EUROPEAN TOURISM TRANSPORT AND ENVIRONMENT

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1 INTRODUCTION

European tourism trips constitute significant shares of passenger transport demand. Tourism is the main travel motive for air transport and for ferries and constitutes between 15% and 20% of all passenger-kilometres travelled within Europe for other transport modes like, car, rail and coach (Peeters, van Egmond et al., 2004). It is therefore not surprising that environmental impacts of tourism caused by the transportation of tourists from their homes to the destinations and back, in the present paper referred to as ‘tourism O/D transport volumes’, are very significant. This insight has only recently been incorporated in tourism research. A broadening of perspective is necessary in order to move from the consideration of the local environmental consequences of tourism (Hunter and Green, 1995) to the consideration of its global environmental consequences (Høyer, 1999; Gössling, 2002; Becken and Cavanagh, 2003; Ceron and Dubois, 2003; Peeters and Schouten, 2006 in press).

The Directorate General Enterprise of the European Commission commissioned a ‘Feasibility and preparatory study regarding a Multi-Stakeholder European Targeted Action for Sustainable Tourism & Transport’, acronym MuSTT. This paper is based on the background information published by Peeters, van Egmond et al. (2004). The goal of the MuSTT study was to investigate the possibilities for a study, which would focus on actions for Sustainable Tourism and Transport. An important subject of this study was to find ways to uncouple tourism growth from transport volume growth. One of the outputs of the MuSTT project is the quantification of tourism flows in Europe and the corresponding environmental impacts. The goal of this paper is to present these results and the way these were obtained. The main methodological improvements are the inclusion of domestic tourism flows and detailed information on modal split and travel performance measured in passenger-kilometres in a way compatible with the WTO definition of tourism. Both data were initially attained from the TEN-STAC modelling approach. Also a forecast for the year 2020 has been made, whose results will be presented in this paper as well. This paper shows that information about tourism

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transport is essential for a thorough analysis of environmental impacts related to tourism O/D flows.

2 METHODOLOGICAL ISSUES AND SOLUTIONS

2.1 The data issues

The problem with most studies on tourism and environment is the focus on 'international' tourism. World-wide tourism statistics like those produced by the World Tourism Organisation (WTO, 2003a, 2003c, 2004a, 2004b), do not systematically contain information on domestic tourism. This causes a distorted view on the importance of tourism in world regions. Often it is concluded that Europe is by far the most important tourism destination, attracting 58% of all *international* tourists in 2003 (WTO, 2004a), whereas the American continent attracts only 17%. For this pattern the average size of countries (very small in Europe, large in America) is the main parameter determining these shares.

The MuSTT study therefore is drafted on all flows at a region-to-region base by transport mode and, thus, including European domestic and international tourism flows. Intercontinental tourism (ICA) to and from Europe is by definition international and has been taken from the WTO data bases. The study also includes both inbound tourism (all tourists visiting Europe regardless of their normal place of residence, whether within or outside the EU) and outbound tourism (all European citizens visiting any place within or outside the EU). The focus of the study is on transport between the tourists' normal place of residence and the tourism destination and is referred to as 'tourism O/D transport volumes'. Generally the amount of local transport, that is tourism transport at or around the destinations, only accounts for a small amount of passenger-kilometres (pkm) travelled by tourists (see for example Peeters and Schouten, 2006 in press).

Often transport and tourism data suffer from agreement on the definition of 'tourism' (Lumsden and Page, 2004: 3). In tourism studies generally the WTO definition is used:

> "Tourism comprises the activities of persons travelling to and staying in places outside their usual environment for not more than one consecutive year for leisure, business and other purposes not related to the exercise of an activity remunerated from within the place visited" (source: WTO, 2002).

Within transport statistics and data the 'tourism' purpose for travel is generally not based on the WTO definition, but interpreted as the leisure kind of tourism, considering holidays and sometimes also short breaks, but excluding multi-day business and visiting friends and family (VFR) trips.

For MuSTT two data sets have been used: transport data from the TEN-STAC model (TEN-STAC, 2003a) and tourism flows from World Tourism Organisation data bases (WTO, 1998, 2000, 2003b, 2003a, 2003c). WTO gives the number of journeys, (a journey is a return trip), while TEN-STAC generates number of trips (one-way, thus two trips equals one journey). TEN-

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STAC defines the travel motive ‘holiday’ as all leisure related trips with at least two nights, where WTO defines tourism as all international (border-crossing) trips for travels with at least one night and not more than one year. Furthermore, TEN-STAC distinguishes also the travel motive ‘business’, but this includes ‘same-day’ returns, which do not fall within the WTO definition of tourism. On the other hand, the TEN-STAC data provided represent inter-regional flows at NUTS 2 level[1]. The motive ‘visiting friends and relatives’ is part of the travel purpose ‘private travel’ in TEN-STAC, which includes same-day leisure visits, commuting and shopping.
Further two important parameters are missing within WTO data: the number of kilometres travelled and data on domestic tourism (tourists staying within their own country). Also data on some countries or parts of countries are missing in either of the data bases. Table 1 gives an overview of specific data covered by the two data bases.

Definition/issue	TEN-STAC	WTO
Number of nights in tourism definition	>2 nights no upper limit	>1 night <1 year
Leisure related	Defined as ‘holiday’	Part of ‘tourism’
Visiting Friends and Relatives (VFR)	Part of motive ‘private’ at NUTS 2[2] level including same day visits.	Part of ‘tourism’
Business	Business inter-regional at NUTS 2[2] level including same day visits.	Part of ‘tourism’
Domestic tourism flows	Yes	No
Intercontinental tourism (to/from outside Europe)	No	Yes
Coverage of number of intra-EU25 international relations	100%	65% relations 98% journeys
Transport mode	Yes (road, rail, air)	No
Passenger-kilometres	Yes (road, rail, air)	No
Travel direction (distinction between inbound and outbound tourists flows)	No	Yes
Canary Isles distinguished	Yes	No
Malta and Cyprus	No	Yes

Table 1: Overview of data and definitions used in the two main data bases used for MuSTT.

2.2 Journeys and transport data

For the analysis the MuSTT data model has been developed, with the purpose to combine the information given by the two data bases used and to introduce more details like additional transport modes and further destinations.

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TOURISM DEFINITION

In order to find a solution for the differences in the tourism definition these discrepancies are investigated in the first step. From initial analyses of the two data bases the sum of international journeys of TEN-STAC 'holiday' and TEN-STAC 'business' appeared to come nearest to the total number of international journeys given by the WTO data (see Figure 1).

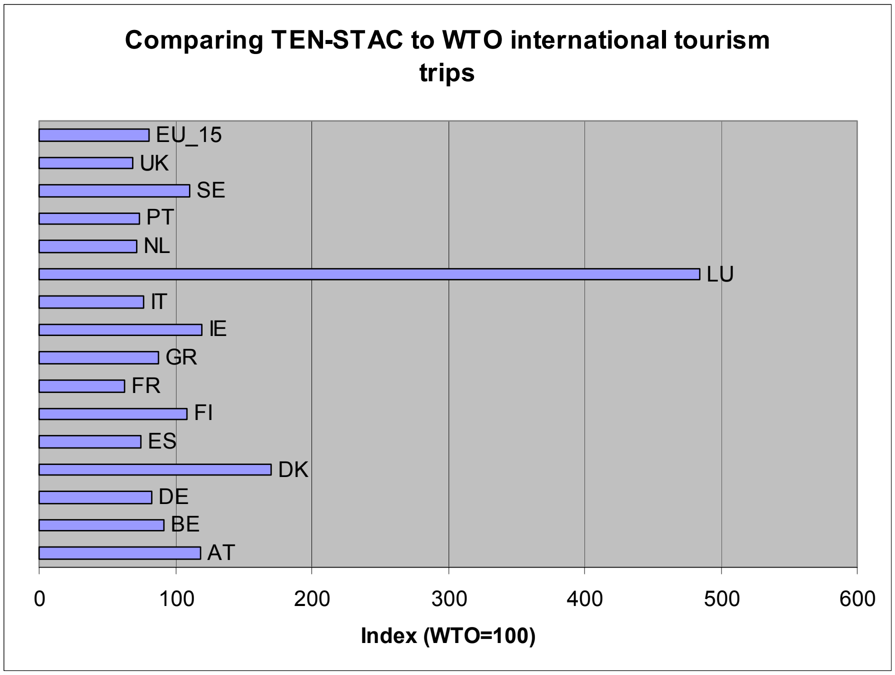

Figure 1: Comparing TEN-STAC and WTO data on international tourism travel for the EU15 states (data for WTO: 2001; TEN-STAC: 2000).

The figure is based on the average of both inbound and outbound tourism volumes from the WTO data and the passenger O/D matrix generated within TEN-STAC. On average international O/D volumes by TEN-STAC make up for 81% of WTO number of journeys.

The following basic choices are made to construct the MuSTT data model:

- Total numbers of international inbound and outbound EU25 tourism flows are taken from WTO data.
- Domestic number of journeys is taken as the TEN-STAC ratio between domestic and international journeys times the number of inbound journeys given by WTO.
- Transport properties (i.e. modal split and pkm travelled) are based on the sum of the 'holiday' and 'business' travel modes of TEN-STAC.
- Number of intercontinental journeys are taken directly from WTO data.

The MuSTT data model generates all intra-EU25 tourism plus the relations with Romania, Bulgaria, Switzerland and Norway. Also intercontinental tourism is taken into account.

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Filling the empty cells and generating domestic tourism

For some 35% of the international O/D relations between the EU25 member states the WTO data base contains no data. These 'empty cells' have been filled using the two equations given below. Since the TEN-STAC transport volumes are symmetric for every relation, without distinguishing between inbound and outbound tourism, two equations were necessary, depending on the place of the cells in the O/D matrix.

For all cells below and left of the 'domestic' diagonal:

$$N_{E\,i,j} = N_{T-S_{i,j}} * \left[\frac{\sum_{i=1}^{25} N_{WTO_{i,j}}}{\sum_{i=1}^{25} N_{T-S_{i,j}}} \right]$$

For all cells above and right of the 'domestic' diagonal:

$$N_{E\,i,j} = N_{T-S_{i,j}} * \left[\frac{\sum_{j=1}^{25} N_{WTO_{i,j}}}{\sum_{j=1}^{25} N_{T-S_{i,j}}} \right]$$

With:

- $N_{E\,i,j}$: the calculated number of journeys for the empty cell for origin *i* and destination *j*
- $N_{T-S_{i,j}}$: the value for origin *i* and destination *j* of the empty cell given by TEN-STAC
- $\sum_{i=1}^{25} N_{WTO_{i,j}}$: the sum of arrivals in a country j in the WTO data base with the empty cells set to zero
- $\sum_{i=1}^{25} N_{T-S_{i,j}}$: the sum of arrivals in a country j in the TEN-STAC data base with the cells set to zero at the same locations i,j with an empty cell in the WTO data base.
- $\sum_{j=1}^{25} N_{WTO_{i,j}}$: the sum of departures in a country j in the WTO data base with the empty cells set to zero
- $\sum_{j=1}^{25} N_{T-S_{i,j}}$: the sum of departures in a country j in the TEN-STAC data base with the cells set to zero at the same locations i,j with an empty cell in the WTO data base.

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The 35% of relations filled this generated just 2% extra journeys. WTO empty cells occur apparently at weak relations only.

INTERCONTINENTAL JOURNEYS

Intercontinental tourism - tourism by EU citizens to destinations outside Europe and visitors of EU destinations by citizens from outside Europe - is based on WTO data (WTO, 2003c). Outbound travel from Europe is (with 5.5 million journeys in 2000) slightly larger than inbound to Europe (with 4.2 million journeys per year). These numbers are small compared to the total number – including domestic tourism – of tourism departures (6%) and arrivals (4%).
It is assumed that – because of the long distances covered – all ICA journeys are performed by air. This assumption causes some minor discrepancies, which for example are due to the role of the Trans Siberian Express in long haul travel to Asia and some short haul travel by road or sea between Europe and neighbouring countries in Asia and Africa. The distances travelled have been obtained from the Internet (WebFlyer, 2003) taking Amsterdam as the main anchor point for all EU countries and the main international airport for the country of destination. These distances were not corrected for detours, which for long haul flights are generally less than 5%.

MALTA AND CYPRUS

Tourism volumes to Malta and Cyprus are only given by WTO. Inbound tourism to these Isles from all EU25 countries have been taken directly from WTO (2003b), assuming all arrivals to be performed by air. This gives an over-estimate for air travel of presumably some 3%, as this is the share of ferry traffic given by WTO (2003a) to Malta and Cyprus. The origin of ferry journeys is not given in he WTO data bases. For outbound tourism WTO (2003a) gives only the totals for Malta and Cyprus. WTO (2003a) First an estimated 20,000 trips have been assumed from Malta to Italy and 5,000 trips from Cyprus to Greece (from Cyprus), in order to assign in both cases a share of about 30% for those presumed most important destination from these islands. The remaining trips have been split up over destinations with the same shares as for outbound international tourism by Italian (for Malta) and Greek (for Cyprus).
The travel distances are calculated by multiplying distances found in the Internet (WebFlyer, 2003) with 1.1, in order to account for an average detour of 10% (see Gössling, Peeters et al., 2004). Domestic tourism for Cyprus is estimated by dividing the number of domestic tourism nights of 737,000 (WTO Compendium) by a factor three, assuming an average domestic length of stay of 3 nights. Transport mode for Cyprus domestic tourism is assumed to be 100% passenger car. As no such data for Malta could be found, Maltesian domestic tourism was set at zero.

CANARY ISLANDS

Tourism to the Canary Islands is distinguished only by TEN-STAC; WTO gives tourism to the Canary Islands as aggregate for tourism to Spain. However, the distances travelled and modes of transport used for journeys between EU member states to Spain and to the Canary Islands differ strongly. Therefore a distinction has been introduced correcting the TEN-STAC data

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according to the data for Spain and, subsequently subtracting these from the number of journeys to Spain by air. All journeys to the Canary Islands have been assumed to be taking place by air.

COACH AND FERRY JOURNEYS

The European Commission required the MuSTT consortium to include information about the use of ferries and coaches. Within TEN-STAC private car, ferry and coach is aggregated to the single mode 'road transport'. For the EU15 countries the shares of coach and ferry journeys for international tourism has been given by Schmidt (2002). The ratio's have been applied to both international and domestic tourism flow. For most new member states the ratio between journeys by coach and by rail as given by Eurostat (2003: 92) have been used in order to estimate coach trips from TEN-STAC data. For ferries no consistent data could be found regarding the ten new member states. Therefore a share for ferries from road transport has been assumed of 5% for countries with a relatively long shoreline, 2% with a short shoreline (Slovenia only) and 0% for countries without a sea shore. The resulting numbers of coach and ferry trips were subtracted from the road trips in order to calculate 'private car' as transport mode and keep the number of trips equal.

2.3 Environmental data

Within TEN-STAC an advanced method has been applied for calculating emissions based on assignment results, and in order to estimate also the number of inhabitants impacted by air pollutants caused by road transport (see Szimba, Rothengatter, Schoch and Guglielminetti 2004; TEN-STAC, 2003a, 2003b). However, since it was not possible to apply the TEN-STAC methodology due to the differing definitions of tourism, the additional modes of transport to be considered, and the limited time frame available for the MuSTT study, a simplified method has been applied, which is based on generalised emission factors, using the following equation:

$$I_e = \sum_m \left(\beta_m * V_m\right)$$

In this form I_e is the total environmental impact of all activities, V_m the volume of activity m and β_m the specific impact (the 'impact factor') per unit of activity m. This equation can be used for all kinds of impact assessments and for all scales of activities. In this paper tourism O/D transport volume is the main activity assessed.

The MuSTT data model incorporates the emissions of particles (PM, air quality), nitrogen oxides (NO_x, air quality, acidification) carbon dioxide (CO_2) and greenhouse gases (GHG, climate change). The emission factors β are based on several European and Dutch studies as described by Peeters, van Egmond et al. (2004) in Appendix VII. Table 2 gives the generalised emission factors used for the analysis.

The equivalence factors listed in Table 2 give the ratio between climate change caused by emissions of carbon dioxide and climate change caused by all greenhouse gas emissions (GHG-emissions). The total GHG-emission is

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expressed in tons of carbon dioxide equivalents (CO_2–e). For most transport modes the equivalence factor is approximately 1.05 (based on Gugele, Huttunen et al., 2003). For air transport a factor between 2 and 4 has been found ({Penner, 1999 #175). Generally a factor of 2.7 is used as an average proxy (see for example Gössling, 2002; Wit, Dings et al., 2002; RCEP, 2003; Gössling, Peeters et al., 2004). Recently Schumann (2003) reported the equivalence factor to be slightly higher (circa 3.0). However, in this study an average value of 2.7 has been applied. For air transport short block distance equivalence factors have been estimated lower, because a relatively large part of these short flights will be flown below cruising altitude, for which the warming potential of the other GHG emissions is less.

Mode	CO_2 factor	equiv. factor	CO_2-e	PM	NO_x
	Kg/pkm	-	kg/pkm	gram/pkm	gram/pkm
Air: <500 km	0.206	2.0	0.412	0.00175	1.028
500-1000 km	0.154	2.3	0.354	0.00135	0.716
1000-1500 km	0.130	2.7	0.351	0.00117	0.578
1500-2000 km	0.121	2.7	0.326	0.00111	0.522
>2000 km	0.111	2.7	0.299	0.00103	0.466
Rail	0.027	1.05	0.0284	0.013	0.16
Car	0.133	1.05	0.1397	0.0225	0.50
Ferries	0.066	1.05	0.0693	0.001	1.6
Coach	0.022	1.05	0.0231	0.0103	0.246

Table 2: Operational emission factors β for tourism O/D transport volume modes[3] (source: Peeters, van Egmond et al., 2004: 45).

2.4 Scenario's for 2020

GENERAL APPROACH

The MuSTT data model has been developed in order to produce data for two reference years: 2000 and 2020. These have been chosen in accordance with TEN-STAC data and WTO prognoses (WTO, 1998). The 2020 MuSTT data model is equal to the 2000 basic model, except for replacing all TEN-STAC 2000 data with the forecasts for the EUROPEAN scenario for 2020. This means the growth factors for all intra-EU tourism O/D transport volumes is based on the EUROPEAN scenario from TEN-STAC. For ICA transport the growth factors were taken from WTO (2000). In contrast to assumptions made within TEN-STAC, the emission factors have been kept constant for all modes and distance classes, besides for air. The emission factors β do not only depend on technology and legislation with respect to emissions, but also on driving style, the composition of the vehicle fleet and the seat occupation. Trends generally oppose each other: Technology and legislation tend to reduce β, but fleet composition and to a lesser extend, driving style, tend to increase the emission factor. Therefore the same net β*'s* have been assumed for 2000 and 2020. For air transport a reduction has been assumed in fuel consumption of 1.4% per year (based on Penner, Lister et al., 1999).

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TEN-STAC EUROPEAN SCENARIO

The objective of the TEN-STAC study was to produce updated transport scenarios, European traffic forecasts and detailed analyses of corridors of the trans-European network, including the New Member States and Candidate countries. After consolidating the base year 2000 forecast scenarios have been designed, in order to assess effects of transport infrastructure policy on the development of the transport systems, transport demand, routing of flows and various types of impacts (economic and environmental impacts, as well as impacts of regional centrality).

The passenger O/D volumes have been generated by the VACLAV model. The VACLAV model has been developed by IWW (Institut für Wirtschaftspolitik und Wirtschaftsforschung of the Universität Karlsruhe). It is a network-based Europe-wide forecasting model for passenger traffic, covering the modes rail, road, air and coach. The model structure follows the classic four-step approach of trip generation, trip distribution, modal choice and trip assignment, considering the trip purposes business, private and holiday.

The zonal system underlying the passenger transport demand modelling is – for most of the European countries – NUTS 3, which results in around 1,200 traffic cells. For MuSTT data have been generated at the level of NUTS 2. The geographical scope of the model is the European continent, including Ireland and the UK.

For the generation and distribution of passenger transport demand a gravitation approach is applied. The modal split calculation is performed by a logit model enhanced by a Box-Cox transformation. For the road assignment road type-specific speed-flow functions are applied, in order to take into account congestion effects. A specific peculiarity of the VACLAV model is its capability of modelling intra-zonal passenger flows, by joining regional socio-demographic and -economic data with grid data on land-use pattern. A detailed documentation of the VACLAV model is provided by Schoch (2004).

For the scenario calculations in the MuSTT data model the TEN-STAC EUROPEAN scenario for the year 2020 has been used as a base. The demographic and economic environment in the TEN-STAC EUROPEAN scenario is compatible with the reference scenario of the transport and energy projections for the year 2020 (Commission of the European Communities, 2001). With regard to the socio-economic and-demographic framework solid economic growth (GDP growth on average 2.5% p. a.) has been assumed, on average slight changes in the number of inhabitants (+0.06% p.a.), and a wide range of growth rates for motorization, varying between 0.13% p.a. for France and 4.4% p.a. for Romania.

With regard to transport infrastructure following assumptions have been made: In EU15 countries the EU's priority infrastructure projects of the year 2002 are realised ('Essen list', European Union 1996), as well as the additional projects in the White Paper (Commission of the European Communities, 2001). In Switzerland the new Gotthard and Simplon/Lötschberg base tunnels have been assumed to be operational. For the new Member States of the EU and the other Central and Eastern European countries the measures associated with the TINA (Transport Infrastructure Needs Assessment) backbone network have been assumed of being realised, as well as additional TINA links scheduled for completion

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before the year 2011 (TEN-STAC, 2003a). The network models for the TEN-STAC EUROPEAN scenario are illustrated by Figure 2.

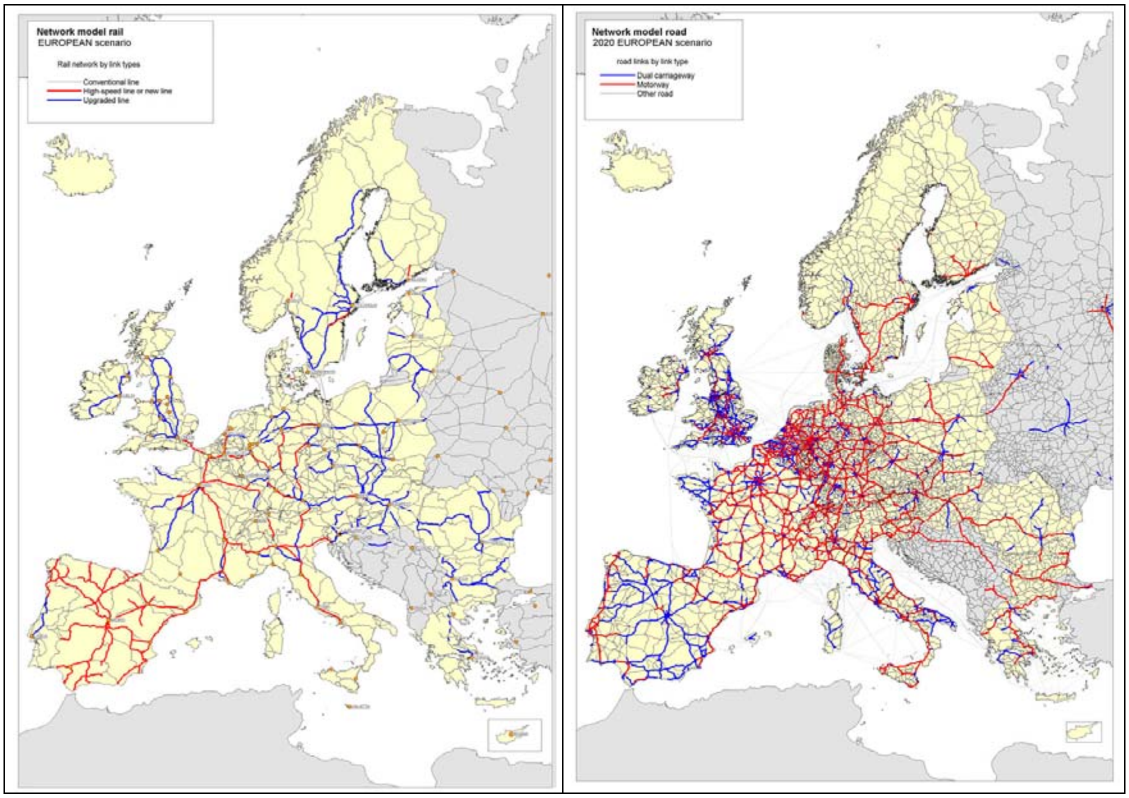

Figure 2: Network models applied for the EUROPEAN scenario (year 2020) in TEN-STAC (source: TEN-STAC, 2003a)

WTO TOURISM VISION 2020

TEN-STAC does not include forecasts for ICA tourism. Therefore use has been made of the WTO 'Tourism 2020 Vision' project, volume Europe (WTO, 2000). The WTO forecasts are not only based on extrapolation of historical tourism growth rates between many regions in the world, but also on tourism developments put forward by a group of fifty travel industry leaders, extensive literature study (including the forecasts of aircraft manufacturers) and the views of many individuals and organisations on the future of tourism. Validation of the draft results has been taken up by regional seminars and round-table debates to reach consensus on the growth rates and key developments.

Factors considered in the forecasts for Europe are competition from other world regions, technology (internet, call centres), theme-parks, the introduction of the Euro, airline deregulation, consolidation of the tour operators and reduction of political and social restraints on travel (i.e. specifically in Eastern Europe). The forecasts have only been used for outbound tourism (i.e. tourism by Europeans to 15 non-European destination regions.

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3 RESULTS OF MUSTT

3.1 Tourism O/D transport volume

TEN-STAC ANALYSES OF THE O/D-FLOWS AT NUTS 0 LEVEL

This section presents a characterisation of O/D flows for the trip purpose holiday, resulting from O/D matrices generated within the TEN-STAC project. The results are presented in maps, which give a view on the holiday motive as defined by TEN-STAC (two nights overstay leisure related journeys). The data refer to the base year 2000 and the forecast year 2020 and the TEN-STAC EUROPEAN scenario. The countries considered within the present analyses are the EU25 countries (without Cyprus and Malta), Bulgaria, Romania, as well as Switzerland and Norway.

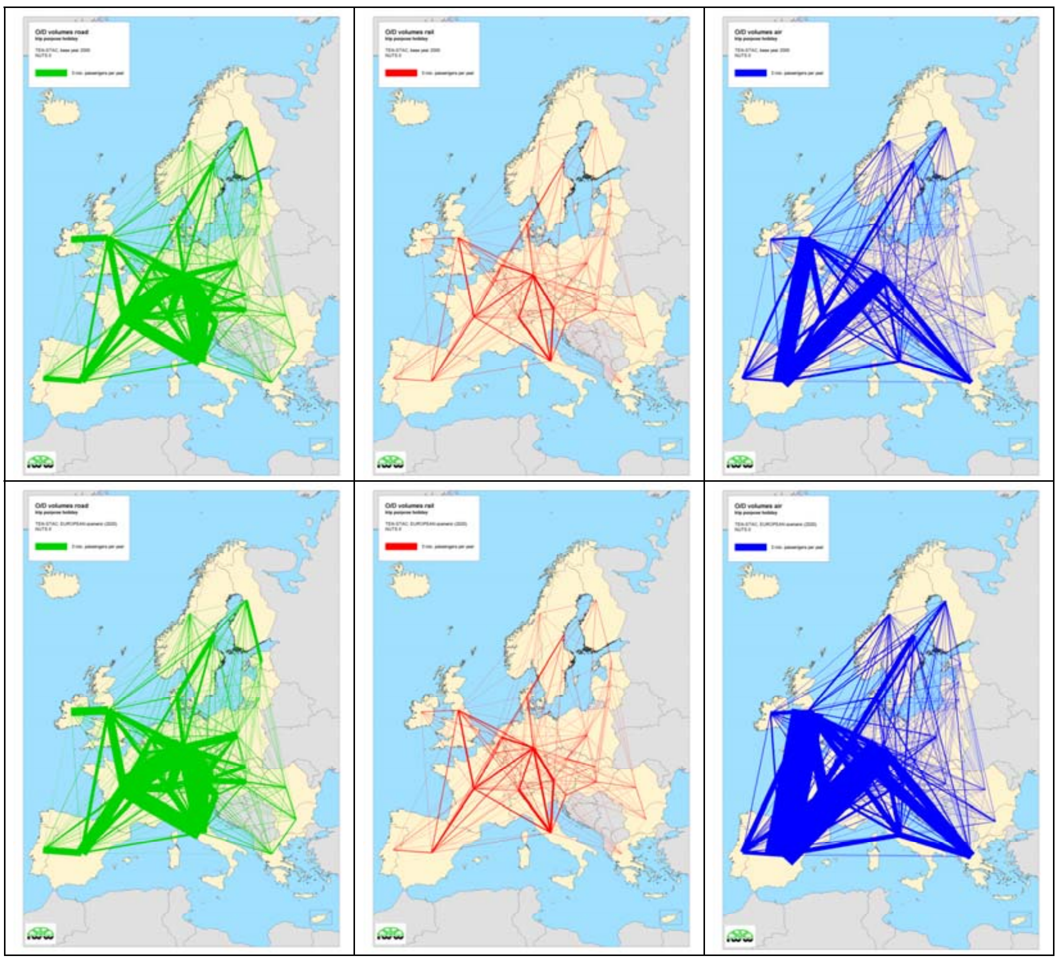

Figure 3: International tourism O/D transport volumes for the trip purpose holiday for the base year 2000 (upper) and 2020 (lower) and for road (left), rail (middle) and air (right) (TEN-STAC EUROPEAN scenario – one direction).

Figure 3 illustrates the tourism O/D transport volumes (>1,000 trips per year) for the trip purpose holiday and the modes road, rail and air. The volumes refer to the base year 2000 and the forecast year 2020 (EUROPEAN

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scenario). In case of relative closeness of origin and destination country, the overwhelming share of holiday trips is operated by the road mode (like between Germany and France, Germany and Italy, France and Italy or France and Spain) or, in case of relative remoteness of origin and destination, by air (like between UK and Spain, Germany and Spain or Germany and Greece). The highest rail volumes for the trip purpose holiday are attained for O/D relations between Switzerland and Italy, Germany and Austria, as well as Austria and Italy.

The strongest increase in demand between 2000 and 2020 is forecasted for holiday trips by air. Especially for O/D flows originating in the new Member States backlog demand is expected for holiday trips and particularly for holiday trips by air, but also international holiday trips between EU15 countries are forecasted to increase considerably. Also rail passenger volumes are forecasted to increase on all NUTS 0 O/D relations, most noticeably between France and Spain (mainly due to the assumed realisation of a new high-speed link between Madrid and Nîmes via Barcelona), France and Italy (resulting among others from the new high-speed line between Lyon and Trieste, via Torino, Milano), France and Germany (assumed new high-speed link Paris – Strasbourg and Paris – Frankfurt), Switzerland and Italy (assumed realisation of the Gotthard and Lötschberg/ Simplon base tunnels), Germany and Italy (realisation of the new Swiss rail base tunnels and the Brenner base tunnel), as well as between Austria and Italy (Brenner base tunnel). The lowest dynamic is expected for holiday trips by road: The volumes for holiday trips are forecasted to increase moderately on some relations and to decrease slightly on other relations, respectively.

Finally the dominance of domestic tourism based on the TEN-STAC travel purposes 'tourism' and 'business' is shown by Figure 4. The large number of domestic tourism becomes very clear for the UK, France, Germany, Italy, Spain and The Netherlands.

The overall number of outbound journeys - EU25 citizens travelling to destinations outside their country of residence - as calculated with the MuSTT data model is given by Figure 5. The two maps clearly show the relatively small share of the three ICA flows relatively to the multitude of the other international intra-European flows (domestic flows are not included in these maps). Also the large growth of the ICA tourism flows is apparent. Main tourism flows concentrate on relation within Western and Southern Europe (UK, France, Germany, Spain and Italy).

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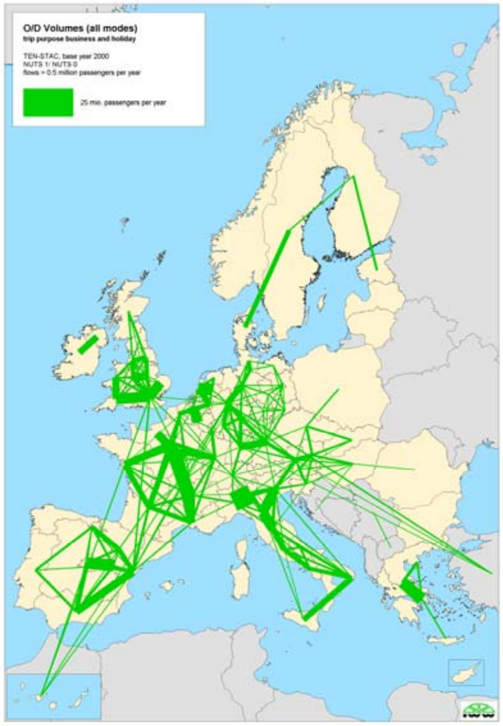

Figure 4: International plus domestic tourism O/D transport volumes for the trip purposes holiday and business at the NUTS1/ NUTS0 level for the base year 2000 (TEN-STAC – one direction). Only flows larger than 0.5 million per year are shown.

In the base year 2000 the total number of tourism journeys (a journey is a return trip) by EU25 citizens (these are defined outbound, also when the tourists stay within their own country) is 875 million journeys, of which 61% are domestic, 29% intra-EU25, 4% to European countries outside the EU25 and 6% to other continents (ICA). The inbound tourism is almost identical to these numbers: a total of 873 million, of which 61% is domestic, 29% intra-EU25, 6% from European countries outside the EU25 and 4% ICA. The importance of domestic tourism is again clearly illustrated by these results.

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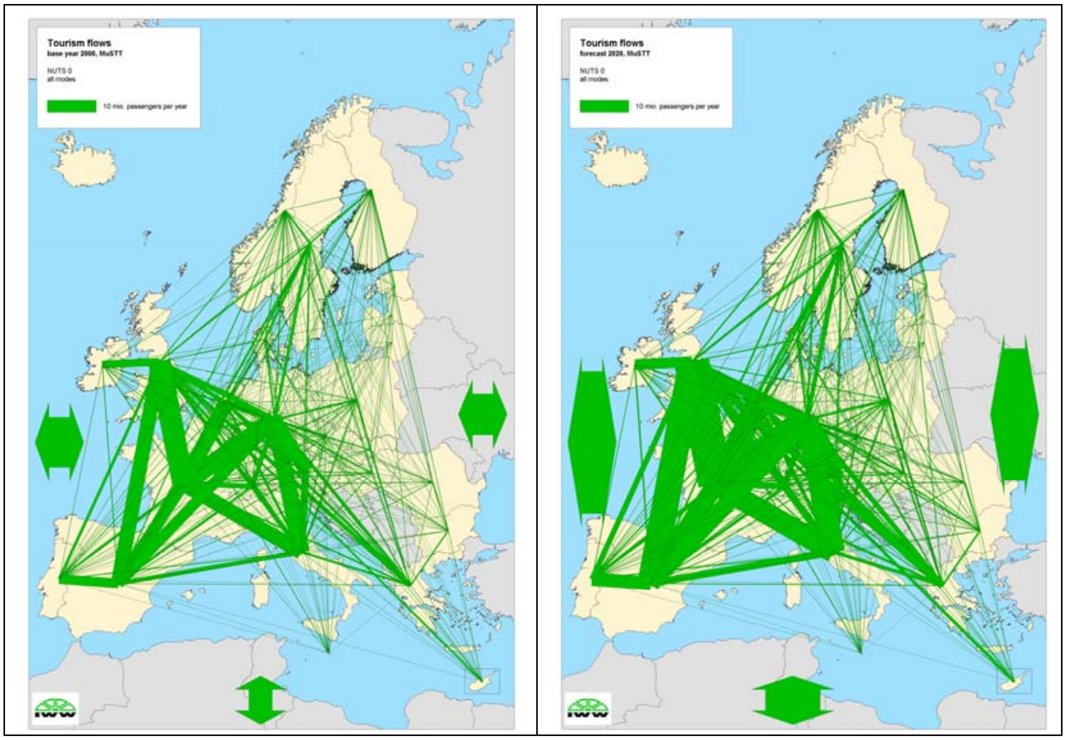

Figure 5: Total O/D international outbound tourism flows (in number of journeys) is presented for 2000 (left) and 2020 (right). The maps show clearly the importance of the many intra-European journeys compared to the three ICA stream shown. The western arrow represents tourism to the American continent, the southern one to Africa and the eastern one to Asia (all based on MuSTT data model output).

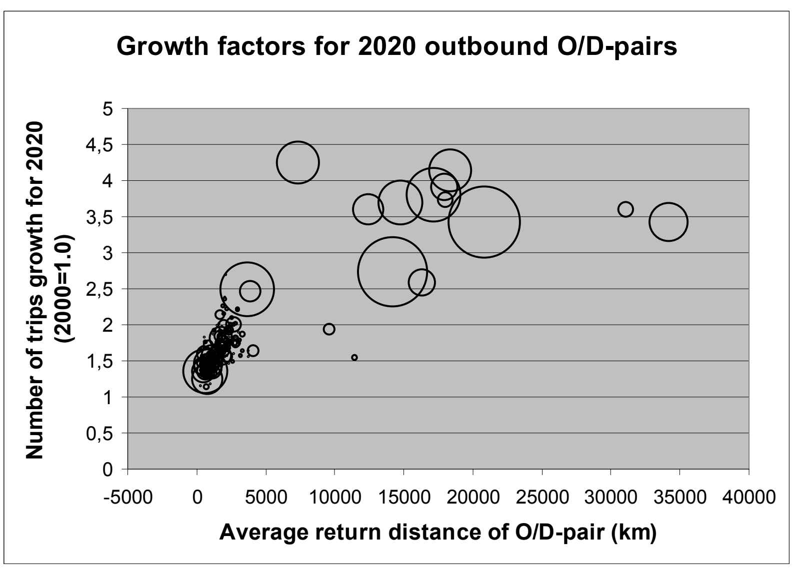

Figure 6: Increase in journey numbers for all O/D-pair with over 100,000 journeys per year. The area of the bubble represents the total of pkm for each O/D category in 2020.

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The prognoses for 2020 show an overall increase for outbound tourism journeys by 2.3% per year up to 1371 million journeys. However the growth is not evenly distributed across travel distance classes (see Figure 6). Large growth rates are expected for journeys with a large O/D return distance. Long distance markets therefore are forecasted to grow much faster and shares for outbound and inbound ICA journeys to increase to 13% and 9% respectively. Total number of journeys, including domestic tourism, is expected to grow by 60%.

With regard to transport performance (measured by passenger-kilometres) – which is with respect to environmental impacts a more meaningful indicator than the transport volume (measured by number of trips) – ICA represented 37% of outbound mobility and 31% of inbound mobility. And again, due to the larger growth of long distance markets, by 2020 these shares will rise to 56% for outbound and 50% for inbound. The domestic market – the largest market with a share of 61% of journeys – generates one third of all tourism mobility in 2000, decreasing to 20% in 2020. The total passenger transport performance is expected to increase substantially: For outbound tourism from 2021 billion pkm in 2000 to 4480 billion in 2020 (+122%). European tourism outbound mobility in 2000 represents about 6.6% of the total world mobility as given by Schäfer & Victor (2000). In 2020 this share is expected to increase to 8.3%.

3.2 Environmental impacts of intra-EU tourism

Using the provisional emission calculation method within the MuSTT data model, total intra-EU tourism transport related emissions of GHG, NO_x and PM are calculated. Emissions of PM total at 1590 tons, of which 87% stem from private cars and 13% approximately equally shared by ferries, coach, air and rail. The total NO_x emissions amount to 570 thousand tons, which is 4.9% of the total EU NO_x emissions (based on total given by Eurostat, 2005). Again the car has the largest share with 54%. However, air transport makes up 35% of the total. For GHG emissions a total of 210 million tons has been calculated, equivalent to 4.4% of the EU total. Air transport has the largest share (57%), with car transport taking almost all of the remainder (41%). This excludes the emissions of ICA tourism air transport.

Which transport mode has the largest overall environmental impact? A way to aggregate the different environmental impacts is to use the method of external costs or externalities. Externalities can be defined as “present whenever some economic agent’s (Y’s) welfare (utility or profit) function includes weal variables whose values are chosen directly by others (X) without particular attention to the effect upon the welfare of agent Y they affect” (Schipper, 1999). Figure 7 shows the results for intra-EU tourism O/D transport volume using generalised cost factors as given by IWW/INFRAS (2004). Because estimates for the external cost of climate change show a very wide range, both a low and a high cost value have been given.

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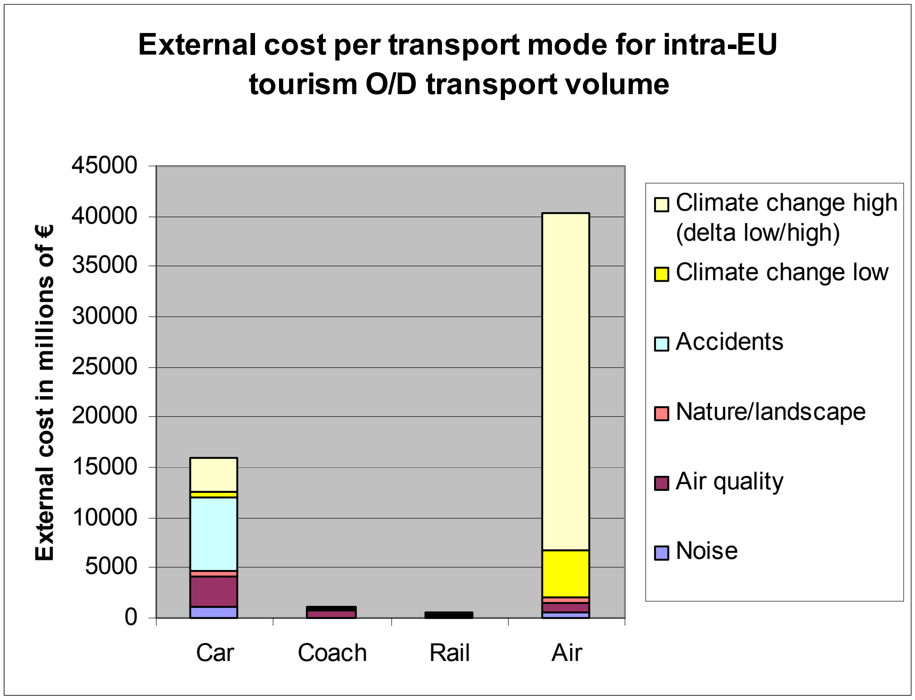

Figure 7: External costs of tourism O/D transport volume in 2000 within the 25 EU member states (based on cost factors given by IWW/INFRAS (2004) and the total number of pkm calculated with the MuSTT data model).

The figure makes clear that air transport has for both climate change estimates the largest *environmental* costs (excluding costs for accidents). It is also clear that environmental costs of tourism transport are dominated by climate change (even at the low estimate). Further it can be concluded that the car is generally responsible for air quality costs and noise. The costs of rail and coach are both in relative and absolute terms lower. Due to the importance of climate change in the present time and in the future, we will discuss climate change in more detail in the next section.

3.3 GHG emissions

Figure 8 shows the division of journeys, mobility and GHG emissions over the transport modes. In 2000 most tourism journeys (and most likely tourism revenues as well) depend on ground transportation, whereas air transport makes up the main share of mobility and more so GHG emissions. This picture becomes more pronounced in 2020.

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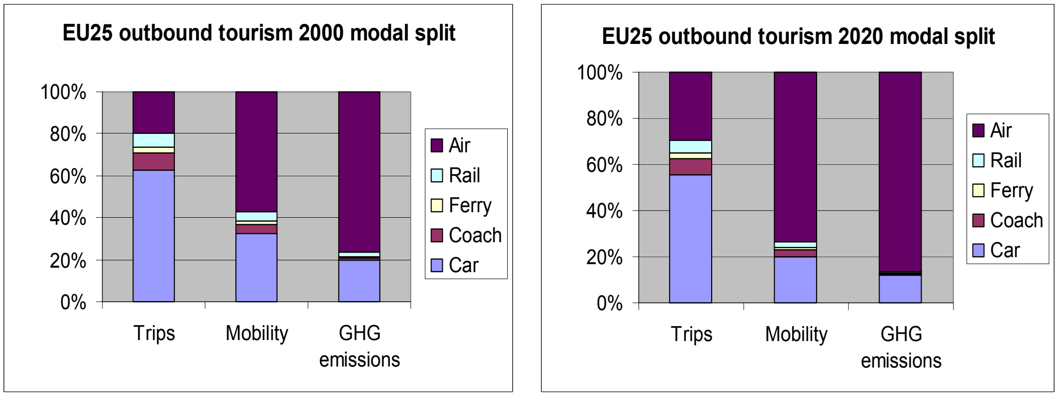

Figure 8: Modal split broken down by number of journeys, mobility (pkm) and GHG emissions of all EU outbound tourism transport (including ICA) in 2000 and 2020. An average energy efficiency increase of 1.4% per annum has been assumed for all transport modes.

Clearly, any overall improvement in technological and operational efficiency of air transport will heavily influence the resulting emissions. The IPCC scenarios presented by Penner et al. (1999, p. 5) show an annual overall efficiency increase in terms of fuel burn per passenger-kilometre of between 1.1% and 1.9%. Four out of seven scenarios assume 1.4%, including both technological and operational efficiency increases. This figure of 1.4% over the period 2000-2020 has been used for Figure 8. The same technological gains were assumed for the other transport modes.

In 2000 total GHG emissions are in the order of 474 million tonnes of CO_2–eq for outbound and 442 million tonnes for inbound tourism. For 2020 these emissions will increase by 90% up to 784 million tonnes for inbound and 878 million tonnes for outbound tourism transport. Comparing tourism transport emissions to EU25 total emissions of CO_2–eq (excluding both international sea and air transport emissions and land use changes) of 4824 million tonnes in 2000 (Eurostat, 2005), it can be seen that outbound tourism makes up about 10% of the total EU25 emissions. If we include the emissions related to tourism arrivals from non-EU states the total emissions for 2000 reach 706 million tons or 14.6% of the EU total. As the EU signed the Kyoto protocol and actual GHG-emissions (excluding international aviation) are declining, the strong growth of tourism O/D transport volume means that these shares will increase in 2020 to 16-18% for inbound respectively outbound and almost 30% for the total.

Figure 9 shows for 2000 and 2020 how tourism journeys and GHG-emissions are distributed when ordered for increasing average O/D-pair distance. The curve for 2000 clearly shows that 80% of the shortest trips (the trips between ‘0%’ and ‘80%’) cause only some 25% of all emissions, thus the remaining 20% at the long haul side of the graph is responsible for 75% of the emissions. When the 15 index points of long haul journeys in 2020 were somehow not made (meaning a reduction of only 10% of the total number of 2020 tourism journeys) the GHG emissions would not increase from the 2000 value.

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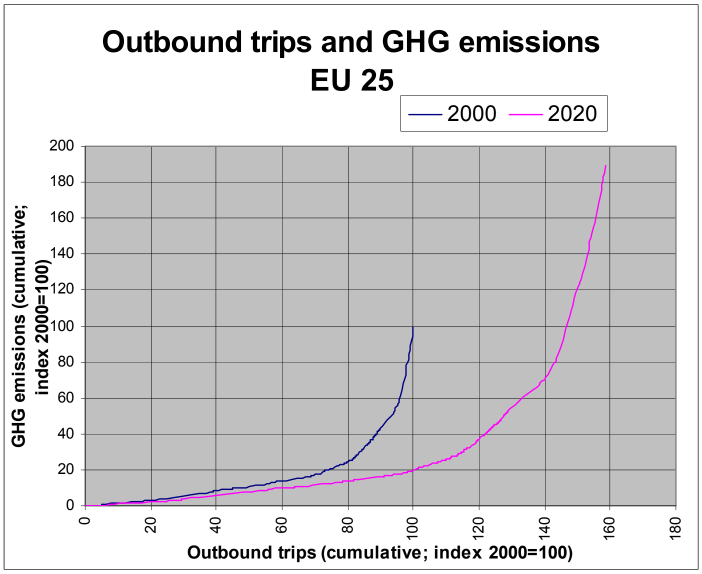

Figure 9: Relation between number of journeys and GHG emissions for base year 2000 and the 2020 scenario with data sorted on O/D-pair average return distance. An efficiency gain of 1.4% per annum is assumed.

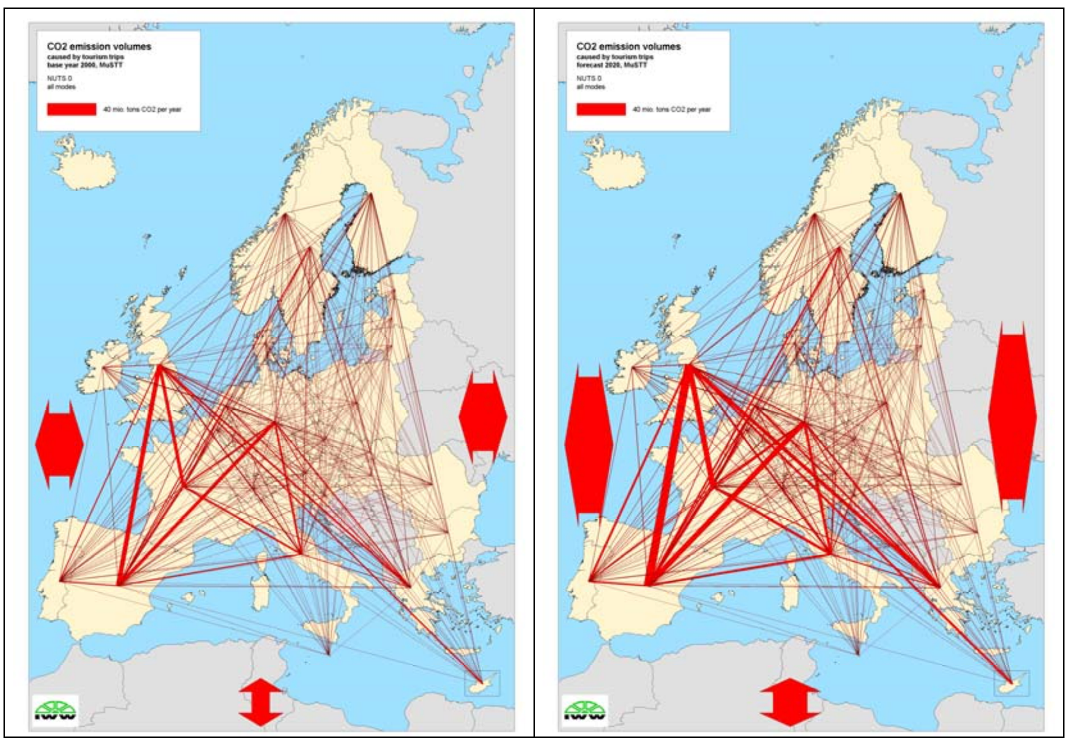

Figure 10: Total international tourism O/D transport volume GHG emissions (in tons of CO_2 –eq.) is presented for 2000 (left) and 2020 (right). The maps make very clear how important the GHG emissions of the three ICA flows are with respect to any of the other intra-European markets shown. The western arrow represents GHG emissions caused by tourism flows to America, the southern one to Africa and the eastern one to Asia (all based on MuSTT data model output).

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The geographical spread of GHG emissions for international tourism O/D transport volumes is presented in Figure 10. The figure again makes clear the large importance of ICA travel (the western arrows represents tourism to the America, the southern one to Africa and the eastern one to Asia). Comparing these maps with those from Figure 5 reveals that the comparatively low transport volumes between Europe and other continents account for a high share of GHG emissions.

4 CONCLUSIONS AND DISCUSSION

4.1 Conclusions

It has been shown to be feasible to merge passenger transport demand data from TEN-STAC with tourism data from WTO, in order to develop a new data model for O/D tourism flows at European level. The main progress achieved has been to include domestic tourism to existing international tourism data bases and to extend the number of modes to five. Also detailed transport data on distances and modes within the definitions of WTO tourism data bases have been created. This allows for detailed assessment of environmental impacts of tourism O/D transport volumes, which can be compared to other tourism related environmental impacts. The new data model can be used as a base for further analysis regarding tourism transport and environmental impact regarding for example European policy.

The results for European Union tourism reveal that, with regard to number of journeys, tourism is determined by the domestic and intra-EU25 markets (together more than 90% of journeys) and by ground transportation (about 80%). Intercontinental trips add only about 5% to all EU25 volumes, though this share is expected of more than doubling until 2020. The private car is the most popular mode of transport with a share of 63% of all journeys. Air transport serves 20% of all tourism journeys in 2000, growing to 30% in 2020. The number of journeys for outbound tourism is almost identical to the number of inbound tourism, as both are dominated by domestic and intra-EU25 flows.

In terms of total external costs, air transport has a share of 50% to 78%, depending on the estimate of the external cost of climate change. In terms of environmental impacts the shares per mode differ strongly. Tourism O/D transport volumes by car cause the largest impacts on air quality, whereas air transport shows the largest share in GHG emissions (80% in 2000). Rail, coach and ferry represent almost 20% of all tourism trips, but are responsible for only a few percent of the different environmental impacts. Tourism transport (inbound plus outbound) is a significant contributor of GHG emissions in the EU25 at approximately 15% of total EU GHG emissions in 2000 ('total' means emissions for all sectors within the EU25). This share is expected to increase to 30% (outbound plus inbound) of total EU25 emissions in 2020.

Due to the high emission volumes of GHG caused by intercontinental in- and outbound air trips, the analyses have impressively emphasised the importance of incorporating intercontinental flows into the scope of passenger

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demand modelling at European level for the purpose of transport and environment policies.

4.2 Discussion

The uneven distribution of emissions over tourism distance markets offers an opportunity to reduce emissions significantly, while affecting only a relatively small part of all tourism and tourism economy. Figure 9 shows clearly that 80% of the harm is caused by only 20% of all trips. However, currently the strongest growth of tourism occurs for long haul trips. This may be caused by the low and decreasing cost of air transport (per pkm), the large differences in cost for accommodations between tourism source countries (most Western) and destinations (most developing countries) and the higher risk of individual travel to long haul destination. This last issue gives an extra incentive to tour operators to concentrate on long haul packages. But even with this strong uneven growth in 2020 the main number of tourism journeys remains within the European Union. Policies with the objective to reduce the external cost of European tourism should therefore seek measures affecting both tourism air transport and intercontinental tourism.

Return distance class (km)	Number of journeys (%)	Transport performance (% pkm)	GHG emissions (%)
Domestic	61	25	14
International intra-EU	29	32	31
Other EU	4	6	8
ICA	6	37	48

Table 3: Distribution of journeys, passenger-kilometres and GHG emissions over the normal segments domestic international and intercontinental for all EU25 outbound tourism.

Return distance class (km)	Number of journeys (%)	Transport performance (% pkm)	GHG emissions (%)
0-1000	71	31	18
1000-2000	16	19	19
2000-4000	7	13	16
above 4000	6	37	47

Table 4: Distribution of journeys, passenger-kilometres and GHG emissions over some distance classes for all EU25 outbound tourism.

Within tourism it is customary to divide the market by geographical attributes, the nature of the journey (e.g. domestic, international, inter-regional or intercontinental). This custom has its roots in the way data are gathered, mainly at country borders. The disadvantage of this is the great differences between domestic tourism within for example Luxembourg and China. In Luxembourg the distance travelled is seldom larger than 100 km, while for China this may just as well be 5000 km. Though domestic tourism will generally show shorter distances than international tourism, there will be a

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large overlap of distance classes. Distance class seems an important parameter determining the transport mode, the cost of transport and the environmental impacts. Distance classes are thus more relevant than crossing borders, though the latter can be prohibitive due to political circumstances for any tourism to evolve. The large number of O/D-pairs available within the MuSTT data base allows some insights into this distance related travel behaviour.
Comparing Table 3 and Table 4 shows clearly that the ICA class almost equals the largest return distance class (>4000 km). The other three distance classes are much different from the other three geo-political classes. It is assumed that future modelling of tourism transport developments will benefit much from data based on distance classes rather than the geo-political classes only. This will also make comparisons between large and small countries (for example China and Germany) easier and more meaningful.

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Notes

[1] Nomenclature of territorial units for statistics - NUTS2 is one of the statistical units defined by EUROSTAT (e.g. Provinces in the Netherlands, regions in France or Regierungsbezirke in Germany).

[2] The generation and distribution of O/D volumes is performed by the VACLAV model at a lower regional level, at NUTS 3 (see section 2.4).

[3] The term 'tourism O/D transport volume modes' should not be misunderstood: These modes are not specifically for tourism transport. Still emissions factors have to be dedicated to the specific purpose of travel because the operational circumstances – like seat occupation rates, speeds, average distances travelled, specific types of vehicles used – may differ to a large extend. For example the average occupation rate for commuting by car in The Netherlands is only 1.1 person, while for leisure this value is twice as high, causing the specific emission factor (g/pkm) for car commuting to be twice the value for car leisure.

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