of the ETIS database. Other countries like Italy adopt a mere administrative criterion to identify long distance coach service and the related applicable regulatory regime: only coach lines crossing the borders of two or more Regions are considered national coach lines, irrespective of their length, and thus are not included in the local public transport regime.

Considering these differences and the risk of data inconsistency linked to a simple data collection and gap filling-based methodology, we decided from the beginning to move towards a more challenging collection activity of single coach transport lines and their components (stops, frequency, operators) in every covered country and at international level, and to build up a matrix of coach transport activity data and GIS layers by applying a common methodology.

Relevant data sources, study references, methodology and results are described in the following.

The developed methodology for the estimation of the coach transport matrix within the ETISplus project can be summarized in six consecutive steps:

1. identification and selection of primary national and international coach transport operators from available studies, statistics, yearbooks, transport authorities and associations;
2. identification of coach lines (from company's website or direct contacts) and collection of relevant data (stops, frequency, etc.) from published timetables (in pdf files or html web pages);
3. georeferencing of detected coach lines and selection of lines that are relevant for the scope of the ETIS system (see the section below on definitions and coverage);
4. cross-check of national and international lines to avoid duplication (i.e. services jointly operated by different companies and/or marketed under other brands like national legs of Eurolines main links);
5. quality check of collected data;
6. estimation of coach transport travel demand from service exploitation.

These steps are fully described in the following paragraphs.

30.6.1 Definitions and geographical coverage

According to the EU Regulation (EC) No 1073/2009³ it is possible to identify four main categories of coach transport services:

- Regular Services (i.e. scheduled intercity coach lines, national and international)
- Special Regular Services (e.g. school transport services, transport of workers, local airport links)
- Occasional Services (i.e. touring and coach hire services)
- Own-account bus and coach transport (e.g. a coach owned by a company or institution to transport exclusively its own members)

The services covered under the ETIS system are REGULAR COACH SERVICES. Some special regular services like airport links have been also detected according to the defined selective territorial criteria within ETIS, whereas school transport services (often including the transport of children with school buses) or other dedicated services (e.g. event-related and limited seasonal services) have been excluded from the collection exercise.

It has to be underlined that especially airport links, also when operated at local level, make large use of coaches and represent a particular segment of non subsidized local/regional transport operated mainly by private coach operator.

³ Regulation (EC) No 1073/2009 of the European Parliament and of the Council of 21 October 2009 on common rules for access to the international market for coach and bus services, and amending Regulation (EC) No 561/2006

Valid coach transport service categories and links to be considered for ETISplus have been identified according to a territorial principle as in the following:

1. REGULAR NATIONAL: Inter-NUTS2 (inter-regional and expressway inter-city coach services excluding seasonal services) + Inter-NUTS3 services;
2. REGULAR INTERNATIONAL: Inter-NUTS1 coach services, including detection and collection activities in neighbouring to identify additional international routes;

The zoning system adopted for the estimation of 2010 coach transport demand is the ETIS2006_zone_level3. The coach transport matrix provides supply information for 43 countries: EU 27 (excluding Malta) + Accession/candidate countries (Croatia, Macedonia and Turkey) + EFTA (Switzerland, Norway, Iceland, Liechtenstein) and the neighbouring countries Andorra, Albania, Bosnia and Herzegovina, Montenegro, Serbia, Kosovo, Moldova, Ukraine, Belarus and Russia.

30.6.2 Collection activities

Primary national and international coach transport operators have been selected by looking at existing public lists or references of companies authorised by a competent authority (normally national or regional bodies) for the operation of a regular coach service not included in local public transport concessions.

Also the websites of national associations of coach transport operators have been detected as well as web search engines/booking aggregators (e.g. Movelia.es) and departure/arrival timetables in coach terminals of the main cities.

It is generally quite easy to detect main national and international players through this typical desk research activity: leading operators (like National Express in UK or Atlassib in Romania) cover the majority of expressway national coach routes and are normally engaged in the international market (e.g. through the Eurolines consortium).

Both organisational, technical and financial constraints limit a lot the possibility to access the market of regular long distance coach lines by minor local companies. There might be some exceptions especially for those services that cannot be directly recognised as expressway coach links, e.g. inter-NUTS2 or inter-NUTS3 services having many stops along the route and more integrated in local public transport networks.

In order to derive the characteristics of the coach transport supply and estimate travel demand a template for the collection of relevant data from scheduled services has been used. Key information includes:

- Country
- Company name
- Line type (national/international)
- Bus capacity (normally set to 50 seats but filled with specific information if available)

- Weekly frequency
- Weeks of service
- Partner companies (if available this information allows to identify services operated by a "pool of companies" and avoid duplications)
- Line name (e.g. Bucharest – Dortmund)
- Progressive Stop ID
- Stop name (one stop per city)
- O (1/0 where 1 means "ascending stop")
- D (1/0 where 1 means "descending stop")

It's important to identify exactly the line itinerary and intermediate stops of each detected line as well as some key rules governing the regulatory system in every country that might affect service provision from a commercial point of view. In some nations (e.g. Italy) it's not possible to sell tickets that covers regional OD (i.e. within the same NUTS2) or OD pairs offered by other coach companies or other interurban public transport operators. Some stops will be therefore only "departure" locations from where it is possible to reach a number of predetermined destinations. Obviously some locations can be at the same time ascending and descending points, so that having both columns O and D marked with the value 1. This information can be easily retrieved by looking at published tariffs and are relevant for the subsequent travel estimation of coach passenger travel demand (infra- Level3 OD pairs have been avoided in any case).

For each covered country interurban coach links have been collected both for national and international services. Timetables are normally available in pdf or html format and have been collected and reported according to the template. In some cases this information was not directly available from the selected sources: it happens especially for those operators or web portals having a search engine that shows information only for the needed origin and destination points. The line itinerary was identified in this case by looking at network service maps if available (e.g. for the network Rede do Expressos in Portugal) or by contacting directly the operator. In absence of valid information the search engine was used to simulate different OD couples and retrieve information about the main intercity links only. The latter case occurred for some coach lines operated in Spain and Turkey.

30.6.3 Definition of the coach transport supply

Collected data on coach links have been processed in order to complete the coach transport supply with information related to Level3 zones for each stop.

Each lines has been checked by georeferencing the progression of stops and identifying the exact route itinerary. The multiple address locator tool of the online web source GPS Visualizer was extensively used to gather latitudes and longitudes of collected stop names and simultaneously to show the itinerary on a tailored maps via Google Maps. Missing or incoherent locations have been filled up or changed by looking at different geographical names for a single location and/or identifying the possible locations in between two consecutive identified stops served by coherent road links.

As a general rule, different stops in the same city have been grouped in one location stop and different names for the same location (e.g. Brussels vs. Bruxelles) have been uniformed as far as possible to produce a single inventory of coach stops.

Within this process another fundamental cross check was the elimination of duplicated lines collected from different operators but jointly operated or detected in both the country of origin and the country of destination for international lines.

30.6.4 Estimation of coach transport travel demand

The estimation of the coach travel demand is derived by processing all possible OD pairs according to the binary 1/0 information in O (origin) and D (destination) columns and excluding OD combinations in the same Level3 zone.

The demand is computed by considering a fixed maximum capacity for each detected run according to the detected coach capacity (generally 50 passengers). This assumption implies that a 50 seats coach can carry maximum 50 passengers along the entire route: descending and ascending passengers in intermediate stops are not considered under this assumption.

For each service, passengers are distributed among locations by considering the weight of the selected OD pair on the overall weight of all OD pairs served by the service. The computation of total passenger-km is made by considering the OD pairs distances included into the ETIS table of Road Impedances. The refinement of coach travel demand estimation was made through the comparison of only few comparable figures from available statistics.

30.6.5 Distribution by trip purposes

The distribution of demand by trip purposes is based upon the distribution by trip purposes modelled for the inter-zonal demand by rail and car modes. In particular it is assumed that no business and commuting trips are made by coach-services.

30.7 Data sources

Here below the list of sources explored for data collection on coach supply services and timetables is reported.

Table 30-9: Data Sources

Country	Operator	Reference
EU27		
Austria	OBB-POSTBUS	http://www.oebb.at/en/Travelling_by_bus/OeBB_Intercitybus/index.jsp
	Dr. Richard Verkehrsbetriebe	http://www.richard.at/Linienverkehr/Fahrplan/index_html
	BLAGUSS	http://blaguss.connexcc-hosting.net/de/home/services/fahrplaene_fuer_linienbusse/

Country	Operator	Reference
Belgium	EUROLINES	http://timetables.eurolines.be/
	L'ELAN CML	http://www.comfortmedlines.be
Bulgaria		http://www.centralnaavtogara.bg
	BIOMET	http://www.biomet.bg/english/schedule.php
	ETAP ADRESS	http://www.etapgroup.com/bg/index.html
	MTT SOFIA	http://www.mttsofia.com/schedule-en.php?cat=23&lang=en
	EUROLINES	http://www.eurolines.bg/CheckStep2.asp
		http://www.union-ivkoni.com/home
		http://www.rta.government.bg/m_prevozi.html
		http://www.bgrazpisanie.com/
Cyprus		www.intercitybusescy.com/
Czech Republic		http://jizdnirady.idnes.cz/autobusy/spojeni/
Denmark		http://www.visitdenmark.com/uk/en-gb/menu/turist/transport/togogbusinformation/longdistancebusconnectionsindenmark.htm
	Hurtigbussen	www.hurtigbussen.dk
	Thinggaard Expres	www.ekspresbus.dk
	Bornholmerbussen/G r�hundbus	www.graahundbus.dk
	S�ndergaards Busser	www.sondergaards-busser.dk
	Abildskous Busser	www.abildskou.dk
		www.fjernbusser.dk
	EUROLINES	www.eurolines.dk
	X-BUS	http://www.xbus.dk
Estonia	GOBUS	www.gobus.ee
	AS Tarbus	http://www.tarbus.ee/
	Peatus	http://www.peatus.ee/#region/eng
	TALLIN - TARTU	http://www.tallinntartu.ee/en
Finland	MATKAHUOLTO	www.matkahuolto.fi
	Linja-autoliitto	http://www.linja-autoliitto.fi/en
	ExpressBus	http://www.expressbus.fi/routes-and-bus-stops
	Koiviston Auto	http://www.koivistonauto.fi/
	Pohjolan Liikenne	http://www.pohjolanliikenne.fi/reittikartat
	Savon Linja	http://www.savonlinja.fi/eng/linjaliikenne/index.html
	Paunu	http://www.paunu.fi/english.html
	Eskelisen Lapin Linjat	http://www.eskelisen-lapinlinjat.com/en/index.php?os=5
	Tapanis Bus	http://www.tapanis.se/xpresssto.html
	Goldline	http://www.goldline.fi/etusivu/12-etusivu/1502-briefly-in-english
France	EUROLINES	http://www.horaires.eurolines.fr
	NOVATEL	http://www.andorabybus.com
Germany	AUTOKRAFT	http://www.berlinlinie.de/de/id999.htm
	AUTOKRAFT	http://www.traveliner.de/de/id491.htm
	AUTOKRAFT	http://www.kielius.de/de/id425.htm

Country	Operator	Reference
	AUTOKRAFT	http://www.schnellbus.de/
	AUTOKRAFT	http://www.traveliner.de/
	BAYERN EXPRESS	https://www.berlinlinienbus.de
	BOHR OMNIBUS	http://omnibusse.bohr.de/it/fahrplan.php
	BUS2GO	http://www.bus2go.de/
	BUSVERKEHR BERLIN	http://www.bvb.net/bus_linie_bayerischer_wald0.0.html
	FASS REISEN	http://www.fass-reisen.de/jade-express-linien.html
	EUROLINES - DEUTSCHE TOURING	http://www.touring.de
Greece	KTEL	http://livinggreece.gr/2008/06/13/ktel-buses-of-greece/
	KTEL	http://www.ktel.org
Hungary	VOLÁN operators	http://www.volanbusz.hu/en/domestictravel/interurban
	VOLÁN operators	http://www.volanbusz.hu/en/search_int.php?search=1
Ireland	Bus Éireann	http://www.buseireann.ie/inner.php?id=237
	Ulsterbus	http://www.translink.co.uk/Timetables/Ulsterbus-Timetables/
	McGeehan	http://www.mcgeehancoaches.com/dublin.html
	EUROLINES	http://www.buseireann.ie/inner.php?id=237
Italy		http://www.autostazionetrieste.it
		http://eurobuslines.info/
	I-BUS	www.ibus.it
	BALTUR-SENA- EUROLINES	http://www.baltour.it/
	INTERBUS-ETNA- SEGESTA	www.etnatrasporti.it
	SAIS	http://www.saisautolinee.it
	SITA	http://www.sitabus.it
	MAROZZI	http://www.marozzivi.it
	MICCOLIS	http://www.miccolis-spa.it/
	SAPS	http://www.sapsbusline.it/
	FERROVIE GARGANO	http://www.ferroviedelgargano.com/
	FERRARI-CLP	http://www.autolineeferrari.too.it/
	CAPUTO	http://www.caputobus.it/
	PETRUZZI	http://www.petrusziautolinee.it/
	LISCIO	http://www.autolineeliscio.it/
	FEDERICO	http://www.autolineefederico.it
	FODERARO	http://www.foderaro.it
	ROMANO	www.autolineeromano.com
	SIMET	www.simetspa.it
	CLP	www.clpbus.it
	LA VALLE	www.lavallelinee.it
	BONELLI BUS	www.bonellibus.it/
	SAF	www.saf.ud.it/
	MANIERI	http://www.mavibus.it/
	SALEMI	www.autoservizisalemi.it

Country	Operator	Reference
	FLORENTIA BUS	http://www.florentiabus.it
	VITA AUTOLINEE	http://www.vitagroup.it
	SAVDA AOSTA	http://www.savda.it
Latvia	Dautrans SIA	http://www.dautrans.lv/index.php?option=com_content&view=article&id=3&Itemid=5&lang=en
	Liepājas Autobusu Parks	http://www.aslap.lv/index.php?id=122&top=-7
	Jelgavas Autobusu Parks	http://www.jap.lv/?page_id=103
	ECOLINES	http://www.ecolines.net/index.php?l=2
		http://www.jurmala.lv/page.php?id=68
		http://www.nordeka.lv/home_eng.html
		http://www.autoosta.lv/eticket/races.jsp?jsessionid=28BC2CDD16778EBCA9B34546A6E35E64
Lithuania	KAUTRA	http://www.autobusubilietai.lt/lithuanian-and-international-routes/bus-stations
		http://www.kautra.lt
		http://www.siuntosautobusais.lt
	KLAP	http://www.klap.lt/?en=1210746888
		http://www.panevezioautobusai.lt
	LUX EXPRESS - EUROLINES	http://www.luxexpress.eu/lang/timetable
	TOKS	http://www.toks.lt/online-booking
Luxemburg	CFL	http://www.cfl.lu/CFLInternet/Espaces/01EspaceVoyageurs/02InfosGare/
Netherlands	EUROLINES	http://timetables.eurolines.nl/
	ECOLINES	http://www.ecolines.net/?l=2
Poland		www.e-podroznik.pl
	POLSKI EXPRESS	http://www.polskiexpress.rozjazdy.pl/
Portugal	SIMON	http://www.portugalexpress.lu/horaire.php
	RODONORTE	http://www.rodonorte.pt/horarios.php
	VIUVAMONTEIRO	http://www.viuvamonteiro.pt/horarios_itinerarios.php
	CITIEXPRESS	http://www.citiexpress.eu/c/mapa-rede
	TAMEGA	http://www.avtamega.pt/lisboa-braganca.html
	RENEX	http://www.renex.pt/HorarDwn.php
	MINHO	http://www.avminho.pt/site/html/index.asp#
	ANDORRA BUS	http://www.interurbana.ad
	REDE EXPRESSOS	http://www.rede-expressos.pt
	EVA TRANSPORTES	http://www.eva-bus.com
		http://thomasallen.home.sapo.pt
		http://www.transpor.pt/default.asp?HSPagina=Sobre&CdConteudo=13762
Romania	ATLASSIB	http://www.atlassib.ro/csp/webatlass/main.csp?lang=1&incarca=grafice&traseu=1
	TRANSMIX	
	ROMFOUR	http://www.romfour-tur.ro/curse_regulate.html
	CDI	http://www.cdy.ro/Transportruteinterne.aspx
	APETRANS	http://www.apetrans.ro/index.php?mdl=rezervari

Country	Operator	Reference
Slovakia	Slovak Lines - eurolines	http://www.autogari.ro/Transport/Bucuresti-Odaia/643-12132.aspx?lang=en
	INTERBUS	http://www.slovaklines.sk/index_en.html
	TURANCAR	http://www.interbus.sk/
	Slovenská autobusová doprav	http://www.turancar.sk/buslinky_new/mainEn.html www.eurolines.sk
Slovenia	VEOLIA	http://www.veolia-transport.si/Vozni_redi_in_vozovnice/Vozni_redi/index.html
	AURIGO	http://www.autostazionetrieste.it/index.php?option=com_content&task=view&id=10&Itemid=0
	KAM BUS	http://kam-bus.si/index.php?kat=1&page=pot
Spain		WWW.MOVELIA.ES
	ALSA	www.alsa.es
	AVANZA	www.avanzabus.com
	VIBASA	www.vibasa.com
	DAMAS	http://www.damas-sa.es
	BILMAN	www.bilmanbus.es
	DAINCO	www.dainco.es
	JIMENEZ	www.grupo-jimenez.com
	COMES	www.tgcomes.es
	GRUPO HIFE	WWW.HIFE.ES
	GRUPO RUIZ	www.gruporuiz.com
Sweden	Flygbussen	http://www.flygbussarna.se
	Swebuss	http://www.swebus.se/SwebusExpress_com/Search-and-Purchase/Time-Table-And-Route-Map/
	Safflebussen	http://www.gobybus.se/tidtabell
United Kingdom		http://www.dhf.co.uk/coaches-printed-timetables.php
	NATIONAL EXPRESS	http://www.nationalexpress.com/coach/destinations/timetablefinder.aspx
	MEGABUS	http://uk.megabus.com/Default.aspx
	EUROLINES	http://www.eurolines.co.uk/coach/index.aspx
	STAGECOACH	http://www.stagecoachbus.com/timetables.aspx
	GREYHOUND uk	http://www.greyhounduk.com/index.php
	OXFORD EXPRESS	http://www.oxfordbus.co.uk/main.php?page_id=27
Candidate countries & EFTA		
Croatia		http://www.akz.hr/EN/voznired.aspx
Former Yugoslav Republic of Macedonia		http://www.skopje.com.mk/angliski/megju.asp
		http://www.sas.com.mk
Iceland		http://www.nat.is/travelguideeng/bus_stop_the_real_icelandic.htm
Liechtenstein	LBA	http://www.lba.li/no_cache/fahrplan-liniennetz/fahrplan.html
Norway		http://eurobuslines.info/
	Nor-Way Bussekspress	http://www.nor-way.no/timetables/category555.html

Country	Operator	Reference
	Nettbuss	http://www.nettbuss.no/ekspresbuss/timekspresen/rutetabeller
	Lavprisekspressen	https://lavprisekspressen.no/
Switzerland		http://212.203.98.98/WD140AWP/WD140Awp.exe/CONNECT/GRweb http://www.alsa-eggmann.ch/buses/horaires/index.php?lang=en
Turkey		http://www.neredennereye.com/buses/
Neighbouring countries		
Albania		http://www.inyourpocket.com/data/download/tirana.pdf
Bosnia and Herzegovina	CENTROTRANS-EUROLINES	http://www.centrolines.ba
Belarus		http://minsktrans.by/
Moldova		http://www.autogara.md/orar/ http://www.marisha.net/crossroads.htm
Montenegro		http://www.pobjeda.co.me/redvoznje.php http://www.autoboka.com/red_voznje.html
Serbia		http://www.bas.rs
Ukraine	Marshrutkas	http://bus.com.ua/cgi-bin/bus-g.pl?tr=1 http://www.marisha.net/crossroads.htm
	REGABUS	http://www.regabus.cz/
	ECOLINES	http://www.ecolines.net/
	AUTOLUX	http://www.autolux.ua/
	GUNSEL	http://www.gunsel.com.ua/site
Kosovo		http://www.virtualtourist.com/travel/Europe/Republic_of_Serbia/Pristina-720377/Transportation-Pristina-TG-C-1.html http://www.inyourpocket.com/kosovo/pristina

30.8 Results, coach passengers

Within ETISplus is now possible to gather detailed information on 4.032 coach lines (2.677 national and 1.355 international coach services from 43 countries. A lower number of lines (3.857) has been used for demand calculations due to the used zoning system, thus excluding national coach lines in Cyprus, Iceland, Moldova and Kosovo.

Whereas for some missing countries the absence of national coach lines is mainly due to their geography (e.g. Andorra and Luxemburg), for others like France, Belgium and the Netherlands the reason is strictly linked to their regulatory system (e.g. in France passenger transport by coach on intercity routes was not allowed until 2011) or the operational configuration of local public transport networks that includes some intercity links in interurban regional transport (i.e. Belgium, Netherlands and Switzerland). Data coverage for Moldova and Russia is limited to international lines only due to the absence of data. If available, domestic related figures for these countries derives from cabotage activity of international lines only.

In the following table the resulting aggregated data in passenger journeys and pkm is reported.

Table 30-10: Coach passenger trips, 2010

Country	Modelled Passenger Trips Regular National	Modelled P-km Regular National	Modelled Passenger Trips Regular International	Modelled P-km Regular International
EU27				
Austria	552,129	61,424,032	1,434,623	762,050,823
Belgium	7,265	609,874	427,913	267,846,425
Bulgaria	4,504,357	809,462,990	964,870	862,323,513
Cyprus	-	-	-	-
Czech Republic	11,174,461	1,515,550,257	2,144,700	978,558,142
Denmark	3,035,540	401,279,673	412,752	148,490,038
Estonia	4,300,400	756,528,904	300,835	117,478,356
Finland	4,612,400	654,294,957	76,138	24,508,938
France	91,699	34,049,576	2,452,519	1,660,710,283
Germany	3,860,173	805,124,118	1,623,798	1,197,385,142
Greece	16,255,200	3,153,422,125	392,502	271,129,411
Hungary	9,033,789	1,013,119,856	648,659	249,560,658
Ireland	5,471,523	773,441,300	855,374	160,140,702
Italy	5,284,198	2,476,469,344	1,037,021	1,076,270,868
Latvia	4,523,192	739,615,280	686,533	234,731,618
Lithuania	9,246,811	1,292,100,403	706,586	207,054,802
Luxemburg	-	-	21,243	26,088,977
Netherlands	22,790	1,804,689	498,289	326,389,454
Poland	14,365,808	2,199,490,154	1,278,947	1,106,515,415
Portugal	5,163,600	1,100,254,937	266,987	285,121,626
Romania	5,486,447	1,077,674,888	1,361,588	955,875,137
Slovakia	2,898,032	385,184,502	1,111,393	442,810,624
Slovenia	2,270,154	178,289,518	183,754	65,548,843
Spain	8,788,598	3,253,358,343	789,531	1,026,067,560
Sweden	1,696,200	435,687,821	605,641	179,854,299
United Kingdom	31,883,798	4,826,233,320	1,803,025	1,040,216,435

Country	Modelled Passenger Trips Regular National	Modelled P-km Regular National	Modelled Passenger Trips Regular International	Modelled P-km Regular International
Candidate countries & EFTA				
Croatia	2,423,740	688,091,006	1,194,865	528,870,631
Former Yugoslav Republic of Macedonia	5,233,153	562,865,664	1,181,973	303,780,768
Iceland	-	-	-	-
Liechtenstein	-	-	-	-
Norway	14,945,061	1,247,718,581	447,702	138,492,687
Switzerland	52,522	7,824,120	1,429,780	883,991,699
Turkey	15,652,000	9,393,566,000	182,420	121,599,610
Neighbouring countries				
Albania	2,373,280	246,704,640	365,560	139,157,513
Andorra	-	-	953	-
Bosnia and Herzegovina	683,121	90,500,213	1,340,723	436,592,587
Belarus	3,201,203	856,076,561	203,743	102,075,444
Moldova			1,550,791	632,464,035
Montenegro	17,456,609	1,488,170,496	1,487,406	448,812,723
Russia	10.046	3.968.757	472.590	258.993.400
Serbia	3,626,173	587,864,418	2,777,674	1,000,720,536
Ukraine	3,254,031	1,026,236,161	1,084,574	604,997,711
Kosovo	-	-	-	-

30.8.1 Key results, coach and bus passengers

Table 30-11: Bus and coach passenger trips, key results

Access via	Collection	Group	Description
ETIS View	Modelled Data	Passenger	Bus and Coach passengers by O/D and trip purpose. (Stored as separate modes – i.e. separate tables)
2010	http://viewer.etisplus.net/ select collection: ETISplus-2010-Modelled highlight: Passenger open tables: - Passenger transport by bus - Passenger trips by coach		
2005	http://viewer.etisplus.net/ select collection: ETISplus-2005-Modelled highlight: Passenger open tables: - Passenger transport by bus - Passenger trips by coach		

31 Car Passenger Matrix

The "Passenger trips by car" database includes total passenger trips by car, at NUTS 3 level (both intra-zonal and inter-zonal) differentiated by trip purpose:

- Business (trips for working purposes with different destination than the usual workplace),
- Private (non business related trips with duration of up to 4 days),
- Vacation (non-business trips with duration of more than 4 days),
- Commuting (daily trips for working or studying purposes).

31.1 Scope of the database

Table 31-1: Overview of the dataset, car passenger matrix

Car Passenger matrix						
Data feature	Data specification					Remarks
Base year	2010					
Scope of data	Link	Terminal	O/D relation	Region	Other	
	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
GIS data	Yes	No				
	<input type="checkbox"/>	<input checked="" type="checkbox"/>				
Country coverage				Completely	Partially	
	EU 27			<input checked="" type="checkbox"/>	<input type="checkbox"/>	
	Candidate countries & EFTA			<input checked="" type="checkbox"/>	<input type="checkbox"/>	
	Neighbouring countries			<input type="checkbox"/>	<input checked="" type="checkbox"/>	
	TRACECA			<input type="checkbox"/>	<input type="checkbox"/>	
	MEDA			<input type="checkbox"/>	<input type="checkbox"/>	
	Other countries			<input type="checkbox"/>	<input checked="" type="checkbox"/>	
	Total number of countries covered:			42		
Main data sources	National Travel surveys; EU Energy and Transport in Figures – Statistical Pocketbook 2010; National transport figures & statistics					Please refer to the model documentation.
Main type of data generation	Observed	<input type="checkbox"/>				
	Harmonized	<input type="checkbox"/>				
	Modelled	<input checked="" type="checkbox"/>				

31.2 Data structure

Table 31-2: Data structure

Indicator	Description of indicator	Unit
Origin Zone	Origin Zone ID at NUTS 3 level	
Destination Zone	Destination Zone ID at NUTS 3 level	
Trip Purpose	Trip purpose	
Passenger Trips by car	Yearly trips	trips/year

The database includes also international trips from Russia, Belarus, Moldova and Ukraine to Europe and return.

The matrix is in the GA (Generation Attraction) format.

This implies that:

- the cell with ORIGIN ZONE A and DESTINATION ZONE B includes the trips made by people living in zone A and going to zone B and the corresponding return trips;
- the cell with ORIGIN ZONE B and DESTINATION ZONE A includes the trips made by people living in zone B and going to zone A and the corresponding return trips;
- the matrix is not symmetric.

Two different methodologies are adopted for the production of the information included into these datasets. A first one is related to the production of

- Intra-zonal trips (local transport); a second one is used for the modelling of
- Inter-zonal trips. Here below the description of both approaches is provided.

31.3 Methodology – Intrazonal trips by Car

The estimation of local demand has a general common approach for all considered transport modes (car, rail, bus, tram&metro, walking and cycling) but some differences exist for each transport mode. The methodology heavily relies on available observed data: EUROSTAT and other international organizations statistics, national statistics, mobility studies, census data, National Travel Surveys, dedicated reports on public transport performances etc. Here below the main steps of the modelling framework are explained.

31.3.1 Estimation of total trips by car

For the estimation of the intra-zonal car and rail trips, the methodology has benefited from the same approach adopted for the estimation of inter-zonal demand and in particular from the output of the implemented generation model (see below).

One of the output of this model is the vector of intra zone passenger trips by motorized modes (i.e. the sum of intra zone trips made by car and rail modes).

Given the above mentioned input, the methodology has mainly focused on splitting the trips between the two modes and on identifying the share of those trips within each distance band. In particular, local traffic by car is estimated as a difference from total motorized intra zonal traffic and intra zonal traffic by rail.

31.3.2 Zones and distance bands

The zoning system adopted for the estimation of 2010 local demand is the ETIS2006_zone_level3. The estimation of local demand is made for 39 countries: EU 27 + Accession + EFTA and the neighbouring countries Albania, Bosnia and Herzegovina, Montenegro, Serbia and Kosovo (1537 zones in total).

Four distance bands have been defined for the estimation of local transport demand:

- Distance Band 1: trips between 0 and 3 Km
- Distance Band 2: trips between 3 and 25 Km
- Distance Band 3: trips between 25 and 50 Km
- Distance Band 4: trips > 50 km.

The definition of these bands was made in relation to:

- Dimensions of ETISplus zoning system;
- Classifications currently used in available National Travel Surveys or other existing documentation.

In particular the first distance band is related to very short trips and to trips by slow modes (walking and cycling).

Distance bands 1 and 2 can be considered with a certain approximation as representative of urban trips, whereas the distance bands 3 and 4 are representative of interurban trips; particularly, distance band 4 is related to those trips, longer than 50 km, which start and end within the traffic zone.

The first step of the methodology was to identify the distance bands belonging to each zone; this was made by considering the dimension of the zone and in particular a "virtual" diameter derived by approximating the zone to a circle.

All ETIS zones have the first and the second distance bands; 1202 zones have the third distance band and 686 zones have also the fourth distance band.

In several cases the defined distance bands intercept the dimension of the "virtual" diameter. As an example the zone AT111 Mittelburgenland has a virtual diameter of about 30km. This implies that 100% of the trips within the first distance band (between 0 and 3 Km) can be supposed to start and end within the zone; in similar way, 100% of the trips belonging to the second distance band (trips between 3 and 25 Km) can be considered within the zone, but only a certain rate of the trips belonging to the third distance band (between 25 and 50 Km) can be supposed to start and end within the zone.

Therefore for the distance bands that cross the virtual dimension of the zone the share of trips supposed to be intra-zonal is computed as a function of the virtual diameter and the upper threshold of the band.

For those zones that have the "virtual" diameter >50 Km (fourth distance band) it is assumed that the share of trips within the Level zone 3 is a function of the ratio between the "virtual" diameter and a fixed threshold of 150Km.

31.3.3 Distribution by distance bands

The distribution of trips within each distance band is made by deriving national coefficients from available sources. For some countries, it is possible to derive the share of trips by transport mode and by the defined distance band from available National Travel Surveys. In a first step, it is assumed that these rates apply to all trips generated by each single zone in the country. From the available National Travel Surveys it is also possible to derive information on the average trip length within each distance band by transport mode.

It is assumed that no rail trips exist in the first distance band (0 to 3 km). In order to take into account the different nature of zones and the different availability of local rail services (metropolitan areas have generally more rail services than rural areas), additional coefficients have been estimated and calibrated on the basis of available information. In particular, for each country, different coefficients have been estimated on the basis of zone population in order to identify metropolitan areas, big urban areas, urban areas and rural zones.

The estimation of these coefficients has benefited from consideration on zone dimensions and population and from statistics at zonal level (when available).

31.3.4 Distribution by trip purposes

Based on the information provided by several national travel surveys, the shares of trips by mode and by purpose have been derived at national level. The distribution covered commuting, business and private trip purposes. Where information was not available, data from similar countries has been used as reference.

An additional step was made to include the different characteristics of zones with regard to the amount of Economically Active population. For this purpose, the shares previously computed at national level have been adjusted according to the characteristics of the zones at Zone3 level: based on the ratio between active and total population by zone, the share of commuting and business trips have been increased/decreased depending on the difference with respect to the average national value.

31.3.5 Final comparison

The refinement of local demand estimation was made through the joint comparison of intra and inter zonal demand, both in terms of trips and traffic performances, in order to match EUROSTAT statistics for rail and car modes.

31.4 Data sources - Intrazonal

The modelling of local passenger demand has benefited from an extensive data collection; data was gathered from several available sources and it varies from transport statistics, mobility studies, national travel surveys, census data, dedicated reports etc. As a general remark, it has to be stated that usually traffic data are not available at zone level; in the most of the cases statistics are available at national level or at a more aggregate level than the one adopted by the ETIS zoning system. Statistics are generally more available for public transport than for private transport.

Here below the list of data sources considered for the modelling on intra zone passenger trips by car and rail modes is reported.

Table 31-3: data sources, intrazonal

Country	Data source
International database	ec.europa.eu/transport/publications/statistics/pocketbook-2010_en.htm http://stats.oecd.org UNECE Transport Division Database http://w3.unece.org Eurostat table rail_pa_total
EU27	
Austria	www.statistik.at
Belgium	http://www.plan.be
Bulgaria	Data Collected from Bulgarian Ministry of Transport
Czech Republic	www.czso.cz
Denmark	http://www.statbank.dk National Travel Survey
Estonia	www.stat.ee
Finland	www.stat.fi National Travel Survey http://www.hlt.fi
France	www.developpement-durable.gouv.fr www.insee.fr National Travel Survey
Germany	www.destatis.de National Travel Survey
Hungary	www.ksh.hu
Ireland	http://census.cso.ie
Italy	www.istat.it www.isfort.it
Latvia	www.stat.gov.lt
Netherlands	Mobiliteitsonderzoek Nederland 2007 National Travel Survey
Poland	www.stat.gov.pl
Romania	Data Collected from Romanian Ministry of Transport
Slovakia	www.statistics.sk
Spain	http://www.ine.es
Sweden	www.sl.se National Travel Survey http://www.sika-institute.se/
United Kingdom	www.tfl.gov.uk www.dft.gov.uk/statistics National Travel Survey

Country	Data source
Candidate countries & EFTA	
Croatia	Data Collected from Croatian Ministry of Transport
Norway	www.ssb.no
Switzerland	www.bfs.admin.ch
Turkey	www.turkstat.gov.tr
Neighbouring countries	
Bosnia and Herzegovina	Data Collected from Ministry of Transport of Bosnia and Herzegovina
Serbia	Data Collected from Ministry of Transport of Serbia

31.5 Results - intrazonal

The table below summarizes the modelled intra-zonal trips by car at country level.

Table 31-4: Intrazonal car trips, 2010

Country	Modelled passenger trips by car (intra-zonal)
EU27	
Austria	5,718,388,958
Belgium	5,816,346,414
Germany	52,370,987,490
Denmark	3,232,125,658
Spain	18,344,391,885
Finland	3,253,774,791
France	39,400,153,639
Greece	7,005,591,602
Ireland	2,421,686,247
Italy	32,746,585,334
Luxembourg (Grand-Duché)	298,695,085
Netherlands	7,372,084,508
Portugal	4,376,181,195
Sweden	5,924,550,617
United Kingdom	37,114,693,719
Bulgaria	3,174,590,647
Cyprus	274,363,070
Czech Republic	5,456,174,845
Estonia	759,352,370
Hungary	3,298,958,509
Lithuania	1,905,740,413
Latvia	1,667,857,480
Malta	152,573,844
Poland	28,336,758,920
Romania	7,578,471,027
Slovenia	1,257,939,250
Slovakia	2,430,045,929
Candidate countries & EFTA	
Switzerland	4,363,383,282

Country	Modelled passenger trips by car (intra-zonal)
Iceland	n.a.
Liechtenstein	18,238,148
Norway	2,777,075,537
Croatia	2,257,843,340
Former Yugoslav Republic of Macedonia	554,720,873
Turkey	25,626,475,459
Neighbouring countries	
Albania	531,668,386
Bosnia and Herzegovina	1,871,875,831
Montenegro	180,368,279
Serbia	2,132,203,983
Kosovo	390,899,545

The table below summarizes the modelled intra-zonal pass-km by car at country level.

Table 31-5: Intazonal car passenger kms, 2010

Country	Modelled pass-km by car (intra-zonal)
EU27	
Austria	33,388,757,735
Belgium	43,926,783,512
Germany	390,822,382,415
Denmark	32,834,906,881
Spain	202,552,246,328
Finland	42,459,221,776
France	435,148,304,391
Greece	71,198,064,130
Ireland	31,131,700,794
Italy	528,513,982,431
Luxembourg (Grand-Duché)	2,177,141,859
Netherlands	67,242,886,159
Portugal	49,052,323,065
Sweden	72,996,181,766
United Kingdom	410,050,768,170
Bulgaria	31,193,717,470
Cyprus	5,937,647,498
Czech Republic	35,407,341,519
Estonia	7,637,840,407
Hungary	32,950,974,299
Lithuania	23,760,342,575
Latvia	11,327,888,532
Malta	1,654,357,645
Poland	208,183,853,292
Romania	54,189,680,183
Slovenia	16,805,594,256
Slovakia	16,357,923,212
Candidate countries & EFTA	

Country	Modelled pass-km by car (intra-zonal)
Switzerland	50,652,490,888
Iceland	n.a.
Liechtenstein	78,799,145
Norway	36,489,274,462
Croatia	15,524,783,313
Former Yugoslav Republic of Macedonia	4,824,831,442
Turkey	289,248,133,201
Neighbouring countries	
Albania	4,383,402,133
Bosnia and Herzegovina	16,319,273,835
Montenegro	1,178,003,055
Serbia	22,208,480,162
Kosovo	3,945,776,953

31.6 Methodology –Interzonal trips by car

The modelling of inter-zonal trips follows the classical 4-step approach:

- Generation model;
- Distribution model;
- Mode choice model;
- Assignment model.

To ensure consistency between rail and car trips at the level of O/D relations the passenger model covers rail and car trips.

The generation model computes the number of inter-zonal originating land based passenger trips by rail and car for all NUTS 3 regions, as well as the number of attracted trips and distinguishes by purpose. The joint consideration of passenger trip demand by rail and car as well as a rough estimation of passenger trip demand by other modes ensures consistency at the level of NUTS 3 regions with regard to originating trips. The distribution model applies a gravity model to compute the distribution of generated origin trips by rail and car to respective destinations. At the level of O/D relations, the mode choice model computes the shares of passenger trips by rail and car in relation to the respective travel costs for both modes.

Finally, the assignment model computes the networks loads for rail and car based on the previous computed trip matrices which distinguishes four purposes and the two modes rail and car. At the level of networks links the comparison of observed AADTs with modelled loads enables a refinement of previous sub-models of the 4-step model (feedback-loop).

Further information is available in the ETISplus Passenger Model documentation.

31.7 Data Sources -Interzonal

Several data sources were exploited such as national travel surveys and passenger transport statistics on the European or National level. Based on the observed data several

key indicators were derived such as 'passenger trips per capita by country, purpose and mode' and 'passenger mileage by country, purpose and mode'.

31.8 Results - Interzonal

The following table summarises the number of inter-zonal passenger trips by car for every country. This indicator was calculated based on the G/A matrices. It covers only outward trips by car and not the return. For this reason, figures show only half of the trip demand.

Table 31-6: Interzonal car trips, 2010

Country	Passenger outward trips by car (inter-zonal)
EU27	
Austria	204,250,717
Belgium	427,870,347
Germany	2,332,516,312
Denmark	90,812,847
Spain	294,240,609
Finland	62,018,305
France	1,039,515,402
Greece	117,651,034
Ireland	72,013,240
Italy	703,651,608
Luxembourg (Grand-Duché)	12,802,222
Netherlands	502,623,034
Portugal	136,611,951
Sweden	70,449,733
United Kingdom	1,101,838,545
Bulgaria	58,315,610
Cyprus	61,017
Czech Republic	135,804,334
Estonia	6,758,946
Hungary	87,746,345
Lithuania	27,321,923
Latvia	19,236,302
Malta	1,605,833
Poland	404,406,362
Romania	158,646,351
Slovenia	42,902,540
Slovakia	59,075,115
Candidate countries & EFTA	
Switzerland	188,900,316
Iceland	n.a.
Liechtenstein	1,368,866
Norway	72,121,040
Croatia	58,294,060
Former Yugoslav Republic of Macedonia, the	10,287,018
Turkey	208,967,553

Country	Passenger outward trips by car (inter-zonal)
Neighbouring countries	
Albania	12,849,620
Bosnia and Herzegovina	29,758,832
Montenegro	8,592,885
Serbia and Kosovo	60,320,720

The following table summarises modelled pkm for inter-zonal car passenger demand. This indicator was calculated based on the G/A matrices and corresponding network impedances for the O/D relation. It covers outward and return trips by car.

Table 31-7: Interzonal car passenger kms, 2010

Country	Modelled pkm (inter-zonal)
EU27	
Austria	38,057,179,294
Belgium	62,553,806,894
Germany	482,452,197,254
Denmark	19,356,431,568
Spain	127,752,753,512
Finland	23,950,196,683
France	296,031,410,578
Greece	32,400,563,105
Ireland	14,250,571,821
Italy	178,802,613,858
Luxembourg (Grand-Duché)	4,697,247,631
Netherlands	73,112,433,466
Portugal	32,949,489,864
Sweden	26,812,027,742
United Kingdom	165,331,515,889
Bulgaria	15,507,595,290
Cyprus	86,889,845
Czech Republic	31,877,450,934
Estonia	2,375,677,277
Hungary	18,960,301,839
Lithuania	6,864,861,500
Latvia	4,688,774,949
Malta	411,459,752
Poland	90,387,208,739
Romania	39,483,530,914
Slovenia	7,278,705,010
Slovakia	11,997,984,059
Candidate countries & EFTA	
Switzerland	35,987,653,667
Iceland	n.a.
Liechtenstein	380,682,700
Norway	24,199,349,477
Croatia	11,804,618,891

Country	Modelled pkm (inter-zonal)
Former Yugoslav Republic of Macedonia, the	1,816,720,052
Turkey	72,945,545,469
Neighbouring countries	
Albania	2,050,814,610
Bosnia and Herzegovina	7,057,370,314
Montenegro	1,206,648,585
Serbia and Kosovo	11,229,896,729

Table and graph here below provide with an overview of the overall comparison between total pass-km by car (both intra and inter zonal) and the ETIF statistics for 2010.

Table 31-8: ETISplus, ETIF comparisons

Country	Intra-zonal [Thousand mio pkm]	Inter-zonal [Thousand mio pkm]	Total [Thousand mio pkm]	ETIF [Thousand mio pkm]	Variation (%)
EU27					
Austria	33.39	38.1	71.4	73.00	-2%
Belgium	43.93	62.6	106.5	109.10	-2%
Germany	390.82	482.5	873.3	887.00	-2%
Denmark	32.83	19.4	52.2	51.01	2%
Spain	202.55	127.8	330.3	341.63	-3%
Finland	42.46	24.0	66.4	64.75	3%
France	435.15	296.0	731.2	727.30	1%
Greece	71.20	32.4	103.6	99.60	4%
Ireland	31.13	14.3	45.4	46.00	-1%
Italy	528.51	178.8	707.3	700.21	1%
Luxembourg (Grand-Duché)	2.18	4.7	6.9	6.50	6%
Netherlands	67.24	73.1	140.4	141.20	-1%
Portugal	49.05	32.9	82.0	83.70	-2%
Sweden	73.00	26.8	99.8	99.21	1%
United Kingdom	410.05	165.3	575.4	653.82	-12%
Bulgaria	31.19	15.5	46.7	46.90	0%
Cyprus	5.94	0.1	6.0	5.90	2%
Czech Republic	35.41	31.9	67.3	63.57	6%
Estonia	7.64	2.4	10.0	10.10	-1%
Hungary	32.95	19.0	51.9	52.60	-1%
Lithuania	23.76	6.9	30.6	29.92	2%
Latvia	11.33	4.7	16.0	16.50	-3%
Malta	1.65	0.4	2.1	2.20	-6%
Poland	208.18	90.4	298.571	297.90	0%
Romania	54.19	39.5	93.7	75.50	24%*
Slovenia	16.81	7.3	24.1	25.64	-6%
Slovakia	16.36	12.0	28.4	26.88	5%
Candidate countries & EFTA					
Switzerland	50.65	36.0	86.6	85.55	1%
Iceland	n.a	n.a	n.a	4.80	n.a.

Country	Intra-zonal [Thousand mio pkm]	Inter-zonal [Thousand mio pkm]	Total [Thousand mio pkm]	ETIF [Thousand mio pkm]	Variation (%)
Liechtenstein	0.08	0.4	0.4	n.a	n.a
Norway	36.49	24.2	60.7	59.84	1%
Croatia	15.52	11.8	27.3	25.70	6%
Former Yugoslav Republic of Macedonia	4.82	1.8	6.6	5.50	21%**
Turkey	289.25	72.9	362.2	125.20	189%***
Neighbouring countries					
Albania	4.38	2.1	6.4	n.a.	n.a.
Bosnia and Herzegovina	16.32	7.1	23.4	n.a.	n.a.
Montenegro	1.18	1.2	2.4	n.a.	n.a.
Serbia and Kosovo	26.15	11.23	37.38	n.a.	n.a.

* ETIF statistics for ROMANIA proved to be underestimated

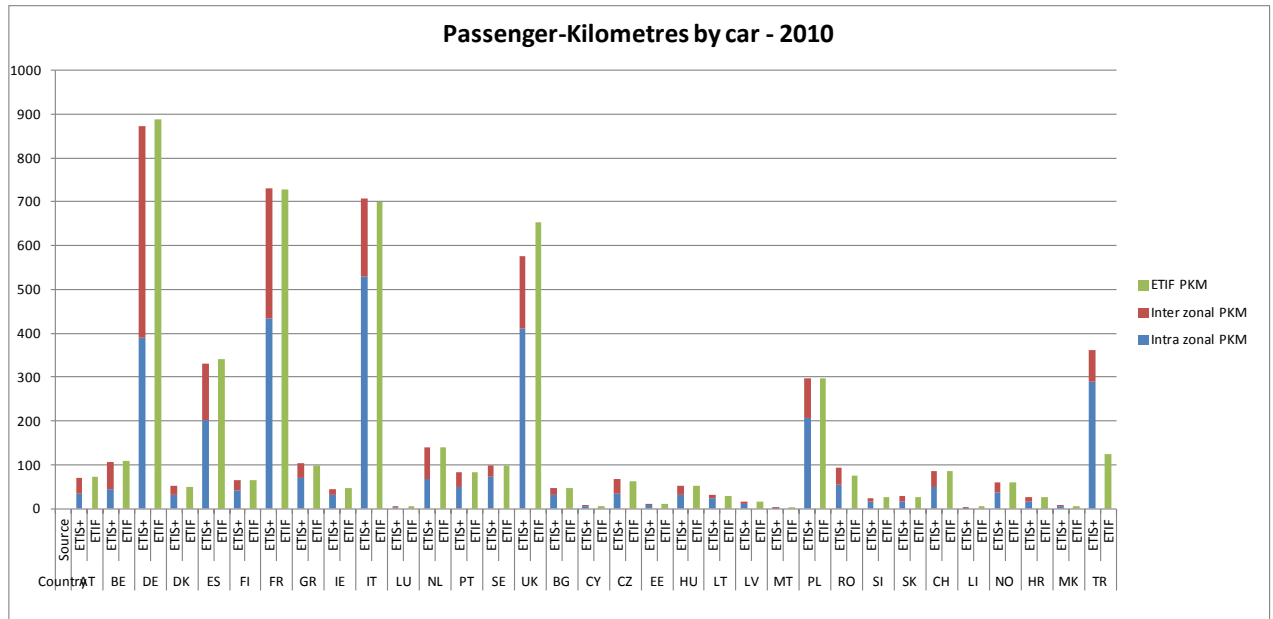
** ETIF statistics for FORMER YUGOSLAV REPUBLIC OF MACEDONIA proved to be underestimated

*** ETIF statistics for TURKEY proved to be underestimated

Figure 31-1: Car passenger trips, key results

Access via	Collection	Group	Description
ETIS View	Modelled Data	Passenger	Car passengers by O/D and trip purpose. (Separate tables for intrazonal car trips are available separately)
2010	http://viewer.etisplus.net/ select collection: ETISplus-2010-Modelled highlight: Passenger open tables: - Passenger transport by car		
2005	http://viewer.etisplus.net/ select collection: ETISplus-2005-Modelled highlight: Passenger open tables: - Passenger transport by car		

Figure 31-2: Comparison between total pass-km by car and ETIF statistics - 2010



32 Rail Passenger Matrix

The "Passenger trips by train" database includes total passenger trips by train, at NUTS 3 level (both intra-zonal and inter-zonal) differentiated by trip purpose:

- Business (trips for working purposes with different destination than the usual workplace),
- Private (non business related trips with duration of up to 4 days),
- Vacation (non-business trips with duration of more than 4 days),
- Commuting (daily trips for working or studying purposes).

32.1 Scope of the database

Table 32-1: Overview of the dataset, rail passenger matrix

Rail Passenger Matrix																														
Data feature	Data specification					Remarks																								
Base year	2010																													
Scope of data	Link	Terminal	O/D relation	Region	Other																									
	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>																									
GIS data	Yes	No																												
	<input type="checkbox"/>	<input checked="" type="checkbox"/>																												
Country coverage	<table><thead><tr><th></th><th>Completely</th><th>Partially</th></tr></thead><tbody><tr><td>EU 27</td><td><input checked="" type="checkbox"/></td><td><input type="checkbox"/></td></tr><tr><td>Candidate countries & EFTA</td><td><input checked="" type="checkbox"/></td><td><input type="checkbox"/></td></tr><tr><td>Neighbouring countries</td><td><input type="checkbox"/></td><td><input checked="" type="checkbox"/></td></tr><tr><td>TRACECA</td><td><input type="checkbox"/></td><td><input type="checkbox"/></td></tr><tr><td>MEDA</td><td><input type="checkbox"/></td><td><input type="checkbox"/></td></tr><tr><td>Other countries</td><td><input type="checkbox"/></td><td><input checked="" type="checkbox"/></td></tr><tr><td>Total number of countries covered:</td><td>42</td><td></td></tr></tbody></table>						Completely	Partially	EU 27	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Candidate countries & EFTA	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Neighbouring countries	<input type="checkbox"/>	<input checked="" type="checkbox"/>	TRACECA	<input type="checkbox"/>	<input type="checkbox"/>	MEDA	<input type="checkbox"/>	<input type="checkbox"/>	Other countries	<input type="checkbox"/>	<input checked="" type="checkbox"/>	Total number of countries covered:	42		
	Completely	Partially																												
EU 27	<input checked="" type="checkbox"/>	<input type="checkbox"/>																												
Candidate countries & EFTA	<input checked="" type="checkbox"/>	<input type="checkbox"/>																												
Neighbouring countries	<input type="checkbox"/>	<input checked="" type="checkbox"/>																												
TRACECA	<input type="checkbox"/>	<input type="checkbox"/>																												
MEDA	<input type="checkbox"/>	<input type="checkbox"/>																												
Other countries	<input type="checkbox"/>	<input checked="" type="checkbox"/>																												
Total number of countries covered:	42																													
Main data sources	National Travel surveys; EU Energy and Transport in Figures – Statistical Pocketbook 2010; National transport figures & statistics					Please refer to the model documentation.																								
Main type of data generation	Observed	<input type="checkbox"/>																												
	Harmonized	<input type="checkbox"/>																												
	Modelled	<input checked="" type="checkbox"/>																												

32.2 Data structure

Table 32-2: Data structure

Indicator	Description of indicator	Unit
Origin Zone	Origin Zone ID at NUTS 3 level	
Destination Zone	Destination Zone ID at NUTS 3 level	
Trip Purpose	Trip purpose	
Passenger Trips by train	Yearly trips	trips/year

The database includes also international trips from Russia, Belarus, Moldova and Ukraine to Europe and return.

The matrix is in the GA (Generation Attraction) format.

This implies that:

- the cell with ORIGIN ZONE A and DESTINATION ZONE B includes the trips made by people living in zone A and going to zone B and the corresponding return trips;
- the cell with ORIGIN ZONE B and DESTINATION ZONE A includes the trips made by people living in zone B and going to zone A and the corresponding return trips;
- the matrix is not symmetric.

32.3 Methodology – Intrazonal Trips by Rail

Two different methodologies are adopted for the production of the information included into these datasets.

A first one is related to the production of

- Intra-zonal trips (local transport); a second one is used for the modelling of
- Inter-zonal trips.

Inter-zonal methodology is described further on, in section 32.6. The methodology for intra-zonal trips is shown here.

The estimation of local demand has a general common approach for all considered transport modes (car, rail, bus, tram and metro, walking and cycling) but some differences exist for each transport mode.

The methodology heavily relies on available observed data: EUROSTAT and other international organizations statistics, national statistics, mobility studies, census data, National Travel Surveys, dedicated reports on public transport performances etc.

Here below the main steps of the modelling framework are explained.

32.3.1 Estimation of total trips by train

For the estimation of the intra-zonal car and rail trips, the methodology has benefited from the same approach adopted for the estimation of inter-zonal demand and in particular from the output of the implemented generation model (see below).

One of the output of this model is the vector of intra zone passenger trips by motorized modes (i.e. the sum of intra zone trips made by car and rail modes).

Given the above mentioned input, the methodology has mainly focused on splitting the trips between the two modes and on identifying the share of those trips within each distance band.

32.3.2 Zones and distance bands

The zoning system adopted for the estimation of 2010 local demand is the ETIS2006_zone_level3. The estimation of local demand is made for 39 countries: EU 27 + Accession + EFTA and the neighbouring countries Albania, Bosnia and Herzegovina, Montenegro, Serbia and Kosovo (1537 zones in total).

Four distance bands have been defined for the estimation of local transport demand:

- Distance Band 1: trips between 0 and 3 Km
- Distance Band 2: trips between 3 and 25 Km
- Distance Band 3: trips between 25 and 50 Km
- Distance Band 4: trips > 50 km.

The definition of these bands was made in relation to:

- Dimensions of ETISplus zoning system;
- Classifications currently used in available National Travel Surveys or other existing documentation.

In particular the first distance band is related to very short trips and to trips by slow modes (walking and cycling).

Distance bands 1 and 2 can be considered with a certain approximation as representative of urban trips, whereas the distance bands 3 and 4 are representative of interurban trips; particularly, distance band 4 is related to those trips, longer than 50 km, which start and end within the traffic zone.

The first step of the methodology was to identify the distance bands belonging to each zone; this was made by considering the dimension of the zone and in particular a "virtual" diameter derived by approximating the zone to a circle.

All ETIS zones have the first and the second distance bands; 1202 zones have the third distance band and 686 zones have also the fourth distance band.

In several cases the defined distance bands intercept the dimension of the "virtual" diameter. As an example the zone AT111 Mittelburgenland has a virtual diameter of about 30km. This implies that 100% of the trips within the first distance band (between 0 and 3 Km) can be supposed to start and end within the zone; in similar way, 100% of the trips belonging to the second distance band (trips between 3 and 25 Km) can be considered within the zone, but only a certain rate of the trips belonging to the third distance band (between 25 and 50 Km) can be supposed to start and end within the zone. Therefore for the distance bands that cross the virtual dimension of the zone the share of trips supposed to be intra-zonal is computed as a function of the virtual diameter and the upper threshold of the band.

For those zones that have the "virtual" diameter >50 Km (fourth distance band) it is assumed that the share of trips within the Level zone 3 is a function of the ratio between the "virtual" diameter and a fixed threshold of 150Km.

32.3.3 Distribution by distance bands

The distribution of trips within each distance band is made by deriving national coefficients from available sources. For some countries, it is possible to derive the share of trips by transport mode and by the defined distance band from available National Travel Surveys. In a first step, it is assumed that these rates apply to all trips generated by each single zone in the country.

From the available National Travel Surveys it is also possible to derive information on the average trip length within each distance band by transport mode. It is assumed that no rail trips exist in the first distance band (0 to 3 km).

In order to take into account the different nature of zones and the different availability of local rail services (metropolitan areas have generally more rail services than rural areas), additional coefficients have been estimated and calibrated on the basis of available information. In particular, for each country, different coefficients have been estimated on the basis of zone population in order to identify metropolitan areas, big urban areas, urban areas and rural zones.

The estimation of these coefficients has benefited from consideration on zone dimensions and population and from statistics at zonal level (when available).

32.3.4 Distribution by trip purposes

Based on the information provided by several national travel surveys, the shares of trips by mode and by purpose have been derived at national level. The distribution covered commuting, business and private trip purposes. Where information was not available, data from similar countries has been used as reference.

An additional step was made to include the different characteristics of zones with regard to the amount of Economically Active population. For this purpose, the

shares previously computed at national level have been adjusted according to the characteristics of the zones at Zone3 level: based on the ratio between active and total population by zone, the share of commuting and business trips have been increased/decreased depending on the difference with respect to the average national value.

32.3.5 Final comparison

The refinement of local demand estimation was made through the joint comparison of intra and inter zonal demand, both in terms of trips and traffic performances, in order to match EUROSTAT statistics for rail and car modes.

32.4 Data sources - Intrazonal

The modelling of local passenger demand has benefited from an extensive data collection; data was gathered from several available sources and it varies from transport statistics, mobility studies, national travel surveys, census data, dedicated reports etc.

As a general remark, it has to be stated that usually traffic data are not available at zone level; in the most of the cases statistics are available at national level or at a more aggregate level than the one adopted by the ETIS zoning system. Statistics are generally more available for public transport than for private transport.

Here below the list of data sources considered for the modelling on intra zone passenger trips by car and rail modes is reported.

Table 32-3: Data sources, Intrazonal Rail Passengers

Country	Data source
International database	ec.europa.eu/transport/publications/statistics/pocketbook-2010_en.htm http://stats.oecd.org UNECE Transport Division Database http://w3.unece.org Eurostat table rail_pa_total
EU27	
Austria	www.statistik.at
Belgium	http://www.plan.be
Bulgaria	Data Collected from Bulgarian Ministry of Transport
Czech Republic	www.czso.cz
Denmark	http://www.statbank.dk National Travel Survey
Estonia	www.stat.ee
Finland	www.stat.fi National Travel Survey http://www.hlt.fi
France	www.developpement-durable.gouv.fr www.insee.fr National Travel Survey
Germany	www.destatis.de National Travel Survey
Hungary	www.ksh.hu
Ireland	http://census.cso.ie
Italy	www.istat.it www.isfort.it
Latvia	www.stat.gov.lt

Country	Data source
Netherlands	Mobiliteitsonderzoek Nederland 2007
Poland	National Travel Survey www.stat.gov.pl
Romania	Data Collected from Romanian Ministry of Transport
Slovakia	www.statistics.sk
Spain	http://www.ine.es
Sweden	www.sl.se National Travel Survey http://www.sika-institute.se/
United Kingdom	www.tfl.gov.uk www.dft.gov.uk/statistics National Travel Survey
Candidate countries & EFTA	
Croatia	Data Collected from Croatian Ministry of Transport
Norway	www.ssb.no
Switzerland	www.bfs.admin.ch
Turkey	www.turkstat.gov.tr
Neighbouring countries	
Bosnia and Herzegovina	Data Collected from Ministry of Transport of Bosnia and Herzegovina
Serbia	Data Collected from Ministry of Transport of Serbia

32.5 Results - Intrazonal

The table below summarizes the modelled intrazonal trips by train at country level.

Table 32-4: Intrazonal passenger trips by rail, 2010

Country	Modelled passenger trips by train (intra-zonal)
EU27	
Austria	197,514,008
Belgium	158,766,624
Germany	2,067,128,338
Denmark	159,921,918
Spain	524,616,651
Finland	55,185,017
France	888,812,039
Greece	5,574,144
Ireland	31,065,999
Italy	725,236,402
Luxembourg (Grand-Duché)	17,074,885
Netherlands	203,287,150
Portugal	151,230,781
Sweden	160,252,399
United Kingdom	1,068,921,941
Bulgaria	23,826,989
Cyprus	-
Czech Republic	123,866,355
Estonia	4,240,062
Hungary	109,782,751
Lithuania	2,098,535
Latvia	17,107,184

Country	Modelled passenger trips by train (intra-zonal)
Malta	-
Poland	195,697,470
Romania	43,813,401
Slovenia	13,114,932
Slovakia	35,115,505
Candidate countries & EFTA	
Switzerland	331,782,222
Iceland	-
Liechtenstein	-
Norway	49,419,485
Croatia	61,416,752
Former Yugoslav Republic of Macedonia	1,207,639
Turkey	78,290,057
Neighbouring countries	
Albania	829,712
Bosnia and Herzegovina	853,671
Montenegro	17,913
Serbia	4,327,661
Kosovo	246,783

The table below summarizes the modelled intra-zonal pass-km by train at country level.

Table 32-5: Intrazonal passenger kms by rail, 2010

Country	Modelled pass-km by train (intra-zonal)
EU27	
Austria	2,799,172,723
Belgium	2,366,352,464
Germany	29,639,378,329
Denmark	2,642,739,976
Spain	8,808,780,048
Finland	1,653,937,722
France	27,860,804,006
Greece	210,264,581
Ireland	561,642,403
Italy	22,871,066,110
Luxembourg (Grand-Duché)	250,474,124
Netherlands	3,926,107,270
Portugal	2,318,711,138
Sweden	5,486,983,139
United Kingdom	20,879,126,384
Bulgaria	568,683,968
Cyprus	-
Czech Republic	2,748,216,939
Estonia	104,008,916
Hungary	3,586,192,005

Country	Modelled pass-km by train (intra-zonal)
Lithuania	52,299,389
Latvia	346,848,093
Malta	-
Poland	5,383,362,403
Romania	1,601,377,966
Slovenia	448,757,595
Slovakia	653,445,264
Candidate countries & EFTA	
Switzerland	7,854,230,261
Iceland	-
Liechtenstein	-
Norway	1,221,418,991
Croatia	936,934,644
Former Yugoslav Republic of Macedonia	37,347,862
Turkey	3,152,795,654
Neighbouring countries	
Albania	24,860,501
Bosnia and Herzegovina	40,242,013
Montenegro	428,880
Serbia	125,286,850
Kosovo	6,502,926

32.6 Methodology – Interzonal trips by train

The modelling of inter-zonal trips follows the classical 4-step approach:

- Generation model;
- Distribution model;
- Mode choice model;
- Assignment model.

To ensure consistency between rail and car trips at the level of O/D relations the passenger model covers rail and car trips.

The generation model computes the number of inter-zonal originating land based passenger trips by rail and car for all NUTS 3 regions, as well as the number of attracted trips and distinguishes by purpose. The joint consideration of passenger trip demand by rail and car as well as a rough estimation of passenger trip demand by other modes ensures consistency at the level of NUTS 3 regions with regard to originating trips.

The distribution model applies a gravity model to compute the distribution of generated origin trips by rail and car to respective destinations.

At the level of O/D relations, the mode choice model computes the shares of passenger trips by rail and car in relation to the respective travel costs for both modes. Finally, the assignment model computes the networks loads for rail and

car based on the previous computed trip matrices which distinguishes four purposes and the two modes rail and car. At the level of networks links the comparison of observed AADTs with modelled loads enables a refinement of previous sub-models of the 4-step model (feedback-loop).

Further information is available in the ETISplus Passenger Model documentation.

32.7 Data Sources - Interzonal

Several data sources were exploited such as national travel surveys and passenger transport statistics on the European or National level. Based on the observed data several key indicators were derived such as 'passenger trips per capita by country, purpose and mode' and 'passenger mileage by country, purpose and mode'.

Further information is available in the ETISplus Passenger Model documentation (section: harmonisation process).

32.8 Results - Interzonal

The following table summarises the number of inter-zonal passenger trips by train for every country. This indicator was calculated based on the G/A matrices. It covers only outward trips by train and not the return. For this reason, figures show only half of the trip demand.

Table 32-6: Interzonal passenger trips, 2010

Country	Passenger outward trips by train (inter-zonal)
EU27	
Austria	19,970,707
Belgium	27,142,797
Germany	141,750,382
Denmark	10,257,642
Spain	16,563,759
Finland	5,805,293
France	102,764,824
Greece	3,411,387
Ireland	4,135,185
Italy	60,949,921
Luxembourg (Grand-Duché)	445,316
Netherlands	70,853,557
Portugal	3,150,799
Sweden	11,048,605
United Kingdom	152,834,367
Bulgaria	3,926,388
Cyprus	-
Czech Republic	9,556,202
Estonia	366,700
Hungary	11,546,717

Country	Passenger outward trips by train (inter-zonal)
Lithuania	1,228,304
Latvia	1,431,526
Malta	-
Poland	34,704,578
Romania	11,107,465
Slovenia	1,349,557
Slovakia	5,862,252
Candidate countries & EFTA	
Switzerland	48,815,611
Iceland	-
Liechtenstein	-
Norway	3,865,722
Croatia	2,184,464
Former Yugoslav Republic of Macedonia, the	97,132
Turkey	3,919,875
Neighbouring countries	
Albania	250,372
Bosnia and Herzegovina	61,439
Montenegro	11,747
Serbia and Kosovo	1,014,841

The following table summarises modelled pkm for inter-zonal rail passenger demand. This indicator was calculated based on the G/A matrices and corresponding network impedances for the O/D relation. It covers outward and return trips by train.

Table 32-7: Interzonal passenger kms, 2010

Country	Modelled pkm (inter-zonal)
EU27	
Austria	7,447,830,331
Belgium	7,253,928,909
Germany	48,605,874,261
Denmark	3,654,442,694
Spain	13,685,330,072
Finland	2,140,810,480
France	57,071,984,403
Greece	1,396,900,127
Ireland	1,171,812,611
Italy	24,526,266,924
Luxembourg (Grand-Duché)	242,086,023
Netherlands	11,329,532,860
Portugal	2,087,974,437
Sweden	5,709,074,949
United Kingdom	32,695,802,885
Bulgaria	1,520,593,523
Cyprus	-

Country	Modelled pkm (inter-zonal)
Czech Republic	3,598,000,428
Estonia	96,233,233
Hungary	3,519,645,896
Lithuania	427,019,639
Latvia	395,946,117
Malta	-
Poland	10,794,179,769
Romania	3,848,355,428
Slovenia	373,705,413
Slovakia	1,588,168,855
Candidate countries & EFTA	
Switzerland	10,378,507,547
Iceland	-
Liechtenstein	-
Norway	1,926,548,893
Croatia	763,376,202
Former Yugoslav Republic of Macedonia, the	41,216,083
Turkey	2,356,430,771
Neighbouring countries	
Albania	54,148,240
Bosnia and Herzegovina	31,259,306
Montenegro	24,611,398
Serbia and Kosovo	399,166,869

Table and graph here below provide with an overview of the overall comparison between total pass-km by train (both intra and inter zonal) and the ETIF statistics for 2010.

32.8.1 Key results

Figure 32-1: Rail passenger trips, key results

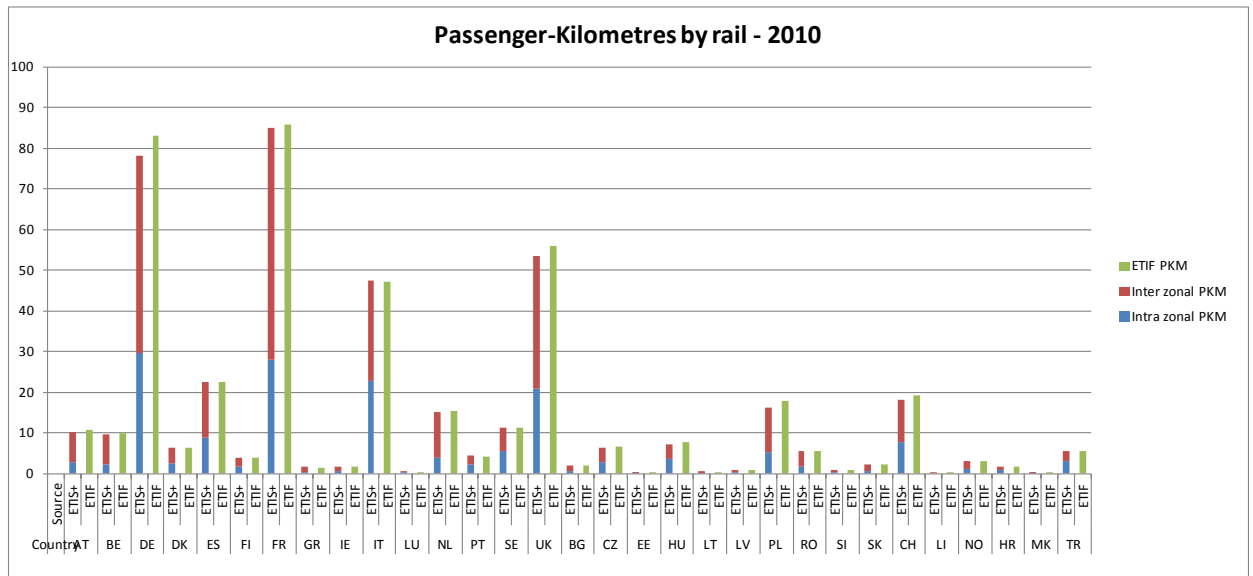
Access via	Collection	Group	Description
ETIS View	Modelled Data	Passenger	Rail passengers by O/D and trip purpose. (Separate tables for intrazonal car trips are available separately)
2010	http://viewer.etisplus.net/ select collection: ETISplus-2010-Modelled highlight: Passenger open tables: - Passenger transport by rail		
2005	http://viewer.etisplus.net/ select collection: ETISplus-2005-Modelled highlight: Passenger open tables: - Passenger transport by rail		

Table 32-8: Intra and Inter- zonal passenger trips, ETIF comparison, 2010

Country	Intra-zonal [Thousand mio pkm]	Inter-zonal [Thousand mio pkm]	Total [Thousand mio pkm]	ETIF [Thousand mio pkm]	Variation (%)
EU27					
Austria	2.80	7.45	10.25	10.74	-5%
Belgium	2.37	7.25	9.62	10.03	-4%
Germany	29.64	48.61	78.25	83.03	-6%
Denmark	2.64	3.65	6.30	6.35	-1%
Spain	8.81	13.69	22.49	22.39	0%
Finland	1.65	2.14	3.79	3.96	-4%
France	27.86	57.07	84.93	85.85	-1%
Greece	0.21	1.40	1.61	1.34	20%
Ireland	0.56	1.17	1.73	1.68	3%
Italy	22.87	24.53	47.40	47.29	0%
Luxembourg (Grand-Duché)	0.25	0.24	0.49	0.35	42%
Netherlands	3.93	11.33	15.26	15.40	-1%
Portugal	2.32	2.09	4.41	4.11	7%
Sweden	5.49	5.71	11.20	11.20	0%
United Kingdom	20.88	32.70	53.57	55.83	-4%
Bulgaria	0.57	1.52	2.09	2.10	0%
Cyprus	-	-	-	-	-
Czech Republic	2.75	3.60	6.35	6.59	-4%
Estonia	0.10	0.10	0.20	0.25	-19%

Country	Intra-zonal [Thousand mio pkm]	Inter-zonal [Thousand mio pkm]	Total [Thousand mio pkm]	ETIF [Thousand mio pkm]	Variation (%)
Hungary	3.59	3.52	7.11	7.69	-8%
Lithuania	0.05	0.43	0.48	0.37	28%
Latvia	0.35	0.40	0.74	0.75	-1%
Malta	-	-	-	-	-
Poland	5.38	10.79	16.18	17.92	-10%
Romania	1.60	3.85	5.45	5.44	0%
Slovenia	0.45	0.37	0.82	0.81	1%
Slovakia	0.65	1.59	2.24	2.31	-3%
Candidate countries & EFTA					
Switzerland	7.85	10.38	18.23	19.12	-5%
Iceland	-	-	-	-	-
Liechtenstein	-	-	-	-	-
Norway	1.22	1.93	3.15	3.08	2%
Croatia	0.94	0.76	1.70	1.74	-2%
Former Yugoslav Republic of Macedonia	0.04	0.04	0.08	0.16	-49%
Turkey	3.15	2.36	5.51	5.49	0%
Neighbouring countries					
Albania	0.02	0.05	0.08	n.a.	n.a.
Bosnia and Herzegovina	0.04	0.03	0.07	n.a.	n.a.
Montenegro	0.00	0.02	0.03	n.a.	n.a.
Serbia and Kosovo	0.13	0.40	0.53	n.a.	n.a.

Figure 32-2: Comparison between total pass-km by train and ETIF statistics - 2010



33 Tram and Metro Passenger Matrix

The database includes total passenger trips by tram and metro at the year 2010, at NUTS3 level differentiated by trip purpose:

- Business (trips for working purposes with different destination than the usual workplace),
- Private (non business related trips with duration of up to 4 days),
- Vacation (non-business trips with duration of more than 4 days),
- Commuting (daily trips for working or studying purposes).

33.1 Scope of the database

Table 33-1: Overview of the dataset, tram and metro passengers

Tram and Metro Passenger Matrix																														
Data feature	Data specification					Remarks																								
Base year	2010																													
Scope of data	Link	Terminal	O/D relation	Region	Other																									
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>																									
GIS data	Yes	No																												
	<input type="checkbox"/>	<input checked="" type="checkbox"/>																												
Country coverage	<table><thead><tr><th></th><th>Completely</th><th>Partially</th></tr></thead><tbody><tr><td>EU 27</td><td><input checked="" type="checkbox"/></td><td><input type="checkbox"/></td></tr><tr><td>Candidate countries & EFTA</td><td><input checked="" type="checkbox"/></td><td><input type="checkbox"/></td></tr><tr><td>Neighbouring countries</td><td><input checked="" type="checkbox"/></td><td><input type="checkbox"/></td></tr><tr><td>TRACECA</td><td><input type="checkbox"/></td><td><input type="checkbox"/></td></tr><tr><td>MEDA</td><td><input type="checkbox"/></td><td><input type="checkbox"/></td></tr><tr><td>Other countries</td><td><input type="checkbox"/></td><td><input type="checkbox"/></td></tr><tr><td>Total number of countries covered:</td><td>39</td><td></td></tr></tbody></table>						Completely	Partially	EU 27	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Candidate countries & EFTA	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Neighbouring countries	<input checked="" type="checkbox"/>	<input type="checkbox"/>	TRACECA	<input type="checkbox"/>	<input type="checkbox"/>	MEDA	<input type="checkbox"/>	<input type="checkbox"/>	Other countries	<input type="checkbox"/>	<input type="checkbox"/>	Total number of countries covered:	39		
	Completely	Partially																												
EU 27	<input checked="" type="checkbox"/>	<input type="checkbox"/>																												
Candidate countries & EFTA	<input checked="" type="checkbox"/>	<input type="checkbox"/>																												
Neighbouring countries	<input checked="" type="checkbox"/>	<input type="checkbox"/>																												
TRACECA	<input type="checkbox"/>	<input type="checkbox"/>																												
MEDA	<input type="checkbox"/>	<input type="checkbox"/>																												
Other countries	<input type="checkbox"/>	<input type="checkbox"/>																												
Total number of countries covered:	39																													
Main data sources	EU Energy and Transport in Figures – Statistical Pocketbook 2010; Figures & statistics of local transport network; www.lrta.org					See below for more details																								
Main type of data generation	Observed	<input type="checkbox"/>																												
	Harmonized	<input type="checkbox"/>																												
	Modelled	<input checked="" type="checkbox"/>																												

33.2 Data structure

Table 33-2: Data structure

Indicator	Description of indicator	Unit
Origin Zone	Origin Zone ID at NUTS3 level	
Destination Zone	Destination Zone ID at NUTS3 level	
Trip Purpose	Trip purpose	
Passenger Trips by tram and metro	Yearly trips	trips/year

It is assumed that there are no trips by tram and metro for vacation purpose. Trips are intra-zone and refer to the zoning system of the ETISplus project at the year 2005.

33.3 Methodology

Tram and metro modes are generally strictly related to the urban context of mobility and usually not widely available in all cities (zones) of the Countries. Therefore the estimation carried on for the purpose of the ETISplus project has followed a bottom-up approach, starting from the identification of cities where these transport services were in place at 2010 and followed by a collection of data (where available) at urban level. The consistency of urban indicators (both in terms of trips and pass-km) was then checked against aggregated data at national level available from several data sources (e.g. EUROSTAT).

33.3.1 Estimation of total trips

Data for metro and tram has been collected and estimated separately, in order to take into account the differences between the two modes in terms of average distances and network availability and allow for a more detailed evaluation of local demand.

The first step for the estimation consisted in collecting available data at local level on transport demand (passenger carried and passenger-km) by metro and tram modes, according to the list of cities where these public transport networks exist. Where punctual data was not available, information from national statistics was distributed among the zones according to an indicator related to the length of the network and amount of population living in the zone (therefore potential users of the system). For London, Manchester and Paris, where the urban area covered by the public transport network is split in more than one ETISplus zone, an additional step has been required in order to distribute the share of inter zone trips: specific data has been collected for this purpose.

33.3.2 Distribution by distance bands

In order to improve the accuracy of the estimate, the distribution of trips among different distance bands was taken into account. As mentioned above, tram and metro systems are related to the urban context of mobility, therefore only distance bands 1 (0 to 3 Km) and 2 (3 to 25 Km) have been taken into account. According to collected data, the average distance travelled by both tram and metro is usually lower than the one travelled by bus mode (e.g. in Germany the average distance is 6.2 km by bus, 4.1 by tram and 4.8 km by metro). The reason for the difference might be related to the structure of the network, which is usually less extensive and diffused. Therefore, starting from the parameters already estimated for the bus mode, the distribution have been adjusted in order to reproduce the average distance travelled by tram and metro: in the distance band 1 the share of trips is slightly increased with respect to the bus mode, while the average distance is the same; in the distance band 2 the average distance travelled is generally lower than the bus mode. Where possible, local condition and/or the availability of detailed information have been taken into account. Finally, the estimated data have been aggregated at national level and compared with the available statistics.

It should be noticed that collected data refers to the total amount of trips made by tram and metro, regardless of the zone of residence of the traveller. Therefore, especially in the case of large cities, collected statistics include also tourists and commuters travelling within the city by these modes. This evidence is reflected in the modelled data.

33.3.3 Distribution by trip purposes

The last step of the estimation consisted in the distribution of trips by purpose. Based on the information provided by several national travel surveys, the shares of trips by tram and metro and by purpose has been derived at national level. The distribution covered commuting, business and private trip purposes. Where information was not available, data from similar countries has been used as reference. An additional step was made to include the different characteristics of zones with regard to the amount of Economically Active population. For this purpose, the shares previously computed at national level have been adjusted according to the characteristics of the zones at NUTS3 level: based on the ratio between active and total population by zone, the share of commuting and business trips have been increased/decreased depending on the difference with respect to the average national value.

Additional assumptions were made in order to take into account the additional share of tourists travelling by tram and metro in some attractive zones (e.g. capital or other touristic cities); for these specific zones the share of private trips was adjusted based on the estimated comparison between the potential usage of these services by tourists (assumed to be 3 days/tourist in average) and the potential usage by residents (assumed to be 365 days/resident).

33.3.4 Final comparison

The final comparison in terms of pass-km was made against EUROSTAT data at national level, resulting in a satisfactory level of approximation.

33.4 Data Sources

Here below the list of data sources considered for the modelling on intra zone passenger trips by tram and metro modes is reported.

Table 33-3: Data sources

Country	Data source
International database	ec.europa.eu/transport/publications/statistics/pocketbook-2010_en.htm www.lrt.org
EU27	
Austria	www.wienerlinien.at www.ivb.at www.holding-graz.at/linien
Belgium	www.stib.be www.infotec.be
Bulgaria	www.metropolitan.bg www.nsi.bg
Czech Republic	www.czso.cz
Denmark	intl.m.dk/
Estonia	www.hot.ee/tallinnatramm/history110.html
Finland	www.stat.fi
France	www.stif.info www.developpement-durable.gouv.fr
Germany	www.destatis.de www.bvg.de www.vdv.de www.vgf-ffm.de www.mvg-mobil.de www.vgn.de
Greece	www.oasa.gr
Hungary	www.ksh.hu
Ireland	www.cso.ie
Italy	www.mit.gov.it www.trail.liguria.it/Mobil_passeggeri/TPL.htm www.agenziamobilita.roma.it
Latvia	www.rigassatiksme.lv
Netherlands	www.ret.nl
Poland	www.metro.waw.pl
Portugal	www.metroisboa.pt www.carris.pt/ www.stcp.pt/
Romania	www.metrorex.ro
Slovakia	www.statistics.sk
Spain	www.fgv.es
Sweden	www.sl.se
United Kingdom	www.tfl.gov.uk www.dft.gov.uk/statistics
Candidate countries & EFTA	
Croatia	www.dzs.hr
Norway	www.ssb.no
Switzerland	www.bfs.admin.ch www.stadt-zuerich.ch/content/vbz
Turkey	www.turkstat.gov.tr

Country	Data source
	www.estramp.com.tr
Neighbouring countries	-
Bosnia and Herzegovina	www.gras.ba
Serbia	www.gsp.rs

33.5 Results

Table 33-4: Tram and metro Passengers, Key results

Access via	Collection	Group	Description
ETIS View	Modelled Data	Passenger	Tram and metro passengers by O/D and trip purpose.
2010	http://viewer.etisplus.net/ select collection: ETISplus-2010-Modelled highlight: Passenger open tables: - Passenger trips by tram and metro		
2005	http://viewer.etisplus.net/ select collection: ETISplus-2005-Modelled highlight: Passenger open tables: - Passenger trips by tram and metro		

Here below the table summarizing the passenger trips by tram and metro by country (both at intra zone and extra zone level¹).

Table 33-5: Passenger trips by tram and metro, 2010

Country	Passenger trips by tram and metro
EU27	
Austria	891,731,300
Belgium	343,192,300
Germany	3,727,374,900
Denmark	52,000,000
Spain	1,228,814,000
Finland	113,022,900
France	2,914,713,470
Greece	219,479,200
Ireland	32,375,100
Italy	1,055,804,300
Luxembourg (Grand-Duché)	-

¹ For London, Manchester and Paris only.

Country	Passenger trips by tram and metro
Netherlands	410,664,800
Portugal	235,511,200
Sweden	435,211,700
United Kingdom	1,266,242,321
Bulgaria	183,298,000
Cyprus	-
Czech Republic	1,252,300,000
Estonia	30,275,600
Hungary	677,629,000
Lithuania	-
Latvia	41,007,500
Malta	-
Poland	1,165,859,300
Romania	803,670,000
Slovenia	-
Slovakia	89,629,900
Candidate countries & EFTA	
Switzerland	477,237,700
Iceland	-
Liechtenstein	-
Norway	121,078,300
Croatia	183,000,000
Former Yugoslav Republic of Macedonia, the	-
Turkey	557,556,300
Neighbouring countries	
Albania	-
Bosnia and Herzegovina	35,523,000
Montenegro	-
Serbia	108,014,900
Kosovo	-

Here below the table and the figure summarizing the comparison at the year 2010 in terms of yearly passenger-km by tram and metro at national level between modelled data and data from the EU Energy and Transport in Figures Statistical Pocketbook.

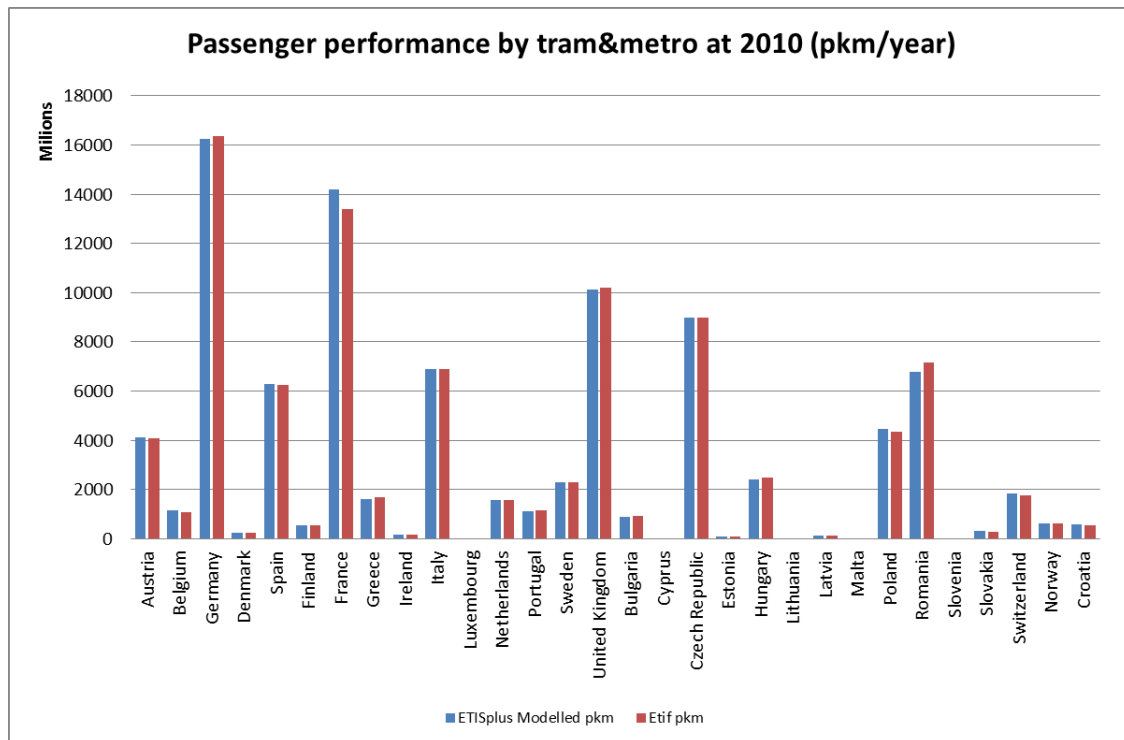
Table 33-6: Passenger kilometres by tram and metro, 2010

Country	Modelled pkm 2010	ETiF pkm 2010	% variation
EU27			
Austria	4,128,657,500	4,059,000,000	2%
Belgium	1,131,395,600	1,070,000,000	6%
Germany	16,243,286,800	16,349,000,000	-1%
Denmark	236,797,800	239,000,000	-1%
Spain	6,272,296,000	6,250,000,000	0%
Finland	543,290,300	530,000,000	3%

France	14,193,685,930	13,398,589,550	6%
Greece*	1,590,424,000	1,692,746,498	-6%
Ireland	145,921,700	143,847,997	1%
Italy	6,893,877,200	6,876,000,000	0%
Luxembourg (Grand-Duché)	-	-	-
Netherlands	1,575,744,500	1,580,301,937	0%
Portugal	1,101,180,500	1,133,233,000	-3%
Sweden	2,274,779,900	2,280,000,000	0%
United Kingdom	10,125,513,418	10,185,000,000	-1%
Bulgaria	898,046,200	909,000,000	-1%
Cyprus	-	-	-
Czech Republic	8,976,674,500	8,997,000,000	0%
Estonia	75,897,300	73,500,000	3%
Hungary	2,390,247,900	2,489,000,000	-4%
Lithuania	-	-	-
Latvia	126,051,000	123,000,000	2%
Malta	-	-	-
Poland	4,455,398,000	4,340,000,000	3%
Romania	6,758,761,000	7,138,710,098	-5%
Slovenia	-	-	-
Slovakia	305,881,600	283,443,100	8%
Candidate countries & EFTA			
Switzerland	1,832,292,000	1,768,000,000	4%
Iceland	-	-	-
Liechtenstein	-	-	-
Norway	624,848,700	620,000,000	1%
Croatia	565,085,900	549,357,000	3%
Former Yugoslav Republic of Macedonia, the	-	-	-
Turkey	2,067,720,600	n.a.	-
Neighbouring countries			
Albania	-	-	-
Bosnia and Herzegovina	110,642,800	-	-
Montenegro	-	-	-
Serbia	341,644,100	-	-
Kosovo	-	-	-

* Modelled data includes only metro and tram

Figure 33-1: Passenger performance by tram and metro, 2010



34 Cycling and Walking Matrix

Cycling and walking are shown as separate results in ETISplus. The "Passenger transport by walking" database contains the information on modelled total intra-zonal trips by walking while the analogous "Passenger transport by cycling" database includes the modelled intra-zonal trips by cycling.

Data is differentiated by four trip purposes:

- Business (trips for working purposes with different destination than the usual workplace),
- Private (non business related trips with duration of up to 4 days),
- Vacation (non-business trips with duration of more than 4 days),
- Commuting (daily trips for working or studying purposes).

It is assumed that there are no vacation trips by walking and cycling modes.

34.1 Scope of the database

Table 34-1: Overview of the dataset, cycling and walking

Cycling and Walking Matrix		
Data feature	Data specification	Remarks
Base year	2010	
Scope of data	<div> <div>Link</div> <div>Terminal</div> <div>O/D relation</div> <div>Region</div> <div>Other</div> </div> <div> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> </div>	
GIS data	<div>Yes</div> <div>No</div> <div> <input type="checkbox"/> <input checked="" type="checkbox"/> </div>	
Country coverage	<div> <div>Completely</div> <div>Partially</div> </div> <div> <div>EU 27</div> <div>Candidate countries & EFTA</div> <div>Neighbouring countries</div> <div>TRACECA</div> <div>MEDA</div> <div>Other countries</div> </div> <div> <input checked="" type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> </div> <div> <input type="checkbox"/> <input type="checkbox"/> </div> <div> Total number of countries covered: 39 </div>	
Main data sources	See below for more details	
Main type of data generation	<div>Observed</div> <div>Harmonized</div> <div>Modelled</div> <div> <input type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> </div>	

34.2 Data Structure

Table 34-2: Data structure of the Passenger transport by walking dataset

Indicator	Description of indicator	Unit
Origin Zone	Origin Zone ID at NUTS3 level	
Destination Zone	Destination Zone ID at NUTS3 level	
Trip Purpose	Trip purpose	
Passenger trips by walking	Yearly trips	trips/year

Table 34-3: Data structure of the Passenger transport by cycling dataset

Indicator	Description of indicator	Unit
Origin Zone	Origin Zone ID at NUTS3 level	
Destination Zone	Destination Zone ID at NUTS3 level	
Trip Purpose	Trip purpose	
Passenger trips by cycling	Yearly trips	trips/year

The tables have the structure of OD tables (to ensure consistency with the other tables included into the ETISplus passenger dataset) but, given the local nature of the transport modes covered, they only provide information within Level3 zones.

34.3 Methodology

In ETISplus the estimation of local demand has a general common approach for all considered transport modes (car, rail, bus, tram&metro, walking and cycling) but some differences exist for each transport mode.

The methodology heavily relies on available observed data: EUROSTAT and other international organizations statistics, national statistics, mobility studies, census data, National Travel Surveys, dedicated reports on public transport performances etc. Here below the main steps of the modelling framework are explained.

34.3.1 Estimation of total trips by walking and cycling modes

The first step for the estimation consisted in collecting available data on transport demand by walking and cycling modes. Unfortunately these transport modes are rarely considered in national statistics and therefore data was gathered from few available sources and mainly from mobility studies, national travel surveys, census data, dedicated reports etc. which allowed deriving personal trip rates and average distances by modes and purposes at national level.

For countries where no data was available, trip rates have been estimated making assumptions on similarities with other countries. These rates have then been applied to the zone population in order to estimate total intra-zonal trips by mode.

It was no possible to collect data allowing the differentiation of the demand by cycling among zones (e.g. by considering the length of cycle lanes within a zone) since this kind of indicator is generally available for few urban contexts and is not coherent with the definition of the ETISplus zoning system.

34.3.2 Zones and distance bands

The zoning system adopted for the estimation of 2010 local demand is the ETIS2006_zone_level3. The estimation of local demand is made for 39 countries: EU 27 + Accession + EFTA and the neighbouring countries Albania, Bosnia and Herzegovina, Montenegro, Serbia and Kosovo (1537 zones in total).

Four distance bands have been defined for the estimation of local transport demand:

- Distance Band 1: trips between 0 and 3 Km
- Distance Band 2: trips between 3 and 25 Km
- Distance Band 3: trips between 25 and 50 Km
- Distance Band 4: trips > 50 km.

The definition of these bands was made in relation to:

- Dimensions of ETISplus zoning system;
- Classifications currently used in available National Travel Surveys or other existing documentation.

In particular the first distance band is related to very short trips and to trips by slow modes (walking and cycling).

The first step of the methodology was to identify the distance bands belonging to each zone; this was made by considering the dimension of the zone and in particular a "virtual" diameter derived by approximating the zone to a circle.

All ETIS zones have the first and the second distance bands; 1202 zones have the third distance band and 686 zones have also the fourth distance band.

34.3.3 Distribution by distance bands

It is assumed that all walking and cycling trips are within the first distance band (i.e. below 3 km).

34.3.4 Distribution by trip purposes

The last step of the estimation consisted in the distribution of trips by purpose. Based on the information provided by several national travel surveys, the shares of trips and average distances by mode and by purpose have been derived at national level. The distribution covered commuting, business and private trip purposes.\

Where information was not available, data from similar countries has been used as reference.

An additional step was made to include the different characteristics of zones with regard to the amount of Economically Active population. For this purpose, the

shares previously computed at national level have been adjusted according to the characteristics of the zones at Zone3 level: based on the ratio between active and total population by zone, the share of commuting and business trips have been increased/decreased depending on the difference with respect to the average national value.

34.4 Data Sources

The modelling of ETISplus local passenger demand has generally benefited from an extensive data collection; data was gathered from several available sources and it varies from transport statistics, mobility studies, national travel surveys, census data, dedicated reports etc.

In the specific case of walking and cycling demand it has to be noted that unfortunately these transport modes are not considered in national statistics and therefore data was gathered from few available sources and mainly from mobility studies, national travel surveys, census data, dedicated reports etc.

Here below the list of data sources considered for the modelling on intra zone passenger trips by walking and cycling is reported.

Table 34-4: Data sources

Country	Data source
EU27	
Austria	Mobility study “Radfahren – Potenziale und Trends”
Denmark	National Travel Survey Bicycle statistics from Denmark
Estonia	www.stat.ee
Finland	National Travel Survey http://www.hlt.fi
France	www.insee.fr National Travel Survey
Germany	National Travel Survey
Hungary	Hungarian Central Statistical Office Data
Ireland	http://census.cso.ie
Italy	www.istat.it www.isfort.it
Netherlands	National Travel Survey Mobility study “Importance of cycling in the Netherlands”
Poland	www.stat.gov.pl
Sweden	National Travel Survey http://www.sika-institute.se/
United Kingdom	National Travel Survey Great Britain National Travel Survey Northern Ireland National Travel Survey Scotland
Candidate countries & EFTA	
Norway	PROMPT National reports Norway
Switzerland	Mobility study “La mobilité en Suisse Résultats du microrecensement 2005 sur le comportement de la population en matière de transports”

34.5 Results

Table 34-5: Cycling and walking, key results

Access via	Collection	Group	Description
ETIS View	Modelled Data	Passenger	Cycling and walking trips by O/D and trip purpose.
2010	http://viewer.etisplus.net/ select collection: ETISplus-2010-Modelled highlight: Passenger open tables: - Passenger trips by cycling - Passenger trips by walking		
2005	http://viewer.etisplus.net/ select collection: ETISplus-2005-Modelled highlight: Passenger open tables: - Passenger trips by cycling - Passenger trips by walking		

Here below the table summarizing the modelled passenger trips by walking and cycling at country level is provided.

Table 34-6: Modelled cycling and walking trips, 2010

Country	Modelled trips by walking	Modelled trips by cycling
EU27		
Austria	2,428,692,000	443,864,400
Belgium	2,775,014,400	997,270,800
Germany	23,769,549,300	10,537,016,700
Denmark	1,004,948,200	954,978,400
Spain	17,690,042,300	2,863,662,200
Finland	1,238,113,800	525,260,400
France	15,743,200,000	2,392,966,400
Greece	3,636,592,400	337,764,000
Ireland	1,096,277,000	62,644,400
Italy	19,923,614,900	3,270,137,400
Luxembourg (Grand-Duché)	151,473,400	15,198,000
Netherlands	3,232,944,000	4,907,443,200
Portugal	3,777,271,000	361,766,800
Sweden	2,270,032,600	797,325,500
United Kingdom	15,243,091,500	871,033,800
Bulgaria	2,253,445,200	390,302,600
Cyprus	382,992,500	41,121,300

Country	Modelled trips by walking	Modelled trips by cycling
Czech Republic	2,347,537,500	396,473,000
Estonia	381,928,500	54,944,100
Hungary	2,663,857,000	550,797,500
Lithuania	995,371,000	109,857,000
Latvia	708,246,000	78,694,000
Malta	176,662,200	14,929,200
Poland	9,473,500,800	2,559,373,200
Romania	8,854,348,300	321,586,500
Slovenia	507,586,500	55,039,500
Slovakia	1,249,153,000	108,622,000
Candidate countries & EFTA		
Switzerland	2,094,027,600	548,996,000
Iceland	77,017,575	8,948,100
Liechtenstein	9,585,300	2,513,000
Norway	1,128,666,000	478,828,000
Croatia	1,386,509,800	150,241,000
Former Yugoslav Republic of Macedonia	828,927,200	71,813,000
Turkey	29,883,552,000	2,563,540,000
Neighbouring countries		
Albania	1,233,631,000	146,363,000
Bosnia and Herzegovina	2,480,964,000	294,768,000
Montenegro	209,343,800	25,334,600
Serbia	2,333,664,000	284,415,300
Kosovo	580,832,000	70,788,900

Here below the table summarizing the modelled pass-km by walking and cycling at country level is provided.

Table 34-7: Person-kms by cycling and walking

Country	Modelled pass-km by walking	Modelled pass-km by cycling
EU27		
Austria	3,164,129,020	1,102,664,180
Belgium	4,010,682,078	3,377,544,619
Germany	34,540,273,283	34,686,907,204
Denmark	1,206,550,623	2,757,139,254
Spain	21,309,400,098	6,538,434,336
Finland	2,315,674,730	1,581,258,914
France	20,118,877,307	5,273,675,834
Greece	5,206,199,916	1,099,793,498
Ireland	1,236,761,730	240,044,052
Italy	28,861,838,381	10,767,831,591
Luxembourg (Grand-Duché)	219,271,099	40,735,187
Netherlands	3,280,490,797	14,958,493,909
Portugal	4,505,869,661	825,987,612
Sweden	3,174,605,452	2,279,829,030
United Kingdom	17,276,384,091	3,329,315,252

Country	Modelled pass-km by walking	Modelled pass-km by cycling
Bulgaria	2,464,571,439	1,046,152,738
Cyprus	553,992,554	133,893,715
Czech Republic	3,281,246,623	1,338,184,328
Estonia	610,091,003	201,811,144
Hungary	2,925,654,002	1,476,328,439
Lithuania	1,192,622,169	294,457,026
Latvia	844,986,100	210,927,172
Malta	255,544,288	48,610,611
Poland	10,403,533,192	6,859,887,824
Romania	12,807,351,389	1,047,103,709
Slovenia	608,105,711	147,522,996
Slovakia	1,496,631,746	291,144,495
Candidate countries & EFTA		
Switzerland	3,020,804,713	1,594,788,264
Iceland	130,929,878	28,633,920
Liechtenstein	13,875,567	8,731,323
Norway	1,915,650,071	1,521,085,287
Croatia	1,791,927,929	402,693,568
Former Yugoslav Republic of Macedonia	992,300,688	192,502,338
Turkey	43,233,474,557	8,430,722,306
Neighbouring countries		
Albania	1,476,587,612	392,290,218
Bosnia and Herzegovina	2,828,512,259	790,156,783
Montenegro	242,459,659	67,912,073
Serbia	2,783,718,377	762,309,964
Kosovo	672,713,157	189,757,129

Given the absence of observed statistics in terms of trips and passenger-km no comparison between observed and estimated data is possible.

35 Passenger Trips by Mode and Purpose

35.1 Scope of the database

Table 35-1: Overview of the dataset

Passenger Trips by Mode and Purpose						
Data feature	Data specification					Remarks
Base year	2010					
Scope of data	Link	Terminal	O/D relation	Region	Other	
	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
GIS data	Yes	No				
	<input type="checkbox"/>	<input checked="" type="checkbox"/>				
Country coverage				Completely	Partially	
	EU 27		<input checked="" type="checkbox"/>	<input type="checkbox"/>		
	Candidate countries & EFTA		<input checked="" type="checkbox"/>	<input type="checkbox"/>		
	Neighbouring countries		<input type="checkbox"/>	<input checked="" type="checkbox"/>		
	TRACECA		<input type="checkbox"/>	<input type="checkbox"/>		
	MEDA		<input type="checkbox"/>	<input type="checkbox"/>		
	Other countries		<input type="checkbox"/>	<input checked="" type="checkbox"/>		
	Total number of countries covered:		42			
Main data sources	See below for more details					
Main type of data generation	Observed	<input type="checkbox"/>				
	Harmonized	<input type="checkbox"/>				
	Modelled	<input checked="" type="checkbox"/>				

35.2 Data structure

Table 35-2: Data structure of the Total passenger trips by mode dataset

Indicator	Description of indicator	Unit
Origin Zone	Origin Zone ID at NUTS3 level	
Destination Zone	Destination Zone ID at NUTS3 level	
MODE_PAS	Passenger transport mode	
Total passenger trips by mode	Yearly trips	trips/year

Table 35-3: Data structure of the Total passenger trips by purpose dataset

Indicator	Description of indicator	Unit
Origin Zone	Origin Zone ID at NUTS3 level	
Destination Zone	Destination Zone ID at NUTS3 level	
Trip Purpose	Trip purpose	
Total passenger trips by purpose	Yearly trips	trips/year

The “Total passenger trips by mode” and the “Total passenger trips by purpose” datasets summarize the information on modelled inter-zonal trips by transport mode and trips purpose.

In particular the “Total passenger trips by mode” dataset includes the information of total inter-zonal trips by the following transport modes:

- Car
- Air
- Rail

while the “Total passenger trips by purpose” dataset includes the information related to the same transport modes but disaggregated by the four trip purposes:

- Business (trips for working purposes with different destination than the usual workplace),
- Private (non business related trips with duration of up to 4 days),
- Vacation (non-business trips with duration of more than 4 days),
- Commuting (daily trips for working or studying purposes).

The tables are not in the GA (Generation Attraction) format, but in the OD (Origin Destination) format.

This implies that:

- the number of trips between zone A and zone B is the total number of trips occurring between the two zones and it is provided regardless of the nationality of travellers;
- the matrix is symmetric.

The matrices are provided in the Origin Destination format in order to provide a comparison of matrices that **originally** have a different format (i.e. the Generation Attraction matrices for car and rail and the Origin Destination matrix for air).

Intra-zonal trips are not included.

The bus mode is not included into these tablee because it covers only part of inter-zonal demand (Demand for non-scheduled long-distance services (e.g.

touristic coach services) and short-distance services between ETIS Zoning level 3 regions is not covered).

35.3 Methodology, data sources and results

These tables are intended as summary tables obtained through the aggregation of the following tables:

- Passenger trips by car
- Passenger trips by rail
- Passenger trips by air

The matrices include all the Origin Destination pairs of car and rail matrices integrated with the data for the air mode of the corresponding OD. The Origin Destination pairs available only in the matrix for air mode have not been included (since data for car and rail was not available).

See the corresponding metadata files for an overview of methodology, data sources and results.

36 Passenger Trips by Destination, Mode and Purpose

36.1 Scope of the database

Table 36-1: Overview of the dataset

Passenger Trips by Destination, Mode and Purpose						
Data feature	Data specification					Remarks
Base year	2010					
Scope of data	Link	Terminal	O/D relation	Region	Other	
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
GIS data	Yes	No				
	<input type="checkbox"/>	<input checked="" type="checkbox"/>				
Country coverage				Completely	Partially	
	EU 27			<input checked="" type="checkbox"/>	<input type="checkbox"/>	
	Candidate countries & EFTA			<input checked="" type="checkbox"/>	<input type="checkbox"/>	
	Neighbouring countries			<input type="checkbox"/>	<input checked="" type="checkbox"/>	
	TRACECA			<input type="checkbox"/>	<input type="checkbox"/>	
	MEDA			<input type="checkbox"/>	<input type="checkbox"/>	
	Other countries			<input type="checkbox"/>	<input checked="" type="checkbox"/>	
	Total number of countries covered:			42		
Main data sources	See below for more details					
Main type of data generation	Observed <input type="checkbox"/> Harmonized <input type="checkbox"/> Modelled <input checked="" type="checkbox"/>					

36.2 Data structure

Table 36-2: Data structure of the Total passenger trips per destination and mode dataset

Indicator	Description of indicator	Unit
Destination Zone	Destination Zone ID at NUTS3 level	
MODE_PAS	Passenger transport mode	
Total passenger trips per destination and mode	Yearly trips	trips/year

Table 36-3: Data structure of the Total passenger trips per destination and purpose dataset

Indicator	Description of indicator	Unit
Destination Zone	Destination Zone ID at NUTS3 level	
Trip Purpose	Trip purpose	
Total passenger trips per destination and purpose	Yearly trips	trips/year

The “Total passenger trips per destination and mode” and the “Total passenger trips per destination and purpose” datasets summarize the information on total modelled destination trips (both inter-zonal and intra-zonal) respectively by transport mode and trip purpose.

The tables are elaborated from matrices in the OD (Origin Destination) format, not in the GA (Generation Attraction) format.

The matrices are provided in the Origin Destination format in order to provide a comparison of matrices that originally have a different format (i.e. the Generation Attraction matrices for car and rail and the Origin Destination matrix for air).

In particular the “Total passenger trips per destination and mode” dataset includes the information on total attracted trips by the following transport modes:

- Car
- Air
- Rail
- Tram&metro
- Walking
- Cycling

while the “Total passenger trips per destination and purpose” dataset includes the information related to the same transport modes but disaggregated by the four trip purposes:

- Business (trips for working purposes with different destination than the usual workplace),
- Private (non business related trips with duration of up to 4 days),
- Vacation (non-business trips with duration of more than 4 days),
- Commuting (daily trips for working or studying purposes).

The bus mode is not included into these tables because it covers only part of demand (Demand for non-scheduled long-distance services (e.g. touristic coach services) and short-distance services between ETIS Zoning level 3 regions is not covered).

36.3 Methodology, data sources and results

These tables are intended as summary tables obtained through the aggregation of the following tables:

- Passenger trips by car
- Passenger trips by rail
- Passenger trips by air
- Passenger trips by tram&metro
- Passenger trips by walking
- Passenger trips by cycling

See the corresponding metadata files for an overview of methodology, data sources and results.

37 Passenger trips by Origin, Mode and Purpose

37.1 Scope of the databases

Table 37-1: Overview of the dataset

Passenger trips by Origin, Mode and Purpose							
Data feature	Data specification					Remarks	
Base year	2010						
Scope of data	Link	Terminal	O/D relation	Region	Other		
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>		
GIS data	Yes	No					
	<input type="checkbox"/>	<input checked="" type="checkbox"/>					
Country coverage				Completely	Partially		
	EU 27			<input checked="" type="checkbox"/>	<input type="checkbox"/>		
	Candidate countries & EFTA			<input checked="" type="checkbox"/>	<input type="checkbox"/>		
	Neighbouring countries			<input type="checkbox"/>	<input checked="" type="checkbox"/>		
	TRACECA			<input type="checkbox"/>	<input type="checkbox"/>		
	MEDA			<input type="checkbox"/>	<input type="checkbox"/>		
	Other countries			<input type="checkbox"/>	<input checked="" type="checkbox"/>		
	Total number of countries covered:			42			
Main data sources	See below for more details						
Main type of data generation	Observed	<input type="checkbox"/>	Harmonized	<input type="checkbox"/>	Modelled	<input checked="" type="checkbox"/>	

37.2 Data structure

Table 37-2: Data structure of the Total passenger trips per origin and mode dataset

Indicator	Description of indicator	Unit
Origin Zone	Origin Zone ID at NUTS3 level	
MODE_PAS	Passenger transport mode	
Total passenger trips per origin and mode	Yearly trips	trips/year

Table 37-3: Data structure of the Total passenger trips per origin and purpose dataset

Indicator	Description of indicator	Unit
Origin Zone	Origin Zone ID at NUTS3 level	
Trip Purpose	Trip purpose	
Total passenger trips per origin and purpose	Yearly trips	trips/year

The “Total passenger trips per origin and mode” and the “Total passenger trips per origin and purpose” datasets summarize the information on total modelled originated trips (both inter-zonal and intra-zonal) respectively by transport mode and trip purpose.

The tables are elaborated from matrices in the OD (Origin Destination) format, not in the GA (Generation Attraction) format.

The matrices are provided in the Origin Destination format in order to provide a comparison of matrices that originally have a different format (i.e. the Generation Attraction matrices for car and rail and the Origin Destination matrix for air).

In particular the “Total passenger trips per origin and mode” dataset includes the information of total originated trips by the following transport modes:

- Car
- Air
- Rail
- Tram&metro
- Walking
- Cycling

while the “Total passenger trips per origin and purpose” dataset includes the information related to the same transport modes but disaggregated by the four trip purposes:

- Business (trips for working purposes with different destination than the usual workplace),
- Private (non business related trips with duration of up to 4 days),
- Vacation (non-business trips with duration of more than 4 days),
- Commuting (daily trips for working or studying purposes).

The bus mode is not included into these tables because it covers only part of demand (Demand for non-scheduled long-distance services (e.g. touristic coach services) and short-distance services between ETIS Zoning level 3 regions is not covered).

37.3 Methodology, data sources and results

These tables are intended as summary tables obtained through the aggregation of the following tables:

- Passenger trips by car
- Passenger trips by rail
- Passenger trips by air
- Passenger trips by tram&metro
- Passenger trips by walking
- Passenger trips by cycling

See the corresponding metadata files for an overview of methodology, data sources and results.

38 Passenger Modelling methodology

38.1 Overview: scope and methodology

WP9 of ETISplus deals with the computation of passenger demand at the level of O/D relations¹. The final results of WP9 are several trip matrices distinguished by purpose² and mode³, which contain the number of passenger trips for the respective O/D relation. Trips that originate and end in the same region are called intra-zonal, otherwise such trips are called inter-zonal.

The main responsibilities in WP9 are split among three project partners. The work-package leader, TRT, is responsible for intra-zonal passenger trip⁴ demand and inter-zonal trip demand by coach⁵. MKmetric is responsible for passenger trip demand by air⁶. KIT is responsible for inter-zonal passenger trip demand by rail and car.

To ensure consistency of the final trip matrices, intermediately, the results were exchanged and discussed continuously among partners throughout the duration of the project. Certainly, models of TRT and KIT rely on the same geographical scope. For the second base year 2010, the NUTS 3⁷ zoning system of 2006 was used. The model covers EU27, Norway, Switzerland, candidates and neighbouring countries. For modelling purposes of land-based, inter-zonal passenger trips, non-accessible regions were excluded from the model. In line with 2005, Iceland has not been considered. Such regions with a large distance to continental Europe are, for instance, the French overseas islands or the Canary Islands. For Russia, Moldavia, Ukraine and Belarus, only international trips to Europe were modelled. Hence, the situation for the Russian enclave Kaliningrad is very particular since Russian transit traffic through Lithuania is not reported by the final trip matrices. Furthermore, all regions which are located in the east of the Ural were aggregated to one region to reduce the model size.

The model follows the 4-step approach:

- (1) Generation model;
- (2) Distribution model;
- (3) Mode choice model;
- (4) Assignment model.

The generation model computes the number of trips by rail and car that are generated by an origin region, as well as the number of trips that are attracted by a destination region for all NUTS 3 regions and all purposes. The distribution model applies a gravity model to compute the distribution of generated origin

¹ O/D relation: relation from origin to destination

² Purposes are: business, commuting, private, vacation.

³ Modes are: air, coach, rail, private car.

⁴ Additional modes are considered for intra-zonal trips: non-motorised/ slow modes and local public transport modes.

⁵ See WP9 metadata – Passenger trips by bus and coaches 2010.

⁶ See WP9 metadata – Passenger trips by air 2010.

⁷ NUTS: Nomenclature of Territorial Units for Statistics.

trips to respective destinations. At the level of O/D relations, the mode choice model computes the shares of passenger trips by rail and of passenger trips by car in relation to the respective travel costs for both modes. Finally, the assignment model computes the networks loads for rail and car based on the previously computed trip matrices, which distinguish between four purposes and two modes.

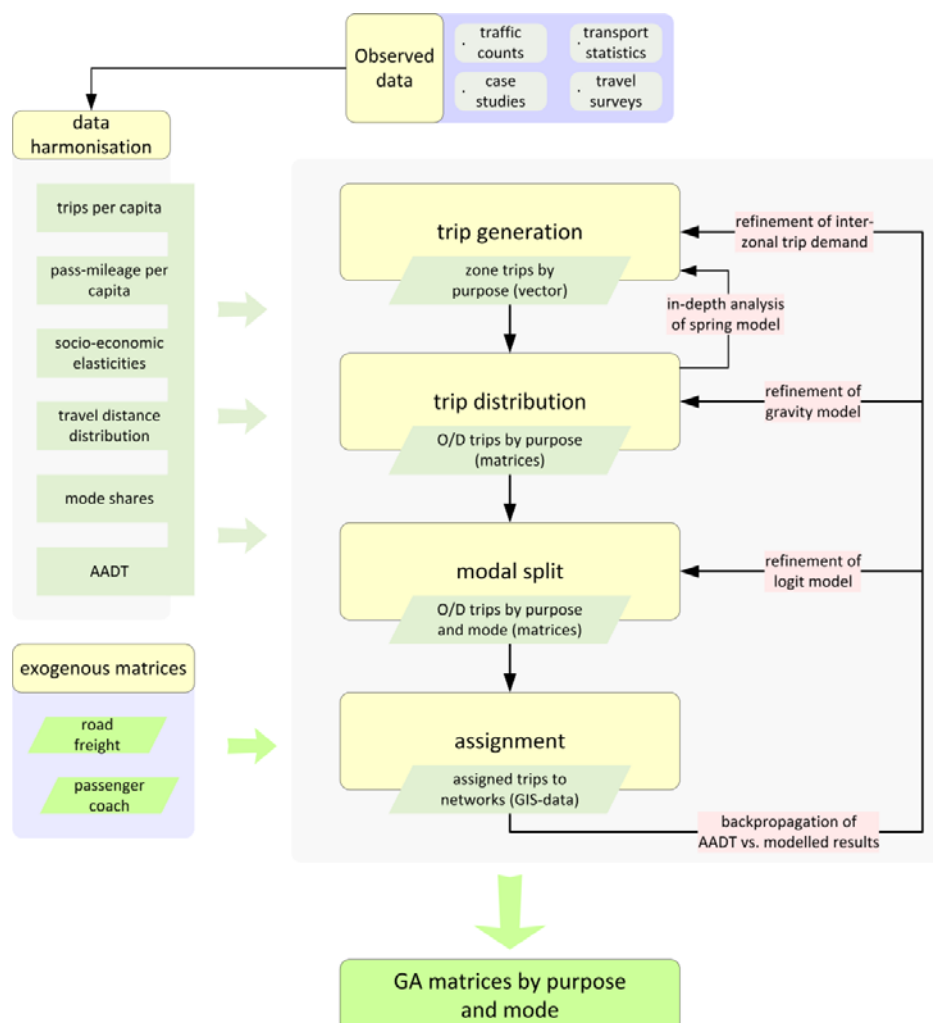
Two different strategies are applied to calibrate the model:

- (1) Iterative calibration of every model step to fit a priori constraints;
- (2) Feedback loop of model discrepancies to previous modules.

Every model is calibrated iteratively to satisfy its constraints which were computed a priori. For instance, the marginal total of all computed trips for the respective country has to be consistent with the statistics (generation model). The feedback loop is largely based on the comparison of modelled loads with AADTs at the level of network-links (assignment model). The application of a modified Furness model (see distribution model) enables a second feedback loop.

The figure below shows the entire model:

Figure 38-1: Passenger model: modules, statistics and calibration strategies



The following sections involve the computation of inter-zonal passenger demand by the modes rail and car.

38.2 Methodology

38.2.1 Step 0: Survey-analysis and harmonisation process

The passenger model of KIT deals with inter-zonal trips by rail and car. Several data sources have been exploited to allow modelling of several macroeconomic aspects and to calibrate the model:

Surveys	e.g. UK NTS (DfT 2008), German MOP (Zumkeller <i>et al.</i> 2007), Danish NTS (DTU 2011), Mobilität in der Schweiz (BFS <i>et al.</i> 2007), German MiD (infas <i>et al.</i> 2010), Finish NTS (Finnra and The Finnish Rail Administration 2006), Netherlands NTS (MVW 2010), Italian NTS (ISFORT 2010)
Statistics	e.g. EU energy and transport in figures (EC 2009), national transport statistics, statistics on commuting trips on regional level
Studies	e.g. iTREN-2030 (Fiorello <i>et al.</i> 2009), Rail Baltica (COWI <i>et al.</i> 2006), Mobility in German cities (Ahrens <i>et al.</i> 2009)
Other	e.g. traffic counts for rail and road ¹ , O/D matrices and results of EU-projects such as ETIS-BASE (NEA <i>et al.</i> 2005), iTREN-2030, TINA-TURKEY (TINA Transport Strategies <i>et al.</i> 2007), TEN-CONNECT (Petersen <i>et al.</i> 2009)

According to availability of socio-economic data, network impedances and GIS data, key elasticities based on travel surveys are determined in this step. Such elasticities enable modelling of different mobility patterns, for instance in order to distinguish between urban and rural regions. The comprehensive analyses of several travel surveys and transport-related statistics pursues a second goal: the definition of boundary conditions such as passenger-mileage or passenger-trips by mode and by purpose on national level, where the model will ultimately satisfy.

As a result of the data analysis and harmonisation process, a complete data set which covers model parameters, elasticities and socio-economic indicators is generated. This data set is used as input in the 4-step model.

¹ Further information is available in the documentation of WP7, networks

38.2.2 Analysis of socio-economic data, network impedances and GIS data

Modelling of socio-economic aspects of the population requires indicators. Such indicators are selected according to the following criteria:

- (1) Completeness of the indicator for all NUTS 3 zones;
- (2) Significance of the indicator to derive mobility patterns;
- (3) Availability of the indicator in travel surveys (observed data)

The analysis of data gaps of the indicators (1) highlights the fact that complete data sets rather are exceptional on the level of NUTS 3-zones. With regard to the effort to overcome data gaps and to the criteria (2) and (3), following indicators have been selected:

GDP	Key driver to model mobility patterns with regard to travel-budget restrictions;
Area	Allows distinction of intra-zonal and inter-zonal trips;
PPS	Purchasing power standard: weighting of national differences in currency;
Population	Key driver to determine the trip demand on the level of NUTS 3 zones;
Age, gender	Allows modelling of different mobility patterns e.g. enables differentiation between pupils and employed persons;
Jobs	The number of jobs correlates with the number of commuting trips and indicates prosperity of the region;
Cars	The number of cars correlates with the number passenger trips by car;
Tourism	The number of hotels and hotel beds correlates with the number of attracted vacation trips.

To allow modelling of geographic aspects of the region further indicators such as its accessibility, its centrality or its neighbours are derived based on the analysis of networks and GIS data.

38.2.3 Analysis of travel surveys and statistics

Two major constraints for the passenger model are the number of passenger trips and passenger mileage by purpose and by mode per year on national level. In order to allow modelling of different mobility patterns, several elasticities were derived such as:

- Variance of trip demand by cohort indicators (age, gender);
- Variance of trip demand by economic indicators (e.g. income);
- Variance of trip demand by region type (e.g. level of urbanisation);
- Variance of trip demand by spatial indicators (e.g. centrality).

38.2.4 Harmonisation process/ conduction of indicators

With regard to data availability, it can be concluded that only few European countries publish comprehensive travel surveys. Often, different survey methodologies are used e.g. different definitions of the observed population, purposes or modes. Especially for the new member states, data availability in terms of mobility data is poor. However, it can be concluded, that for most countries travelled mileage per capita by mode, which is one of the two key parameters, could be derived based on national statistics or surveys. The situation for trips per capita, especially by car is less favourable. For trips by rail several sources were exploited such as Eurostat¹, UIC², UNECE³ and national sources. The general approach to generate a consistent data set is as follows:

- (1) Harmonisation of surveys to ETISplus definitions (purposes, modes);
- (2) Analysis of inconsistencies and data gaps;
- (3) Evaluation of feasible solutions and application of regression models.

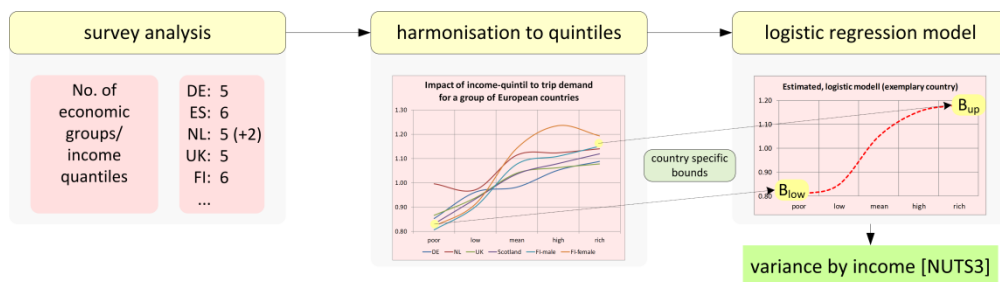
The subsequent regression exemplary illustrates the estimation of elasticities between the economic status of a person and individual trip rates (see Figure 38-2) After evaluation of several travel surveys three major trends can be identified:

- (1) Mobility increases with increasing income;
- (2) With increasing prosperity of a country discrepancy of (1) decreases;
- (3) The respective outlier class differs more from the national average.

A logistic model which relates mobility changes to the income level of a country is applied to model (1) – (3).

The approach is illustrated below.

Figure 38-2: Impact of income to generation of trips per capita



As an outcome of the survey analysis, the correlation between income level and variation of trip demand compared to the national average is investigated. The correlation follows a logistic function which is limited by a lower bound B_{low} and an upper bound B_{up} . The lower bound B_{low} shows the weighting factor to model the decreased mobility for the lowest income group. On the other hand, the upper bound B_{up} shows the weighting factor to model the increased mobility of

¹ Eurostat: Statistical office of the European Union

² UIC: International Union of Railways

³ UNECE: United Nations Economic Commission for Europe

the highest income group. The bounds B_i , $i = \{low, up\}$ are estimated for each country according to following logistic regression model:

$$B_i f(x) = \frac{A_i^1 + A_i^2}{1 + \left(\frac{x}{x_i^0}\right)^p} + A_i^2$$

The explanatory variable x refers to the country-specific indicator GDP per head in purchasing power parities given in relation to EU27¹. The parameter estimation of A_i^1 , A_i^2 , x_i^0 , p was performed with the data analysis software OriginPro².

After determination of the two country-specific bounds, B_{low} and B_{up} , a logistic model is applied to compute the weighting factor for the respective NUTS 3 region i :

$$\Phi(c_i) = \frac{1}{1 + e^{-5c_i^2 - 0.5}}$$

As already mentioned above, the value range of the logistic model $\Phi(c)$ is limited to B_{low} , B_{up} . Mobility of the most prosperous NUTS 3 region of a country is increased to B_{up} . The explanatory variable c_i refers to the GDP-level of the respective NUTS 3 region i . The parameter λ is left mutable to allow calibration of the logistic model within the generation step (4-step-model).

Taking only the recently derived elasticity covering income-level into account and disregarding all other elasticities which affect mobility, the computation of the total trip demand for a given NUTS 3 region i would satisfy following equation:

$$T_i = POP_i * avgTRIPS_{pc}^{ctry} * \Phi(c_i)$$

POP_i represents the total population of a given NUTS 3 region; $avgTRIPS_{pc}^{ctry}$ represents the average number of annual trips per capita for the corresponding country which is an outcome of the survey analysis.

Three comparable regression models were estimated to depict elasticities between the indicators age and gender, the derived indicator degree of urbanisation, the indicators accessibility and availability of cars, and mobility patterns.

Please note that for the majority of countries no suitable survey data could be accessed. Given the fact that survey data for countries with a low income level was missing, reliability of the regression had to be ensured by comparing computed trip rates to available data sources such as transport statistics, economic studies or observed traffic flows.

¹EU energy transport in figures: statistical pocketbook, table: General data (EC 2009)

² OriginLab, data analysis and graphing software

38.2.5 Trip distance frequency distribution (TDFD)

Besides the computation of mobility indicators and their applicability towards elasticities, the travel survey analysis pursues another major goal. The trip distance frequency function (TDFD) shows the probability of trips in relation to the travel distance and is therefore the most important input to the distribution model. See section 2.3.2 for further details.

38.2.6 Step 1: Generation model

The generation model can be sub-divided in four parts (A, B, C, D) which address the computation of:

- A: The number of generated trips per region by purpose (origin trips);
- B: The share of inter-zonal origin trips;
- C: The number of attracted trips by purpose (destination trips);
- D: The intra-zonal trip demand by slow modes.

For every NUTS 3 region a set of such parameters is computed. These set is used within the subsequent distribution step.

38.2.7 Computation of origin trips

In the first run, the total trip demand of an origin region is computed and the total trip demand is derived on country level. The total trip demand $TRIPS^{ctry}$ covers all trips of all purposes and by the modes passenger rail and car for all respective NUTS 3 regions on country level. $TRIPS^{ctry}$ is one of the a priori constraints the generation step has to fulfil. The application of the previous computed elasticities within the survey analysis allows to address various mobility patterns which are derived based on the socio-economic indicators of the respective NUTS 3 region i :

- ϕ_i^{coh} Modelling of elasticities by cohort indicators (age, gender);
- ϕ_i^{eco} Modelling of elasticities by economic indicators (GDP, employment);
- ϕ_i^{mob} Modelling of elasticities by mobility constraints (level of urbanisation, car availability);
- ϕ_i^{spa} Modelling of elasticities by spatial indicators (accessibility, centrality).

The country-specific adjustment is ensured by the calibration of the mutable parameters (see section 2.1) within the modules ϕ_i^{coh} , ϕ_i^{eco} , ϕ_i^{mob} , ϕ_i^{spa} . Moreover, this approach assures the fulfilment of the constraint:

$$TRIPS^{ctry} = \sum_{i \in origin^{ctry}} POP_i * avgTRIPS_{pc}^{ctry} * f(\phi_i^{coh}, \phi_i^{eco}, \phi_i^{mob}, \phi_i^{spa})$$

POP_i represents the total population of a given NUTS 3 region i ; $avgTRIPS_{pc}^{ctry}$ represents the average number of annual trips per capita for the corresponding country; $f(\dots)$ is to be understood as adjustment factor for the current NUTS 3 region i which covers the elasticities mentioned above.

38.2.8 Estimation of inter-zonal share

The second task deals with the computation of the intra-zonal share s_i^{intra} for every NUTS 3 region i . Intra-zonal trips start and end in the origin zone, inter-zonal trips do not. The share of inter-zonal trips decreases with increasing region size. For the purpose of simplification, the radius¹ of a zone is used as a threshold to distinguish between intra- and inter-zonal trips. The trip-distance frequency distribution (TDFD), which is an outcome of the travel survey analysis, is applied to the zone-radius for computation of the intra-zonal share.

The estimation covers three further aspects. Indicator I_{JOB} depicts the employment ratio compared to the country average; I_{TYPE} informs about the urbanisation degree; indicator I_{GIS} , which has been computed based on GIS-data and network impedances, shows the degree of non-accessibility and non-centrality of the origin i :

$$s_i^{intra} = (TDFD(zone_radius_i) * F(I_{JOB}, I_{TYPE}, I_{GIS})) * \hat{\omega}_i^{PAC}$$

The last term, a weighting factor, $\hat{\omega}_i^{PAC}$ incorporates all kinds of regional peculiarities which arise during validation of subsequent model steps. Therefore, $\hat{\omega}_i^{PAC}$ can not be estimated a priori by a generic approach and has to be determined manually by exploiting various studies for the affected region(s). For instance, a study on mobility in German cities could prove the high number of intra-zonal trips of Berlin. This was already indicated by the first assignment results since AADTs² and computed network loads show significant discrepancies.

With regard to the inhomogeneous situation concerning size and shape of NUTS 3 regions and the distribution of population within the region, it can be concluded that the situation for Berlin is not an isolated case. However, in most cases, modelling uncertainties is less significant and therefore less relevant.

38.2.9 Computation of attraction indicators

Different purpose-specific proxies are used to express the attractiveness of a region and to compute the number of destination trips which end in the current region, the following indicators have been used as proxies:

Business	GDP and jobs;
Commuting	Jobs;
Private	Population;
Vacation	Hotels and hotel-beds.

38.2.10 Intra-zonal trip demand by slow modes

The last task involves the estimation of trips by slow modes (non-motorised modes). Indeed, such trips are not relevant for the modelling of traffic loads on rail and road networks on the European scale. However, joint consideration of all

¹ Assumption: all regions are treated as circles to allow computation of their radius

² AADT: annual average daily traffic (for further details, see documentation of WP7)

transportation modes provides several validation possibilities to avoid major inconsistencies¹ on the level of NUTS 3 zones.

Mostly, relevance of motorised trips increases with increasing prosperity of a country and vice versa.

Hence, computation of trip demand by slow modes is very similar to section 2.2.1. Certainly, the four modules ϕ_i^{coh} , ϕ_i^{eco} , ϕ_i^{mob} , ϕ_i^{tpa} , which have already been calibrated, are applied reciprocal and polynomial weakened. For this reason, trip demand by slow modes only cover aspects which arise during the modelling of trips by motorised modes. All intra-zonal aspects with regard to local trips by tram, metro or bus, are not covered by the current modelling approach of KIT.

For the subsequent model steps trips by non-motorised modes (slow modes) are not relevant.

38.2.11 Step 2: Distribution model

A gravity model is applied to compute the G/A matrices² for all purposes. From the previous model step, the computed inter-zonal origin trips, destination attractiveness are used as input. Furthermore, the generalised transport cost (GTC) for an O/D relation³ as travel impedance w . Known from the Swiss transport model, the so-called EVA-function is used as deterrence function. The EVA function provides a number of advantages in contrast to classical deterrence functions such as the exponential or the power function, which are not to be further explained at this point (see Lohse *et al.* 1997).

The four transport purposes are treated independently; four models are estimated for the distribution of passenger trips by rail and car. In the following sections the indices which represent the purpose are not stated out for the reason of clarity.

38.2.12 Computation of travel impedances

At the level of O/D relations the generalised transport costs w are computed for passenger trips by rail and car. For the distribution, the weighted average of both cost components is used.

The computation of w satisfies the equation:

$$w = \alpha_{\text{rail}} (\gamma_1 * \text{cost}_{\text{rail_time}} + \gamma_2 * \text{cost}_{\text{rail_tarife}}) + \alpha_{\text{road}} (\gamma_3 * \text{cost}_{\text{road_time}} + \gamma_4 * \text{cost}_{\text{road_dist}})$$

¹ Further details see documentation: modelling of intra-zonal trip demand.

² G/A matrices: the generation attraction approach was used; the G/A matrices are not symmetric.

³ O/D relation: origin-destination relation.

where

$cost_{rail_time}$	Network based travel time including access-egress time;
$cost_{rail_tarife}$	Price information system-based travel cost;
$cost_{road_time}$	Network-based travel time, including access-egress time;
$cost_{road_dist}$	Network-based travel distance, including tolls, vehicle costs;
$\gamma_{1,2,3,4}$	Average weighting factors on country level;
$\sigma_{rail}, \sigma_{road}$	Average share of mode on country level.

The computation of the parameters underlying the impedances uses three major data inputs: the network-model, time-tables and price-information systems. Further information is available in the documentation of WP7.

38.2.13 Calibration of the deterrence function

The EVA-function satisfies the equation:

$$f(w) = (1 + w)^{\varphi(w)}$$

where

$$\varphi(w) = \frac{E}{1 + e^{F - \sigma w}}$$

In contrast to the classical definition of the EVA-function, two addition parameters p_1 and p_2 are introduced to improve the model accuracy for short distance and long distance trips. The extended EVA-function has five degrees of freedom and satisfies the equation:

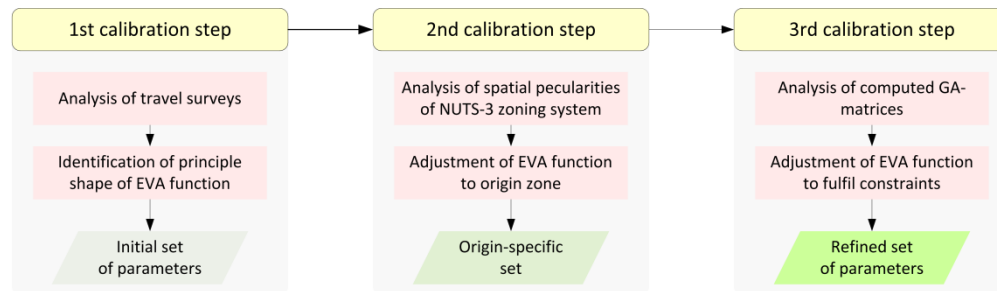
$$f(w) = (1 + w^{p_1})^{\varphi(w)}$$

where

$$\varphi(w) = \frac{E}{1 + e^{F - \sigma w^{p_2}}}$$

The subsequent section describes the calibration process which takes place in three steps (see below).

Figure 38-3: Calibration of the EVA deterrence function



Country-specific parameter sets are calculated based on a precise fit of the EVA function to the respective country-specific trip distance frequency distribution (TDFD). The TDFDs are derived directly from national travel surveys. In the case of data being unavailable from surveys, the country-specific TDFD was derived from a comparable country by the comparison of their socio-economic key indicators and mobility statistics. The conversion $Conv(d \rightarrow w)$ between travel distance d , which is used within travel surveys, and GTC w , which is used within the distribution model, is done based on country-specific average travel costs (avgTC):

$$Conv(d \rightarrow w): w = d * avgTC$$

The adjusted distribution function satisfies the constraints origin trip demand, trip distance frequency distribution and travelled mileage per capita on national level.

The second calibration step involves a rule-based adjustment of the country-specific TDFD to a dedicated NUTS 3 region. Socio-economic aspects as well as spatial aspects and local peculiarities such as the presence of border-crossing economic areas or infrastructure capacity constraints, are considered for the refinement of the TDFD to the respective NUTS 3 region. For instance, trip demand in terms of total trips per capita of (partly) isolated NUTS 3-regions is often lower in comparison to central regions from which many destinations could be reached with short distance trips. Simultaneously, mileage travelled per capita is often greater for non-centralised regions.

The last calibration step ensures the compliance with the constraints e.g. total travelled mileage and total trip demand. However, the low level of detail of the NUTS 3-based data, the high differences between NUTS 3-regions in terms of their spatial extension, their network density, and other unobservable characteristics, in addition to the complexity of the gravity model itself, therefore requires an iterative approach for the parameter adjustment. This methodology is similar to the EM algorithm.

38.2.14 Gravity model/ initialisation

A gravity model is applied to compute the G/A matrices. The O/D cells of the matrices are initialised using the following calculation:

$$T_{ij} = \alpha_{ij} * \frac{O_i * D_j}{f(w)^{-1}}$$

where

T_{ij}	Computed trips between origin i and destination j ;
O_i	Computed inter-zonal origin trips (see generation);
D_j	Computed attraction of destination (see generation);
$f(w)$	Deterrence function, w refers to travel costs between origin and destination, value range: $f(w) \in [0, 1]$;
α_{ij}	Weighting factor to satisfy $\sum_{j \in D} T_{ij} = O_i$ where D : destinations.

After initialisation, the four matrices satisfy two of the three constraints: the origin trip constraint and the TDFD constraint, but not the destination trip constraint.

38.2.15 Gravity model/ extended Furness model

In order to fulfil also the destination trip constraint the Furness model¹ is applied. The Furness model follows an iterative approach to balance the two marginal totals:

- (1) The generated origin trips;
- (2) The estimated destination trips.

It was found, that the ordinary, linear balancing approach skews the matrices towards populous origins and destinations. For this reason the Furness model was extended by a non-linear elastic component. The extended model provides several advantages:

- (1) Specification of a confidence range that the final adjustment factors, which are computed at the level of O/D relations, have to satisfy;
- (2) Increased stability of the final trip matrices due to the non-linear elastic balancing approach;
- (3) Additional validation possibilities at the level of NUTS 3 regions, which are normally available after application of the assignment model.

The non-linear elastic component satisfies the equation:

$$X_{ij} = c_x * x_{ij}$$

where

x_{ij}	Adjustment factor for O/D cell i,j as calculated iteratively by the classical Furness model;
X_{ij}	Modified adjustment factor;
$[X_{low}, X_{up}]$	Confidence range; $x = 1$: no adjustment;
c_x	Non-linear component;

¹ See Ortuzár and Willumsen (2011)

In contrast to the classical Furness model, which adjusts the initialised non-balanced G/A matrix GA_{init} iteratively, the adjustment factors are stored in a separate adjustment matrix $A^{(t)}$. The calculation of the adjustment matrix $A^{(t+1)}$ for the next step $t+1$ satisfies the equation:

$$A^{(t+1)} = FM_{ext}(GA_{init} * A^{(t)})$$

Application of the extended Furness model FM_{ext} ensures that the adjustment factors x_{ij} do not exceed the given confidence range. The extended Furness model terminates once the changes between $A^{(t+1)}$ and $A^{(t)}$ become negligible. The final G/A matrix GA_{final} is calculated as follows:

$$GA_{final} = GA_{init} * A^{(final)}$$

The confidence range $[x_{low}, x_{up}]$ is determined empirically and correlates with the expected modelling uncertainties. Amongst other reasons, the inhomogeneous situation of the NUTS 3 regions with regard to their spatial extension causes uncertainties. For instance, a simplified model based on the radius of the NUTS 3 regions is applied for the computation of the number of inter-zonal trips (see generation model).

An evaluation of the final adjustment matrix $A^{(final)}$ identifies such O/D relations

The procedure terminates after finalisation of the non-linear oscillation process. If the spring deflection y exceeds the thresholds for less than 5% of the O/D relations, the given confidence range is accepted.

For such O/D relations where the final adjustment matrix $A^{(final)}$ exceeds the given confidence range, respective transportation cells go through a detailed post-analysis. For instance, the German capital Berlin (NUTS 3 code: DE300) was identified with this approach. The generation step exposed many inter-zonal trips which could not extend in the neighbouring regions of Berlin and several corresponding adjustment factors exceeded the given confidence range. A comprehensive post-analysis based on the study 'mobility in German cities' finally approved the high number of intra-zonal trips for Berlin compared to other German cities.

38.2.16 Modelling results of distribution model

After completion of the extended Furness model, there are four G/A matrices differentiated by purpose. The differentiation among passenger trips by rail and car is computed by the mode choice model, step 3 of the transportation model.

38.2.17 Step 3: Mode choice model

For the computation of the market shares by transport modes, a logit model is applied, which its basic form is given by the following equation:

$$P_{i,j}^m = \frac{e^{U_{i,j}^m}}{\sum_{m \in A(i,j)} e^{U_{i,j}^m}}$$

where

$P_{i,j}^m$	Probability for the choice of mode m on the O/D relation i,j
U_m	Utility of mode m
$A(i,j)$	Set of alternative modes on the O/D relation i,j

The modal choice set comprises two means of transport:

- Passenger car;
- Railways.

In order to bypass disadvantages of the classical logit models, such as linearity in variables, the logit model is enhanced by a Box-Cox transformation. In this way, the utility function is determined by:

$$U = \beta_0 + \beta_{TTC} * F_{TTC}^{\lambda_{TTC}}(X_k) + \beta_{GTC} * F_{GTC}^{\lambda_{GTC}}(X_l) + \hat{F}$$

where

$X_{k,l}$	Utility components, explanatory variables
β_i	Utility coefficients
λ_i	Box-Cox coefficients

The explanatory variables¹ represent the transport service level between zones i and j . The utility function differentiates between time-based travel cost (TTC) and distance-based generalised travel costs (GTC) which cover several explanatory variables (indicated by F_i). The third component \hat{F} is determined based on various analysis of the results and reflects the fact that regional peculiarities which, among other things, resulting of the inhomogeneous NUTS 3 zones could not be explained by the following explanatory variables which have been used to compute the utility functions:

- Total travel distance for rail (including access/ egress);
- Total travel time for rail (including access/ egress);
- Country-specific rail-tariff cost (differentiation between business and non-business);
- Total travel distance for road (including access/ egress);
- Total travel time for road (including access/ egress);
- Country-specific vehicle cost;
- Country-specific toll cost;
- Country-specific fuel cost;
- Country-specific value of time (VoT).

The resulting dataset is now comprised of eight G/A matrices and distinguishes between four purposes and two modes.

¹ The variables were computed in WP7- passenger supply, based on networks, rail tariff systems, etc.

38.2.18 Step 4: Assignment model

For the computation of traffic loads on the level of network links which result from the G/A matrices, the assignment sub-model of VACLAV was used. The VACLAV model developed at the IWW is a network-based passenger transport model whose European roots lie in the STEMM¹ project (Eberhard *et al.* 1998), and which has been developed continuously since its inception².

The model's geographical scope is the whole European continent, with Russia, Moldavia, Belarus and Ukraine considered as external zones. The zoning system of the traffic cells is mainly in line with the regional structure used by the European Union's statistical authority EUROSTAT, and represents NUTS 3 regions. Recently, the model's zoning system has been adjusted to the zoning systems applied in the ETISplus project.

For the allocation of traffic demand to the road network, an incremental assignment method is applied by road-type-specific speed-flow functions into account. The considered speed-flow functions represent curves that have been applied to transport infrastructure assessment on behalf of the German Ministry of Transport and Housing.

Moreover, the VACLAV passenger transport model has been applied in several major projects – mainly funded by the EU –, such as

- the STEMM project on behalf of the European Commission DG VII;
- the ETIS-BASE (Core Database Development for the European Transport Policy Information System) project on behalf of the European Commission, DG TREN (NEA *et al.* 2005)
- the TRANS-TOOLS (TOOLS for Transport forecasting And Scenario testing) project on behalf of the European Commission, DG TREN (Burgess *et al.* 2008);
- the Feasibility Study on the Rail Baltica railways on behalf of the European Commission, DG Regio (COWI *et al.* 2006);
- the TINA TURKEY project (Technical Assistance to Transport Infrastructure Needs Assessment for Turkey), on behalf of the European Commission/ EU Delegation in Turkey (TINA Transport Strategies *et al.* 2007);
- the WORLDNET (Worldwide cargo flows) project on behalf of the European Commission, DG TREN (NEA *et al.* 2009);
- and the ITREN-2030 (Integrated transport and energy baseline until 2030) project on behalf of the European Commission, DG TREN (Fiorello *et al.* 2009).

Further information regarding the methodology of VACLAV is available in the model documentation (Szimba and Kraft 2011).

¹ STEMM: Strategic European multi-modal modelling.

² The contents of this chapter are largely based on Szimba (2008).

38.2.19 Step 5: Feedback loop/ model calibration

The computation of modelled loads on the level of network links allows the comparison to observed data such as AADT. The identification of discrepancies begins with an iterative refinement process (feedback loop). Besides the minor recalibration of previous model stages, major discrepancies often refer to specific regional peculiarities such as:

- High international volumes for the Øresund region;
- High relevance of intra-zonal trips for Berlin.

However, some of these discrepancies refer to specific limitation of the model such as:

- Heterogenous situation regarding the NUTS 3 zones;
- Modelling of short distance trips;
- Heterogenous situation regarding the network density.

Since a generic approach cannot account for limitations or peculiarities, several parameter refinements had to be resolved manually after in-depth analysis. Some of these refinements address adjustments regarding the intra-zonal shares (generation step); some address modelling of specific regional capacity constraints or specific regional peculiarities (distribution step); and some address statistical effects with regard to access/ egress travel cost to the railway station which get less significant for long-distance trips (modal-choice step).

38.3 Results

The current chapter intends to give a rough overview of the scope and selected contents of the ETISplus passenger model.

Figure 38-4: Passenger trips per capita, Base year 2010

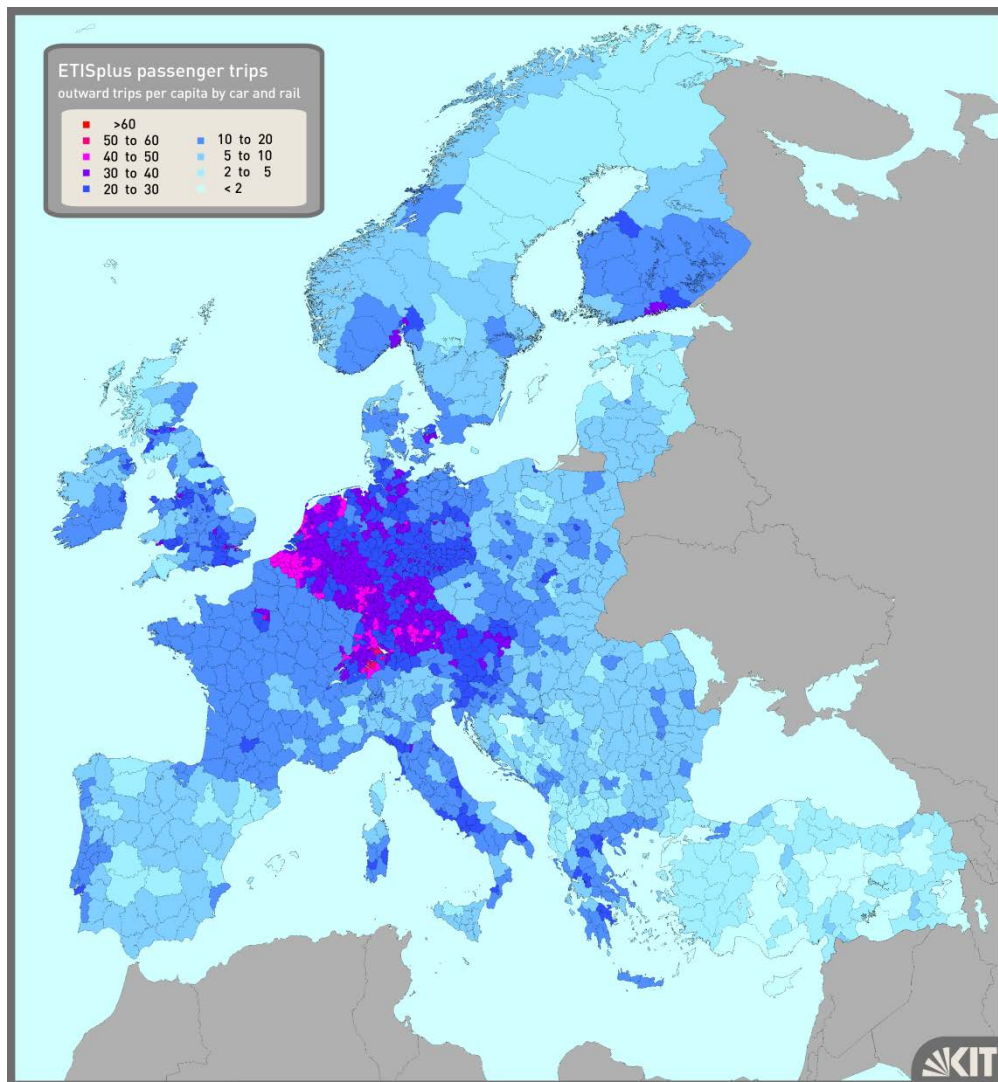


Figure 38-5: Road passenger flows, Base year 2010

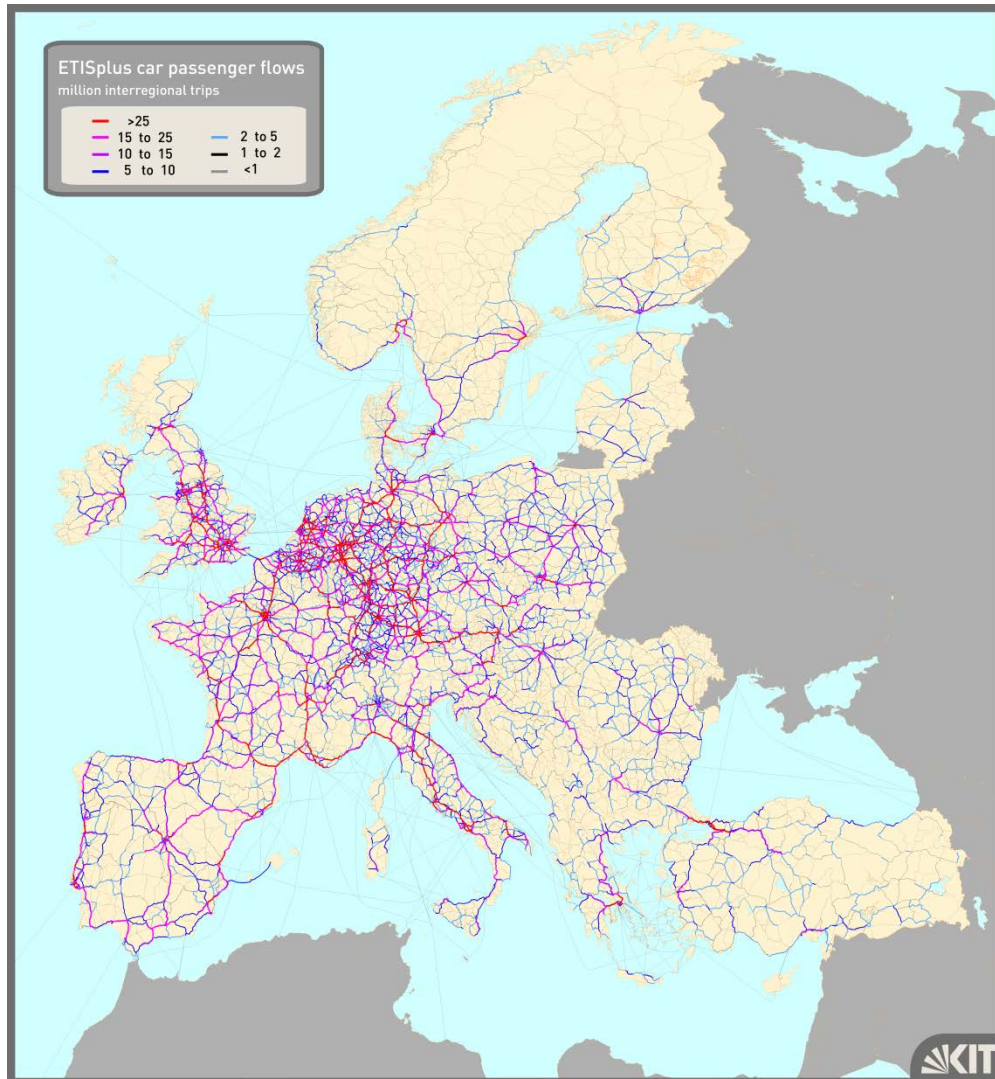
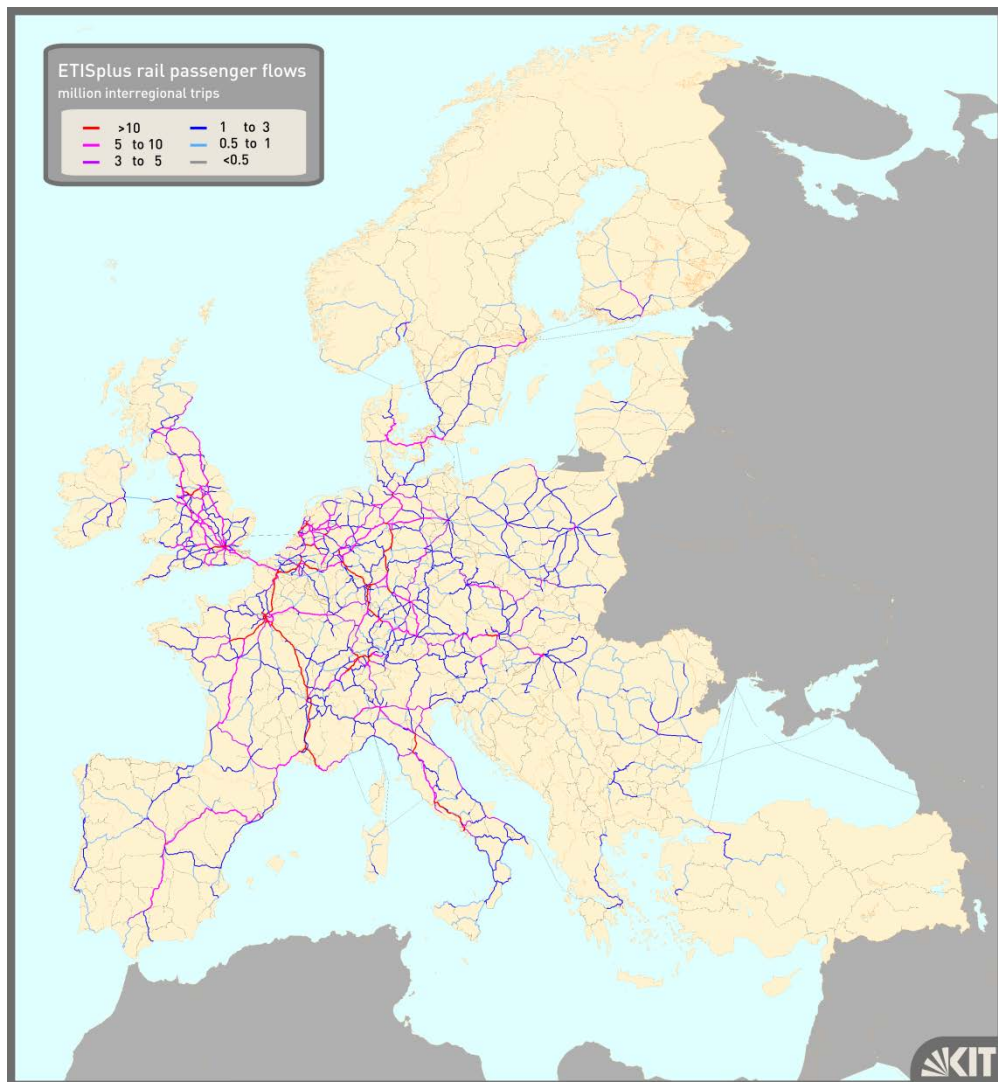


Figure 38-6: Rail passenger flows, Base year 2010



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39 ANNEX 1: Socio-economic data availability

Table 39-1: Data availability for Austria

Data Availability Austria					
Indicator (NUTS3)	NUTS3 data for 2010 available	NUTS3 data for 2010 calculated with available national data for 2010 and most recent available NUTS3 data from the year	NUTS3 data for 2010 calculated with available national or NUTS2 data from the year...	Neither NUTS3 nor national data for 2010 available	Comment
GDPTotal		2008			data from national sources
GDPinPPS		2008			data from national sources
Area		2008			data from national sources
Pop		2008			data from national sources
Pop by sex		2008			data from national sources
GVATotal		2008			data from national sources
GVASectoral		2008			data from national sources
EmpTotal		2008			data from national sources
EmpSectoral		2008			data from national sources
EconActivePop		2008			data from national sources
Unemp		2009			data from national sources
AccomFac	x				
Bedrooms	x				
Beds	x				
Households				x	
VehicleStock			NUTS2: 2009 and 2007		data from national sources
Pop by age groups			NUTS2: 2009		data from national sources
Indicator (NUTS2)	NUTS2 data for 2010 available	NUTS2 data for 2010 calculated with available national data for 2010 and most recent available NUTS2 data from the year	NUTS2 data for 2010 has been calculated (see comment)	Neither NUTS2 nor national data for 2010 available	Comment
Income of households			x		value 2010 = value 2008
R&D expenditures			x		value 2010 = value 2009
R&D personnel			x		value 2010 = value 2009
Number of companies				x	

Table 39-2: Data availability for Belgium

Data Availability Belgium					
Indicator	NUTS3 data for 2010 available	NUTS3 data for 2010 calculated with available national data for 2010 and most recent available NUTS3 data from the year	NUTS3 data for 2010 calculated with available national or NUTS2 data from the year...	NUTS3 data for 2010 has been calculated (see comment)	Comment
GDPTotal		2008			
GDPinPPS		2008			
Area	x				
PopTotal	x				
Pop by sex	x				data from national sources
G VATTotal		2008			data from national sources
G VASectoral		2008			data from national sources
EmpTotal		2008			data from national sources
EmpSectoral		2008			data from national sources
EconActivePo		2007			data from national sources
Unemp		2006			data from national sources
AccomFac		2010 or 2009			
Bedrooms				x	value 2010 = value 2009
Beds		2009			
Households			NUTS0: 2010		data from national sources
VehicleStock			NUTS2: 2007 or 2009		data from national sources
Pop by age groups			NUTS2: 2008		BE333 was divided into BE335 (73.2%) and BE336 (26.8%)
Indicator	NUTS2 data for 2010 available	NUTS2 data for 2010 calculated with available national data for 2010 and most recent available NUTS2 data from the year	NUTS2 data for 2010 has been calculated (see comment)	Neither NUTS2 nor national data for 2010 available	Comment
Income of households			x		value 2010 = value 2008
R&D expenditures		2009			data from national sources
R&D personnel			x		value 2010 = value 2009 data from national sources
Number of companies				x	

Table 39-3: Data availability for Bulgaria

Data Availability Bulgaria				
Indicator	NUTS3 data for 2010 available	NUTS3 data for 2010 calculated with available national data for 2010 and most recent available data from the year	Neither NUTS3 nor national data for 2010 available	Comment
GDPTotal		NUTS3: 2008		data from national sources
GDPinPPS		NUTS3: 2008		-
Area	x			
PopTotal		NUTS3: 2008		data from national sources
Pop by sex		NUTS3: 2008		data from national sources
GVATotal		NUTS3: 2008		
GVASectoral		NUTS3: 2008		
EmpTotal		NUTS3: 2008		data from national sources
EmpSectoral		NUTS3: 2008		data do not include self-employed
EconActivePop		NUTS3: 2008		data from national sources
Unemp		NUTS3: 2008		data from national sources
AccomFac		NUTS3: 2009		data from national sources
Bedrooms	x			
Beds		NUTS3: 2009		
Households			x	
VehicleStock		NUTS2: 2009		data from national sources
Pop by age groups		NUTS2: 2007 and 2009		data from national sources
Indicator	NUTS2 data for 2010 available	NUTS2 data for 2010 calculated with available national data for 2010 and most recent available NUTS2 data from the year	Neither NUTS2 nor national data for 2010 available	Comment
Income of households	x			data from national sources
R&D expenditures	x			data from national sources
R&D personnel	x			data from national sources
Number of companies			x	

Table 39-4: Data availability for Cyprus

Data Availability Cyprus					
Indicator	NUTS3 data for 2010 available	NUTS3 data for 2010 calculated with available national data for 2010 and most recent available NUTS3 data from the year	NUTS3 data for 2010 calculated with available national data for 2010 and most recent available NUTS2 data from the year...	Neither NUTS3 nor national data for 2010 available	Comment
GDPTotal	x				data from national sources
GDPinPPS	x				
Area	x				data from national sources
PopTotal		2009			data from national sources
Pop by sex		2009			data from national sources
GVATotal		2008			data from national sources
GVASectoral		2008			data from national sources
EmpTotal		2008			data from national sources
EmpSectoral		2008			data from national sources
EconActivePop		2009			data from national sources
Unemp		2009			data from national sources
AccomFac	x				data from national sources
Bedrooms	x				data from national sources
Beds	x				data from national sources
Households				x	
VehicleStock	x				data from national sources
Pop by age groups			2009 or 2006		data from national sources
Indicator	NUTS2 data for 2010 available	NUTS2 data for 2010 calculated with available national data for 2010 and most recent available NUTS2 data from the year	NUTS2 data for 2010 has been calculated (see comment)	Neither NUTS2 nor national data for 2010 available	Comment
Income of households	x				
R&D expenditures	x				
R&D personnel			x		value 2010 = value 2009
Number of companies				x	

Table 39-5: Data availability for Czech Republic

Data Availability Czech Republic					
Indicator	NUTS3 data for 2010 available	NUTS3 data for 2010 calculated with available national data for 2010 and most recent available NUTS3 data from the year	NUTS3 data for 2010 calculated with available national data for 2010 and most recent available NUTS2 data from the year...	Neither NUTS3 nor national data for 2010 available	Comment
GDPTotal		2008			data from national sources currency translation (CZK) via EUROSTAT exchange rates
GDPinPPS		2008			data from national sources
Area	x				
PopTotal		2009			data from national sources
Pop by sex		2009			data from national sources
GVATotal		2008			data from national sources currency translation (CZK) via EUROSTAT exchange rates
GVASectoral		2008			data from national sources currency translation (CZK) via EUROSTAT exchange rates
EmpTotal		2008			data from national sources
EmpSectoral		2008			data from national sources
EconActivePop		2008			data from national sources
Unemp		2009			data from national sources
AccomFac		2009			data from national sources
Bedrooms		2009			data from national sources
Beds		2009			data from national sources
Households				x	
VehicleStock			2009		data from national sources
Pop by age groups			2009 or 2007		data from national sources
Indicator	NUTS2 data for 2010 available	NUTS2 data for 2010 calculated with available national data for 2010 and most recent available NUTS2 data from the year	NUTS2 data for 2010 has been calculated (see comment)	Neither NUTS2 nor national data for 2010 available	Comment
Income of households			x		value 2010 = value 2008
R&D expenditures	x				
R&D personnel	x				
Number of companies				x	

Table 39-6: Data availability for Germany

Data Availability Germany					
Indicator	NUTS3 data for 2010 available	NUTS3 data for 2010 calculated with available national data for 2010 and most recent available NUTS3 data from the year	NUTS3 data for 2010 calculated with available national data for 2010 and most recent available NUTS2 data from the year...	NUTS3 data for 2010 has been calculated (see comment)	Comment
GDPTotal		2008			data from national sources
GDPinPPS		2008			data from national sources
Area		2008			data from national sources
PopTotal		2008			data from national sources
Pop by sex		2008			data from national sources
GVATotal		2008			data from national sources
GVASectoral		2008			data from national sources
EmpTotal		2008			data from national sources
EmpSectoral		2008			data from national sources
EconActivePop				x	data from national sources value2010 = value2009 * (value2009 / value2008)
Unemp		2009			data from national sources
AccomFac		2010 or 2009			data from national sources
Bedrooms				x	data from national sources value2010 = value2009 * (value2009 / value2008)
Beds		2010 or 2009			data from national sources
Households			2010		data from national sources
VehicleStock			2009		data from national sources
Pop by age groups				x	value2010 = value2009 NUTS3 data calculated with available (EUROSTAT) NUTS2 data
Indicator	NUTS2 data for 2010 available	NUTS2 data for 2010 calculated with available national data for 2010 and most recent available NUTS2 data from the year	NUTS2 data for 2010 has been calculated (see comment)	Neither NUTS2 nor national data for 2010 available	Comment
Income of households			x		value 2010 = value 2008
R&D expenditures			x		value 2010 = value 2009
R&D personnel			x		value 2010 = value 2009
Number of companies				x	

Table 39-7: Data availability for Denmark

Data Availability Denmark					
Indicator	NUTS3 data for 2010 available	NUTS3 data for 2010 calculated with available national data for 2010 and most recent available data from the year	NUTS3 data for 2010 calculated with available national data for 2010 and geographical population distribution	NUTS3 data for 2010 has been calculated (see comment)	Comment
GDPTotal		NUTS3: 2008			data from national sources
GDPinPPS				x	data from national sources value 2010 = value 2008 * (value 2008 / value 2007) ^2
Area	x				
PopTotal		NUTS3: 2008			data from national sources
Pop by sex		NUTS3: 2008			data from national sources
GVATotal				x	value 2010 = value 2008
GVASectoral				x	value 2010 = value 2008
EmpTotal		NUTS3: 2008			data from national sources
EmpSectoral		NUTS3: 2008			data from national sources
EconActivePop				x	data from national sources value 2010 = value 2009 * (value 2009 / value 2008)
Unemp		NUTS3: 2009			data from national sources
AccomFac		NUTS3: 2009			data from national sources
Bedrooms		NUTS3: 2009			data from national sources
Beds		NUTS3: 2009			data from national sources
Households			x		data from national sources
VehicleStock		NUTS2: 2010, 2008 or 2007			data from national sources
Pop by age groups		NUTS2: 2009			data from national sources
Indicator	NUTS2 data for 2010 available	NUTS2 data for 2010 calculated with available national data for 2010 and most recent available NUTS2 data from the year	NUTS2 data for 2010 has been calculated (see comment)	Neither NUTS2 nor national data for 2010 available	Comment
Income of households			x		value 2010 = value 2008
R&D expenditures			x		value 2010 = value 2009
R&D personnel			x		value 2010 = value 2009
Number of companies				x	

Table 39-8: Data availability for Estonia

Data Availability Estonia					
Indicator	NUTS3 data for 2010 available	NUTS3 data for 2010 calculated with available national data for 2010 and most recent available data from the year	NUTS3 data for 2010 has been calculated (see comment)	Neither NUTS3 nor national data for 2010 available	Comment
GDPTotal		NUTS3: 2008			data from national sources
GDPinPPS			x		value 2010 = value 2009
Area	x				
PopTotal		NUTS3: 2008			data from national sources
Pop by sex		NUTS3: 2008			data from national sources
GVATotal		NUTS3: 2008			data from national sources
GVASectoral		NUTS3: 2008			data from national sources
EmpTotal	x				
EmpSectoral	x				
EconActivePop	x				
Unemp		NUTS3: 2009			data from national sources
AccomFac	x				
Bedrooms	x				
Beds	x				
Households				x	
VehicleStock	x				
Pop by age groups		NUTS2: 2009 or 2007			data from national sources
Indicator	NUTS2 data for 2010 available	NUTS2 data for 2010 calculated with available national data for 2010 and most recent available NUTS2 data from the year	NUTS2 data for 2010 has been calculated (see comment)	Neither NUTS2 nor national data for 2010 available	Comment
Income of households	x				data from national sources
R&D expenditures	x				data from national sources
R&D personnel	x				data from national sources
Number of companies				x	

Table 39-9: Data availability for Spain

Data Availability Spain					
Indicator	NUTS3 data for 2010 available	NUTS3 data for 2010 calculated with available national data for 2010 and most recent available NUTS3 data from the year	NUTS3 data for 2010 calculated with available national data for 2010 and most recent available NUTS2 data from the year...	NUTS3 data for 2010 has been calculated (see comment)	Comment
GDPTotal		2008			data from national sources
GDPinPPS		2008			data from national sources
Area	x				
PopTotal		2008			data from national sources
Pop by sex		2008			data from national sources
GVATotal		2008			data from national sources
GVASectoral		2008			data from national sources
EmpTotal		2008			data from national sources
EmpSectoral		2008			data from national sources
EconActivePop		2009			data from national sources
Unemp		2009			data from national sources
AccomFac	x				
Bedrooms	x				
Beds	x				
Households				x	data from national sources 6+ Households: Total Population - '1-5 Person Households'
VehicleStockPassCars	x				data from national sources
PopAge0004			2009 or 2007		data from national sources
Indicator	NUTS2 data for 2010 available	NUTS2 data for 2010 calculated with available national data for 2010 and most recent available NUTS2 data from the year	NUTS2 data for 2010 has been calculated (see comment)	Neither NUTS2 nor national data for 2010 available	Comment
Income of households			x		value 2010 = value 2008
R&D expenditures			x		value 2010 = value 2009
R&D personnel			x		value 2010 = value 2009
Number of companies				x	

Table 39-10: Data availability for Finland

Data Availability Finland					
Indicator	NUTS3 data for 2010 available	NUTS3 data for 2010 calculated with available national data for 2010 and most recent available data from the year	NUTS3 data for 2010 has been calculated (see comment)	Neither NUTS3 nor national data for 2010 available	Comment
GDPTotal		NUTS3: 2008			data from national sources
GDPinPPS			x		value 2010 = value 2008
Area	x				
PopTotal		NUTS3: 2008			data from national sources
Pop by sex		NUTS3: 2008			data from national sources
GVATotal		NUTS3: 2008			data from national sources
GVASectoral		NUTS3: 2008			data from national sources
EmpTotal			x		data from national sources
EmpSectoral			x		data from national sources
EconActivePop			x		data from national sources
Unemp			x		data from national sources
AccomFac		NUTS3: 2010 or 2009			data from national sources
Bedrooms		NUTS3: 2009			data from national sources
Beds		NUTS3: 2010 or 2009			data from national sources
Households				x	
VehicleStock		NUTS2: 2007 or 2009			data from national sources
PopAge0004		NUTS2: 2007 or 2009			data from national sources
Indicator	NUTS2 data for 2010 available	NUTS2 data for 2010 calculated with available national data for 2010 and most recent available NUTS2 data from the year	NUTS2 data for 2010 has been calculated (see comment)	Neither NUTS2 nor national data for 2010 available	Comment
Income of households			x		value 2010 = value 2008
R&D expenditures			x		value 2010 = value 2009
R&D personnel			x		value 2010 = value 2009
Number of companies				x	

Table 39-11: Data availability for France

Data Availability France					
Indicator	NUTS3 data for 2010 available	NUTS3 data for 2010 calculated with available national data for 2010 and most recent available NUTS3 data from the year	NUTS3 data for 2010 calculated with available national data for 2010 and geographical population distribution	NUTS3 data for 2010 calculated with available national data for 2010 and most recent available NUTS2 data from the year...	Comment
GDPTotal		2008			data from national sources
GDPinPPS		2008			
Area	x				
PopTotal		2008			data from national sources
Pop by sex		2008			data from national sources
GVATotal		2008			data from national sources
GVASectoral		2008			data from national sources
EmpTotal		2008			data from national sources
EmpSectoral		2008			data from national sources
EconActivePop		2009			data from national sources
Unemp		2009			data from national sources
AccomFac		2010 or 2009			data from national sources
Bedrooms	x				data from national sources
Beds		2010 or 2009			data from national sources
Households			2008		data from national sources
VehicleStock				2007 or 2008	data from national sources
Pop by age groups				2009	data from national sources
Indicator	NUTS2 data for 2010 available	NUTS2 data for 2010 calculated with available national data for 2010 and most recent available NUTS2 data from the year	NUTS2 data for 2010 has been calculated (see comment)	Neither NUTS2 nor national data for 2010 available	Comment
Income of households		2009			data from national sources
R&D expenditures		2009			data from national sources
R&D personnel				x	
Number of companies				x	

Table 39-12: Data availability for Greece

Data Availability Greece					
Indicator	NUTS3 data for 2010 available	NUTS3 data for 2010 calculated with available national data for 2010 and most recent available NUTS3 data from the year	NUTS3 data for 2010 calculated with available national data for 2010 and most recent available NUTS2 data from the year...	Neither NUTS3 nor national data for 2010 available	Comment
GDPTotal		2008			data from national sources
GDPinPPS		2008			-
Area	x				-
PopTotal		2008			data from national sources
Pop by sex		2008			data from national sources
GVATotal		2008			data from national sources
GVASectoral		2008			data from national sources
EmpTotal		2008			data from national sources
EmpSectoral		2008			data from national sources
EconActivePop		2009			data from national sources
Unemp		2009			data from national sources
AccomFac	x				data from national sources
Bedrooms	x				-
Beds	x				-
Households				x	
VehicleStock			2009		data from national sources
Pop by age groups			2009 or 2007		data from national sources
Indicator	NUTS2 data for 2010 available	NUTS2 data for 2010 calculated with available national data for 2010 and most recent available NUTS2 data from the year	NUTS2 data for 2010 has been calculated (see comment)	Neither NUTS2 nor national data for 2010 available	Comment
Income of households				x	
R&D expenditures				x	
R&D personnel				x	
Number of companies				x	

Table 39-13: Data availability for Hungary

Data Availability Hungary					
Indicator	NUTS3 data for 2010 available	NUTS3 data for 2010 calculated with available national data for 2010 and most recent available NUTS3 data from the year	NUTS3 data for 2010 has been calculated (see comment)	Neither NUTS3 nor national data for 2010 available	Comment
GDPTotal		2008			data from national sources
GDPinPPS		2008			data from national sources
Area	x				
PopTotal	x				
Pop by sex	x				
GVATotal		2008			data from national sources
GVASectoral		2008			data from national sources
EmpTotal	x				
EmpSectoral	x				
EconActivePop	x				
Unemp	x				
AccomFac			x		value 2010 = value 2009
Bedrooms				x	
Beds			x		value 2010 = value 2009
Households				x	
VehicleStock	x				
Pop by age groups	x				data from national sources
Indicator	NUTS2 data for 2010 available	NUTS2 data for 2010 calculated with available national data for 2010 and most recent available NUTS2 data from the year	NUTS2 data for 2010 has been calculated (see comment)	Neither NUTS2 nor national data for 2010 available	Comment
Income of households		2008			data from national sources
R&D expenditures	x				data from national sources Currency translation via EUROSTAT exchange rates
R&D personnel	x				data from national sources
Number of companies				x	

Table 39-14: Data availability for Ireland

Data Availability Ireland					
Indicator	NUTS3 data for 2010 available	NUTS3 data for 2010 calculated with available national data for 2010 and most recent available NUTS3 data from the year	NUTS3 data for 2010 calculated with available NUTS2 data for 2010 and geographical population distribution	Neither NUTS3 nor national data for 2010 available	Comment
GDPTotal		2008			data from national sources
GDPinPPS		2008			data from national sources
Area	x				
PopTotal		2008			data from national sources
Pop by sex		2008			data from national sources
GVATotal		2008			data from national sources
GVASectoral		2008			data from national sources
EmpTotal		2008			data from national sources
EmpSectoral		2008			data from national sources
EconActivePop		2009			data from national sources
Unemp		2009			data from national sources
AccomFac	x				
Bedrooms	x				
Beds		2010 or 2008			
Households				x	
VehicleStock	x				data from national sources
Pop by age groups			x		data from national sources
Indicator	NUTS2 data for 2010 available	NUTS2 data for 2010 calculated with available national data for 2010 and most recent available NUTS2 data from the year	NUTS2 data for 2010 has been calculated (see comment)	Neither NUTS2 nor national data for 2010 available	Comment
Income of households			x		data from national sources value 2010 = value 2009
R&D expenditures			x		value 2010 = value 2009
R&D personnel			x		value 2010 = value 2009
Number of companies				x	

Table 39-15: Data availability for Italy

Data Availability Italy					
Indicator	NUTS3 data for 2010 available	NUTS3 data for 2010 calculated with available national data for 2010 and most recent available NUTS3 data from the year	NUTS3 data for 2010 calculated with available NUTS2 data for 2010 and geographical population distribution	Neither NUTS3 nor national data for 2010 available	Comment
GDPTotal		NUTS3: 2008			data from national sources
GDPinPPS		NUTS3: 2008			data from national sources
Area	x				
PopTotal		NUTS3: 2008			data from national sources
Pop by sex		NUTS3: 2008			data from national sources
GVATotal		NUTS3: 2007			data from national sources
GVASectoral		NUTS3: 2007			data from national sources
EmpTotal		NUTS3: 2007			data from national sources
EmpSectoral		NUTS3: 2007			data from national sources
EconActivePop		NUTS3: 2007			data from national sources
Unemp		NUTS3: 2007			data from national sources
AccomFac	x				
Bedrooms	x				
Beds	x				
Households				x	
VehicleStock		NUTS2: 2009			
Pop by age groups			x		data from national sources
Indicator	NUTS2 data for 2010 available	NUTS2 data for 2010 calculated with available national data for 2010 and most recent available NUTS2 data from the year	NUTS2 data for 2010 has been calculated (see comment)	Neither NUTS2 nor national data for 2010 available	Comment
Income of households			x		value 2010 = value 2008
R&D expenditures			x		value 2010 = value 2009
R&D personnel			x		value 2010 = value 2009
Number of companies				x	

Table 39-16: Data availability for Lithuania

Data Availability Lithuania					
Indicator	NUTS3 data for 2010 available	NUTS3 data for 2010 calculated with available national data for 2010 and most recent available data from the year	NUTS3 data for 2010 has been calculated (see comment)	Neither NUTS3 nor national data for 2010 available	Comment
GDPTotal		NUTS3: 2008			data from national sources
GDPinPPS			x		value 2010 = value 2008
Area	x				
PopTotal	x				
Pop by sex	x				
GVATotal	x				
GVASectoral			x		value 2010 = value 2008
EmpTotal	x		x		
EmpSectoral		NUTS3: 2008			data from national sources
EconActivePop	x				
Unemp	x				
AccomFac		NUTS3: 2009			data from national sources
Bedrooms		NUTS3: 2009			data from national sources
Beds		NUTS3: 2009			data from national sources
Households				x	
VehicleStock		NUTS2: 2009			data from national sources
Pop by age groups	x				data from national sources
Indicator	NUTS2 data for 2010 available	NUTS2 data for 2010 calculated with available national data for 2010 and most recent available NUTS2 data from the year	NUTS2 data for 2010 has been calculated (see comment)	Neither NUTS2 nor national data for 2010 available	Comment
Income of households			x		value 2010 = value 2008
R&D expenditures	x				
R&D personnel			x		data from national sources value 2010 = value 2009
Number of companies				x	

Table 39-17: Data availability for Luxembourg

Data Availability Luxembourg					
Indicator	NUTS3 data for 2010 available	NUTS3 data for 2010 calculated with available national data for 2010 and most recent available NUTS3 data from the year	NUTS3 data for 2010 has been calculated (see comment)	Neither NUTS3 nor national data for 2010 available	Comment
GDPTotal				x	data from national sources value 2010 = value 2009 * (value 2009 / value 2008)
GDPinPPS				x	data from national sources value 2010 = value 2009 * (value 2009 / value 2008)
Area	x				data from national sources
PopTotal	x				data from national sources
Pop by sex	x				data from national sources
GVATotal	x				data from national sources
GVASectoral	x				data from national sources
EmpTotal	x				data from national sources
EmpSectoral			x		value 2010 = value 2008
EconActivePop	x				data from national sources
Unemp	x				data from national sources
AccomFac			x		value 2010 = value 2009
Bedrooms		2010			
Beds		2010			
Households				x	
VehicleStock	x				
Pop by age groups	x				data from national sources
Indicator	NUTS2 data for 2010 available	NUTS2 data for 2010 calculated with available national data for 2010 and most recent available NUTS2 data from the year	NUTS2 data for 2010 has been calculated (see comment)	Neither NUTS2 nor national data for 2010 available	Comment
Income of households				x	
R&D expenditures	x				
R&D personnel			x		value 2010 = value 2009
Number of companies				x	

Table 39-18: Data availability for Latvia

Data Availability Latvia					
Indicator	NUTS3 data for 2010 available	NUTS3 data for 2010 calculated with available national data for 2010 and most recent available NUTS3 data from the year	NUTS3 data for 2010 calculated with available national data for 2010 and geographical population distribution	Neither NUTS3 nor national data for 2010 available	Comment
GDPTotal		2008			data from national sources
GDPinPPS		2008			
Area	x				
PopTotal	x				
Pop by sex	x				
GVATotal			x		data from national sources
GVASectoral			x		data from national sources
EmpTotal	x				
EmpSectoral	x				
EconActivePop	x				
Unemp	x				
AccomFac		2009 or 2010			data from national sources
Bedrooms	x				
Beds		2009 or 2010			data from national sources
Households				x	
VehicleStock	x				data from national sources
Pop by age groups	x				data from national sources
Indicator	NUTS2 data for 2010 available	NUTS2 data for 2010 calculated with available national data for 2010 and most recent available NUTS2 data from the year	NUTS2 data for 2010 has been calculated (see comment)	Neither NUTS2 nor national data for 2010 available	Comment
Income of households			x		value 2010 = value 2008
R&D expenditures	x				
R&D personnel			x		value 2010 = value 2009
Number of companies				x	

Table 39-19: Data availability for Malta

Data Availability Malta					
Indicator	NUTS3 data for 2010 available	NUTS3 data for 2010 calculated with available national data for 2010 and most recent available NUTS3 data from the year ...	NUTS3 data for 2010 calculated with available national data for 2010 and most recent available NUTS2 data from the year...	Neither NUTS3 nor national data for 2010 available	Comment
GDPTotal		2008			
GDPinPPS		2008			data from national sources
Area	x				
PopTotal		2008			data from national sources
Pop by sex		2008			data from national sources
GVATotal		2008			data from national sources
GVASectoral		2008			data from national sources
EmpTotal		2008			data from national sources
EmpSectoral		2008			data from national sources
EconActivePop		2008			data from national sources
Unemp		2008			
AccomFac		2009 or 2010			
Bedrooms	x				
Beds		2009 or 2010			data from national sources
Households				x	
VehicleStock			2009		data from national sources values for 2010 estimated by NESTEAR
Pop by age groups			2009		data from national sources
Indicator	NUTS2 data for 2010 available	NUTS2 data for 2010 calculated with available national data for 2010 and most recent available NUTS2 data from the year	NUTS2 data for 2010 has been calculated (see comment)	Neither NUTS2 nor national data for 2010 available	Comment
Income of households	x				
R&D expenditures	x				
R&D personnel			x		value 2010 =value 2009
Number of companies				x	

Table 39-20: Data availability for The Netherlands

Data Availability the Netherlands					
Indicator	NUTS3 data for 2010 available	NUTS3 data for 2010 calculated with available national data for 2010 and most recent available NUTS3 data from the year	NUTS3 data for 2010 calculated with available national data for 2010 and geographical population distribution	Neither NUTS3 nor national data for 2010 available	Comment
GDPTotal		2008			
GDPinPPS		2008			
Area	x				
PopTotal	x				
Pop by sex	x				
GVATotal		2008			
GVASectoral		2008			
EmpTotal		2008			data from national sources
EmpSectoral		2008			data from national sources
EconActivePop		2009			data from national sources
Unemp		2009			data from national sources
AccomFac	x				
Bedrooms	x				
Beds	x				
Households			x		
VehicleStock	x				
Pop by age groups	x				
Indicator	NUTS2 data for 2010 available	NUTS2 data for 2010 calculated with available national data for 2010 and most recent available NUTS2 data from the year	NUTS2 data for 2010 has been calculated (see comment)	Neither NUTS2 nor national data for 2010 available	Comment
Income of households			x		value 2010 = value 2008
R&D expenditures			x		value 2010 = value 2009
R&D personnel			x		value 2010 = value 2009
Number of companies				x	

Table 39-21: Data availability for Poland

Data Availability Poland					
Indicator	NUTS3 data for 2010 available	NUTS3 data for 2010 calculated with available national data for 2010 and most recent available NUTS3 data from the year	NUTS3 data for 2010 calculated with available national data for 2010 and geographical population distribution	NUTS3 data for 2010 calculated with available national data for 2010 and most recent available NUTS2 data from the year...	Comment
GDPTotal		2008			data from national sources currency translation via EUROSTAT exchange rates
GDPinPPS		2008			data from national sources
Area	x				
PopTotal		2008			data from national sources
Pop by sex		2008			data from national sources
GVATotal		2008			data from national sources currency translation via EUROSTAT exchange rates
GVASectoral		2008			data from national sources currency translation via EUROSTAT exchange rates
EmpTotal		2008			data from national sources
EmpSectoral		2008			data from national sources
EconActivePop		2009			data from national sources
Unemp		2009			data from national sources
AccomFac		2010 or 2009			data from national sources
Bedrooms	x				
Beds		2009			data from national sources
Households			x		
VehicleStock				2009	data from national sources
Pop by age groups				2009 or 2007	data from national sources

Indicator	NUTS2 data for 2010 available	NUTS2 data for 2010 calculated with available national data for 2010 and most recent available NUTS2 data from the year	Neither NUTS2 nor national data for 2010 available	NUTS2 data for 2010 has been calculated (see comment)	Comment
Income of households				x	value 2010 = value 2008
R&D expenditures	x				data from national sources currency translation via EUROSTAT exchange rates
R&D personnel	x				data from national sources
Number of companies			x		

Table 39-22: Data availability for Portugal

Data Availability Portugal					
Indicator	NUTS3 data for 2010 available	NUTS3 data for 2010 calculated with available national data for 2010 and most recent available NUTS3 data from the year	NUTS3 data for 2010 calculated with available national data for 2010 and most recent available NUTS2 data from the year...	NUTS3 data for 2010 has been calculated (see comment)	Comment
GDPTotal		2008			data from national sources
GDPinPPS		2008			data from national sources
Area	x				
PopTotal		2008			
Pop by sex		2008			
GVATotal		2008			data from national sources
GVASectoral		2008			data from national sources
EmpTotal		2008			data from national sources
EmpSectoral		2008			data from national sources
EconActivePop		2008			data from national sources
Unemp		2008			data from national sources
AccomFac		2010 or 2009			data from national sources
Bedrooms		2010			
Beds		2010 or 2009			data from national sources
Households				x	6+ Households: Total Population - '1-5 Person Households'
VehicleStock	x				data from national sources
Pop by age groups			2009 or 2007		
Indicator	NUTS2 data for 2010 available	NUTS2 data for 2010 calculated with available national data for 2010 and most recent available NUTS2 data from the year	NUTS2 data for 2010 has been calculated (see comment)	Neither NUTS2 nor national data for 2010 available	Comment
Income of households			x		value 2010 = value 2008
R&D expenditures			x		data from national sources value 2010 = value 2009
R&D personnel			x		value 2010 = value 2009
Number of companies				x	

Table 39-23: Data availability for Romania

Data Availability Romania					
Indicator	NUTS3 data for 2010 available	NUTS3 data for 2010 calculated with available national data for 2010 and most recent available NUTS3 data from the year	NUTS3 data for 2010 calculated with available national data for 2010 and most recent available NUTS2 data from the year...	Neither NUTS3 nor national data for 2010 available	Comment
GDPTotal		2008			
GDPinPPS		2008			
Area	x				data from national sources
PopTotal		2008			
Pop by sex		2008			
GVATotal		2008			data from national sources
GVASectoral		2008			data from national sources
EmpTotal		2008			data from national sources
EmpSectoral		2008			data from national sources
EconActivePop		2009			data from national sources
Unemp		2009			data from national sources
AccomFac		2009			data from national sources
Bedrooms	x				
Beds		2009			data from national sources
Households				x	
VehicleStock			2009		data from national sources
Pop by age groups			2009 or 2007		data from national sources
Indicator	NUTS2 data for 2010 available	NUTS2 data for 2010 calculated with available national data for 2010 and most recent available NUTS2 data from the year	NUTS2 data for 2010 has been calculated (see comment)	Neither NUTS2 nor national data for 2010 available	Comment
Income of households			x		value 2010 = value 2008
R&D expenditures	x				data from national sources
R&D personnel	x				data from national sources
Number of companies				x	

Table 39-24: Data availability for Sweden

Data Availability Sweden					
Indicator	NUTS3 data for 2010 available	NUTS3 data for 2010 calculated with available national data for 2010 and most recent available data from the year	NUTS3 data for 2010 has been calculated (see comment)	Neither NUTS3 nor national data for 2010 available	Comment
GDPTotal		NUTS3: 2008			data from national sources
GDPinPPS			x		data from national sources value 2010 = value 2008 * (value 2008 / value 2007) ^ 2
Area	x				data from national sources
PopTotal		NUTS3: 2008			data from national sources
Pop by sex		NUTS3: 2008			data from national sources
GVATotal			x		value 2010= value 2008
GVASectoral			x		value 2010= value 2008
EmpTotal			x		data from national sources value 2010 = value 2008 * (value 2009 / value2008) ^ 2
EmpSectoral			x		data from national sources value 2010 = value 2008 * (value 2009 / value2008) ^ 2
EconActivePop		NUTS3: 2009			data from national sources
Unemp		NUTS3: 2009			data from national sources
AccomFac		NUTS3: 2009			data from national sources
Bedrooms		NUTS3: 2009			data from national sources
Beds		NUTS3: 2010 or 2009			data from national sources
Households				x	
VehicleStock		NUTS2: 2007 or 2009			data from national sources
Pop by age groups		NUTS2: 2007 or 2009			data from national sources
Indicator	NUTS2 data for 2010 available	NUTS2 data for 2010 calculated with available national data for 2010 and most recent available NUTS2 data from the year	NUTS2 data for 2010 has been calculated (see comment)	Neither NUTS2 nor national data for 2010 available	Comment
Income of households			x		value 2010 = value 2008
R&D expenditures			x		value 2010 = value 2009
R&D personnel			x		value 2010 = value 2009
Number of companies				x	

Table 39-25: Data availability for Slovenia

Data Availability Slovenia					
Indicator	NUTS3 data for 2010 available	NUTS3 data for 2010 calculated with available national data for 2010 and most recent available data from the year	NUTS3 data for 2010 calculated with available NUTS2 data for 2010 and geographical population distribution	NUTS3 data for 2010 has been calculated (see comment)	Comment
GDPTotal		NUTS3: 2008			data from national sources
GDPinPPS		NUTS3: 2008			data from national sources
Area	x				
PopTotal		NUTS3: 2008			data from national sources
Pop by sex		NUTS3: 2008			data from national sources
GVATotal		NUTS3: 2008			data from national sources
GVASectoral		NUTS3: 2008			data from national sources
EmpTotal		NUTS3: 2008			data from national sources
EmpSectoral		NUTS3: 2008			data from national sources
EconActivePop		NUTS3: 2009			data from national sources
Unemp		NUTS3: 2009			data from national sources
AccomFac		NUTS3: 2009			data from national sources
Bedrooms		NUTS3: 2009			data from national sources
Beds		NUTS3: 2009			data from national sources
Households				x	6+ Households: Total Population - '1-5 Person Households'
VehicleStock		NUTS2: 2009			data from national sources
Pop by age groups			x		data from national sources
Indicator	NUTS2 data for 2010 available	NUTS2 data for 2010 calculated with available national data for 2010 and most recent available NUTS2 data from the year	NUTS2 data for 2010 has been calculated (see comment)	Neither NUTS2 nor national data for 2010 available	Comment
Income of households			x		value 2010 = value 2008
R&D expenditures			x		value 2010 = value 2009
R&D personnel			x		value 2010 = value 2009
Number of companies				x	

Table 39-26: Data availability for Slovakia

Data Availability Slovakia					
Indicator	NUTS3 data for 2010 available	NUTS3 data for 2010 calculated with available national data for 2010 and most recent available NUTS3 data from the year	NUTS3 data for 2010 calculated with available national data for 2010 and most recent available NUTS2 data from the year...	Neither NUTS3 nor national data for 2010 available	Comment
GDPTotal		2008			data from national sources
GDPinPPS		2008			data from national sources
Area	x				
PopTotal		2008			data from national sources
Pop by sex		2008			data from national sources
GVATotal		2008			data from national sources
GVASectoral		2008			data from national sources
EmpTotal		2008			data from national sources
EmpSectoral		2008			data from national sources
EconActivePop		2008			data from national sources
Unemp		2009			data from national sources
AccomFac		2009			data from national sources
Bedrooms		2009			data from national sources
Beds		2009			data from national sources
Households				x	
VehicleStock			2009		data from national sources
Pop by age groups			2009		data from national sources
Indicator	NUTS2 data for 2010 available	NUTS2 data for 2010 calculated with available national data for 2010 and most recent available NUTS2 data from the year	NUTS2 data for 2010 has been calculated (see comment)	Neither NUTS2 nor national data for 2010 available	Comment
Income of households			x	x	value 2010 = value 2008
R&D expenditures	x				
R&D personnel	x		x		
Number of companies				x	

Table 39-27: Data availability for United Kingdom

Data Availability United Kingdom					
Indicator	NUTS3 data for 2010 available	NUTS3 data for 2010 calculated with available national data for 2010 and most recent available NUTS3 data from the year	NUTS3 data for 2010 has been calculated (see comment)	Neither NUTS3 nor national data for 2010 available	Comment
GDPTotal		NUTS3: 2008			data from national sources currency translation via EUROSTAT exchange rates
GDPinPPS		NUTS3: 2008			data from national sources currency translation via EUROSTAT exchange rates
Area		NUTS3: 2008			
PopTotal		NUTS3: 2007			
Pop by sex		NUTS3: 2007			
GVATotal		NUTS3: 2008			data from national sources currency translation via EUROSTAT exchange rates
GVASectoral			x		value 2010 = value 2008
EmpTotal		NUTS3: 2008			data from national sources
EmpSectoral		NUTS3: 2008			data from national sources
EconActivePop		NUTS3: 2009			data from national sources
Unemp		NUTS3: 2009			data from national sources
AccomFac	x				
Bedrooms	x				
Beds	x				
Households				x	
VehicleStock		NUTS2: 2009			data from national sources
Pop by age groups		NUTS2: 2008			data from national sources
Indicator	NUTS2 data for 2010 available	NUTS2 data for 2010 calculated with available national data for 2010 and most recent available NUTS2 data from the year	NUTS2 data for 2010 has been calculated (see comment)	Neither NUTS2 nor national data for 2010 available	Comment
Income of households			x		value 2010 = value 2008
R&D expenditures			x		value 2010 = value 2009
R&D personnel			x		value 2010 = value 2009
Number of companies				x	

Table 39-28: Data availability for Switzerland

Data Availability Switzerland					
Indicator	NUTS3 data for 2010 available	NUTS3 data for 2010 calculated with available national data for 2010 and most recent available NUTS3 data from the year	NUTS3 data for 2010 calculated with available national data for 2010 and most recent available NUTS2 data from the year...	Neither NUTS3 nor national data for 2010 available	Comment
GDPTotal	x				data from national sources
GDPinPPS	x				data from national sources
Area	x				data from national sources
PopTotal		2008			data from national sources
Pop by sex		2008			data from national sources
GVATotal	x				data from national sources currency translation via EUROSTAT exchange rates
GVASectoral	x				data from national sources currency translation via EUROSTAT exchange rates
EmpTotal	x				data from national sources
EmpSectoral	x				data from national sources
EconActivePop	x				data from national sources
Unemp	x				data from national sources
AccomFac	x				data from national sources
Bedrooms	x				data from national sources
Beds	x				data from national sources
Households				x	
VehicleStock			2006, 2007 or 2009		data from national sources
Pop by age groups			2009 or 2007		data from national sources
Indicator	NUTS2 data for 2010 available	NUTS2 data for 2010 calculated with available national data for 2010 and most recent available NUTS2 data from the year	NUTS2 data for 2010 has been calculated (see comment)	Neither NUTS2 nor national data for 2010 available	Comment
Income of households				x	
R&D expenditures				x	
R&D personnel				x	
Number of companies				x	

Table 39-29: Data availability for Croatia

Data Availability Croatia					
Indicator	NUTS3 data for 2010 available	NUTS3 data for 2010 calculated with available national data for 2010 and most recent available data from the year	NUTS3 data for 2010 has been calculated (see comment)	Neither NUTS3 nor national data for 2010 available	Comment
GDPTotal		NUTS3: 2008			data from national sources
GDPinPPS		NUTS3: 2008			
Area		NUTS3: 2005			
PopTotal		NUTS3: 2008			
Pop by sex		NUTS3: 2008			
GVATotal		NUTS3: 2008			data from national sources
GVASectoral		NUTS3: 2008			data from national sources
EmpTotal		NUTS3: 2008			data from national sources
EmpSectoral		NUTS3: 2008			Data by economic sector do not include self-employed
EconActivePop	x				
Unemp	x				
AccomFac			x		data from national sources value 2010 = value 2009 * (value 2009 / value 2008)
Bedrooms		NUTS3: 2009			data from national sources
Beds		NUTS3: 2009 or 2010			data from national sources
Households				x	
VehicleStock		NUTS2: 2009			
Pop by age groups		NUTS2: 2008 or 2007			data from national sources
Indicator	NUTS2 data for 2010 available	NUTS2 data for 2010 calculated with available national data for 2010 and most recent available NUTS2 data from the year	NUTS2 data for 2010 has been calculated (see comment)	Neither NUTS2 nor national data for 2010 available	Comment
Income of households				x	
R&D expenditures			x		value 2010 = value 2009
R&D personnel			x		value 2010 = value 2009
Number of companies				x	

Table 39-30: Data availability for Iceland

Data Availability Iceland					
Indicator	NUTS3 data for 2010 available	NUTS3 data for 2010 calculated with available national data for 2010 and most recent available NUTS3 data from the year	NUTS3 data for 2010 calculated with available national data for 2010 and most recent available NUTS2 data from the year...	Neither NUTS3 nor national data for 2010 available	Comment
GDPTotal				x	
GDPinPPS				x	
Area	x				data from national sources
PopTotal		2008			data from national sources
Pop by sex		2008			data from national sources
GVATotal				x	
GVASectoral				x	
EmpTotal				x	
EmpSectoral				x	
EconActivePop	x				
Unemp	x				
AccomFac		2010 or 2009			data from national sources
Bedrooms		2009			data from national sources
Beds		2010 or 2009			data from national sources
Households				x	
VehicleStock				x	
VehicleStockBuses				x	
Pop by age groups			2009 or 2006		data from national sources
Indicator	NUTS2 data for 2010 available	NUTS2 data for 2010 calculated with available national data for 2010 and most recent available NUTS2 data from the year	NUTS2 data for 2010 has been calculated (see comment)	Neither NUTS2 nor national data for 2010 available	Comment
Income of households				x	
R&D expenditures			x		value 2010 = value 2009
R&D personnel			x		value 2010 = value 2009
Number of companies				x	

Table 39-31: Data availability for Liechtenstein

Data Availability Liechtenstein					
Indicator	NUTS3 data for 2010 available	NUTS3 data for 2010 calculated with available national data for 2010 and most recent available NUTS3 data from the year	NUTS3 data for 2010 has been calculated (see comment)	Neither NUTS3 nor national data for 2010 available	Comment
GDPTotal			x		data from national sources value 2010 = value 2009 * (value 2009 / value 2008)
GDPinPPS				x	
Area	x				data from national sources
PopTotal	x				data from national sources
Pop by sex	x				data from national sources
GVATotal				x	
GVASectoral				x	
EmpTotal				x	
EmpSectoral				x	
EconActivePop				x	
Unemp				x	
AccomFac			x		data from national sources value 2010 = value 2009
Bedrooms	x				
Beds			x		data from national sources value 2010 = value 2009
Households				x	
VehicleStock	x				data from national sources
Pop by age groups	x				data from national sources
Indicator	NUTS2 data for 2010 available	NUTS2 data for 2010 calculated with available national data for 2010 and most recent available NUTS2 data from the year	NUTS2 data for 2010 has been calculated (see comment)	Neither NUTS2 nor national data for 2010 available	Comment
Income of households				x	
R&D expenditures				x	
R&D personnel				x	
Number of companies				x	

Table 39-32: Data availability for Norway

Data Availability Norway					
Indicator	NUTS3 data for 2010 available	NUTS3 data for 2010 calculated with available national data for 2010 and most recent available NUTS3 data from the year	NUTS3 data for 2010 calculated with available national data for 2010 and most recent available NUTS2 data from the year...	Neither NUTS3 nor national data for 2010 available	Comment
GDPTotal		2005			
GDPinPPS				x	
Area	x				data from national sources
PopTotal		2007			data from national sources
Pop by sex		2007			data from national sources
GVATotal				x	
GVASectoral				x	
EmpTotal		2009			data from national sources
EmpSectoral		2009			data from national sources
EconActivePop		2008			data from national sources
Unemp		2008			data from national sources
AccomFac	x				data from national sources
Bedrooms	x				data from national sources
Beds	x				data from national sources
Households				x	
VehicleStock			2007 or 2009		data from national sources
Pop by age groups			2009 or 2007		data from national sources
Indicator	NUTS2 data for 2010 available	NUTS2 data for 2010 calculated with available national data for 2010 and most recent available NUTS2 data from the year	NUTS2 data for 2010 has been calculated (see comment)	Neither NUTS2 nor national data for 2010 available	Comment
Income of households		2007			data from national sources
R&D expenditures		2009			data from national sources
R&D personnel			x		value 2010 = value 2009
Number of companies				x	

Table 39-33: Data availability for Turkey

Data Availability Turkey					
Indicator	NUTS3 data for 2010 available	NUTS3 data for 2010 calculated with available national data for 2010 and most recent available data from the year	NUTS3 data for 2010 calculated with available national data for 2010 and geographical population distribution	Neither NUTS3 nor national data for 2010 available	Comment
GDPTotal		NUTS3: 2005			
GDPinPPS				x	
Area	x				
PopTotal		NUTS3: 2008			data from national sources
Pop by sex		NUTS3: 2008			data from national sources
GVATotal				x	
GVASectoral				x	
EmpTotal		NUTS3: 2005			
EmpSectoral		NUTS3: 2005			
EconActivePop	x				
Unemp	x				
AccomFac				x	
Bedrooms				x	
Beds				x	
Households			x		
VehicleStock		NUTS2: 2007 or 2009			data from national sources
Pop by age groups		NUTS2: 2009			data from national sources

Table 39-34: Data availability for Albania

Data Availability Albania					
Indicator	NUTS3 data for 2010 available	NUTS3 data for 2010 calculated with available national data for 2010 and most recent available NUTS3 data from the year	NUTS3 data for 2010 has been calculated (see comment)	Neither NUTS3 nor national data for 2010 available	Comment
GDPTotal				x	
GDPinPPS				x	
Area		2005			data from national sources
PopTotal		2005			data from national sources
Pop by sex		2005			data from national sources
GVATotal				x	
GVASectoral				x	
EmpTotal				x	
EmpSectoral				x	
EconActivePop				x	
Unemp				x	
AccomFac				x	
Bedrooms				x	
Beds				x	
Households				x	
VehicleStock				x	
Pop by age groups				x	

Table 39-35: Data availability for Bosnia Herzegovina

Data Availability Bosnia and Herzegovina					
Indicator	NUTS3 data for 2010 available	NUTS3 data for 2010 calculated with available national data for 2010 and most recent available NUTS3 data from the year	NUTS3 data for 2010 has been calculated (see comment)	Neither NUTS3 nor national data for 2010 available	Comment
GDPTotal				x	
GDPinPPS				x	
Area		2005			data from national sources
PopTotal		2005			data from national sources
Pop by sex				x	
GVATotal				x	
GVASectoral				x	
EmpTotal				x	
EmpSectoral				x	
EconActivePop				x	
Unemp				x	
AccomFac				x	
Bedrooms				x	
Beds				x	
Households				x	
VehicleStock				x	
Pop by age groups				x	

Table 39-36: Data availability for Belarus

Data Availability Belarus					
Indicator	NUTS3 data for 2010 available	NUTS3 data for 2010 calculated with available national data for 2010 and most recent available NUTS3 data from the year	NUTS3 data for 2010 has been calculated (see comment)	Neither NUTS3 nor national data for 2010 available	Comment
GDPTotal				x	
GDPinPPS				x	
Area	x				data from national sources
PopTotal		2005			data from national sources
Pop by sex				x	
GVATotal				x	
GVASectoral				x	
EmpTotal				x	
EmpSectoral				x	
EconActivePop				x	
Unemp				x	
AccomFac				x	
Bedrooms				x	
Beds				x	
Households				x	
VehicleStock				x	
Pop by age groups				x	

Table 39-37: Data availability for Montenegro

Data Availability Montenegro					
Indicator	NUTS3 data for 2010 available	NUTS3 data for 2010 calculated with available national data for 2010 and most recent available NUTS3 data from the year	NUTS3 data for 2010 has been calculated (see comment)	Neither NUTS3 nor national data for 2010 available	Comment
GDPTotal				x	
GDPinPPS				x	
Area		2005			data from national sources
PopTotal		2005			data from national sources
Pop by sex		2005			data from national sources
GVATotal				x	
GVASectoral				x	
EmpTotal				x	
EmpSectoral				x	
EconActivePop				x	
Unemp				x	
AccomFac				x	
Bedrooms				x	
Beds				x	
Households				x	
VehicleStock				x	
Pop by age groups				x	

Table 39-38: Data availability for FYR Macedonia

Data Availability FYR Macedonia					
Indicator	NUTS3 data for 2010 available	NUTS3 data for 2010 calculated with available national data for 2010 and most recent available NUTS3 data from the year	NUTS3 data for 2010 calculated with available national data for 2010 and most recent available NUTS2 data from the year...	Neither NUTS3 nor national data for 2010 available	Comment
GDPTotal		2008			data from national sources
GDPinPPS		2008			
Area		2005			
PopTotal		2008			
Pop by sex		2008			
GVATotal		2008			data from national sources
GVASectoral		2008			data from national sources
EmpTotal				x	
EmpSectoral				x	
EconActivePop				x	
Unemp				x	
AccomFac	x				
Bedrooms		2009			data from national sources
Beds		2009			data from national sources
Households				x	
VehicleStock				x	
Pop by age groups			2008		data from national sources

Table 39-39: Data availability for Serbia

Data Availability Serbia					
Indicator	NUTS3 data for 2010 available	NUTS3 data for 2010 calculated with available national data for 2010 and most recent available NUTS3 data from the year	NUTS3 data for 2010 has been calculated (see comment)	Neither NUTS3 nor national data for 2010 available	Comment
GDPTotal				x	
GDPinPPS				x	
Area		2005			data from national sources
PopTotal		2005			data from national sources
Pop by sex		2005			data from national sources
GVATotal				x	
GVASectoral				x	
EmpTotal	x				data from national sources
EmpSectoral	x				data from national sources
EconActivePop	x				data from national sources
Unemp				x	
AccomFac				x	
Bedrooms				x	
Beds				x	
Households				x	
VehicleStock				x	
Pop by age groups				x	

Table 39-40: Data availability for Russia

Data Availability Russia					
Indicator	NUTS3 data for 2010 available	NUTS3 data for 2010 calculated with available national data for 2010 and most recent available NUTS3 data from the year	NUTS3 data for 2010 has been calculated (see comment)	Neither NUTS3 nor national data for 2010 available	Comment
GDPTotal		2005			data from national sources
GDPinPPS				x	
Area		2005			data from national sources
PopTotal		2005			data from national sources
Pop by sex				x	
GVATotal				x	
GVASectoral				x	
EmpTotal		2005			data from national sources
EmpSectoral				x	
EconActivePop				x	
Unemp				x	
AccomFac				x	
Bedrooms				x	
Beds				x	
Households				x	
VehicleStock				x	
Pop by age groups				x	

Table 39-41: Data availability for Ukraine

Data Availability Ukraine					
Indicator	NUTS3 data for 2010 available	NUTS3 data for 2010 calculated with available national data for 2010 and most recent available NUTS3 data from the year	NUTS3 data for 2010 has been calculated (see comment)	Neither NUTS3 nor national data for 2010 available	Comment
GDPTotal	x				
GDPinPPS				x	
Area	x				data from national sources
PopTotal	x				data from national sources
Pop by sex				x	
GVATotal				x	
GVASectoral				x	
EmpTotal	x				data from national sources
EmpSectoral		2005			data from national sources
EconActivePop	x				data from national sources
Unemp	x				data from national sources
AccomFac				x	
Bedrooms				x	
Beds				x	
Households				x	
VehicleStock				x	
Pop by age groups				x	

Table 39-42: Data availability for Kosovo

Data Availability Kosovo					
Indicator	NUTS3 data for 2010 available	NUTS3 data for 2010 calculated with available national data for 2010 and most recent available NUTS3 data from the year	NUTS3 data for 2010 has been calculated (see comment)	Neither NUTS3 nor national data for 2010 available	Comment
GDPTotal				x	
GDPinPPS				x	
Area		2005			data from national sources
PopTotal		2005			data from national sources
Pop by sex				x	
G VATotal				x	
GVASectoral				x	
EmpTotal				x	
EmpSectoral				x	
EconActivePop				x	
Unemp				x	
AccomFac				x	
Bedrooms				x	
Beds				x	
Households				x	
VehicleStock				x	
Pop by age groups				x	