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Mobility module development

SASTDes WP2 Report

SASTDes – Smart Assessment Sustainable Tourist Destinations

DISCOVER YOUR WORLD

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1 Introduction

1.1 Project SASTDes

Project SASTDes aims to resolve key issues in the sustainability assessment process of tourism destinations, with the objective to reduce the costs of assessments both in time and money, and to use the results of assessments for destination branding and marketing. The project's core research question is: '*How can sustainability assessments effectively and efficiently contribute to the sustainable development of tourism destinations and tourism products*?'

The large growth in tourism not only brings economic progress, but also causes negative effects on destinations and beyond, environmentally, socio-culturally and economically. The tourism industry has responded with a number of sustainable tourism initiatives. An often-used method is to subject tourism products to a sustainability assessment, frequently leading to a label. The goal here is to motivate destinations to perform more sustainably and to stimulate consumers to make more sustainable touristic choices. Until now, participation in sustainability assessments in tourism is limited. Hence the effect on consumer choices is also small.

Most assessments suffer from limited participation and interest from tourism businesses. Conducting assessments is too costly for them, costing too much time, and the added value is unclear to them. Moreover, the assessments hardly lead to behaviour changes among the relatively small group of end users interested in sustainability. Finally there is a problem with the content of the assessments: the impacts from transport to destinations is not accounted for, whereas these are often of great importance when determining the environmental impact of tourism trips (Peeters, Szimba, & Duijnisveld, 2007).

1.2 Objective for this report

The objective of Work Package (WP) 2 is to address the last issue, and to develop a module for sustainability assessment-processes that analyses, weighs and incorporates the environmental impacts of transport to and from the destination. A sustainable accessibility index will also be developed for the Green Destinations (GD) [1] destination report.

1.3 Background, steps and deliverables

Whereas origin-destination (O/D) transport causes a large part of the environmental impacts of tourism (Peeters, Szimba, et al., 2007), little attention is paid to this in sustainability assessments. The impacts will vary depending on geography and market mix. The result should be an environmental impact score, both absolute and per traveller, overnight and revenue. A next step is to look at measures to keep impacts as low as possible, e.g. through marketing policies, airline choice, et cetera. Eventually a benchmark should be developed based on geographical and other variables (such as population density, income, political barriers, islands vs mainland, etc.), by which actual transport impacts can be compared.

Accessibility of European destinations per sustainable mode (mainly train) will be analysed in cooperation with Treinreiswinkel, and a young organisation, Green Tickets, that have access to several databases to be used in the GD destination reporting, and coupled with advice for making use of well-connected markets.

WP2 research steps:

- WP2.1. Calculation tool for determining energy, carbon footprint, noise, landscape effects of transport and transport infrastructure. Absolute, per night, and per € (CSTT)
- WP2.2. Standard transport impact given the geographical location (CSTT, WENR)
- WP2.3. Accessibility per train (Treinreiswinkel, CSTT)

[1] See http://greendestinations.org/ for more information on GD. The GD Standard and Reporting System is explained in this document: http://greendestinations.org/wp-content/uploads/2017/11/Green-Destinations-Standard-1.4.2.pdf

- WP2.4. User manual and report writing
- WP2.5. Development of a method to determine standard transport impact of a geographical location through GIS (WENR)

Deliverables:

- Mobility tool plus benchmark for European destinations
- Module report
- Sustainable accessibility as part of GD-destination reporting (for WP3)
- User manual tool

2 WP2.1 mobility impacts calculation tool

2.1 Goal

The goal is the development of a mobility calculation tool. And an analysis of tourism transport and infrastructure effects to determine the key factors for the tool (options could be energy, carbon footprint, noise, landscape pollution, or others). Absolute, relative (e.g. per stay/overnight), and per Euro spent, will be taken into account.

2.2 Key factors

2.2.1 Introduction

Key negative impacts associated with different transport modes and infrastructure are:

Impact	**Main areas**	**Main (transport) source**	**Source**
Noise pollution		Road, Air, Train	EEA (2014)
NOx emissions		Road, Cruise	
SOx emissions		Cruise	
PM emissions	Urban	Road, Cruise	
CO emissions		Road	
Safety		Road	
CO_2 emissions		Road, Air, Cruise	Peeters, Szimba, et al. (2007)
Landscape pollution		Roads, Airports	

Here, we will discuss various possible factors in tourism transport, and finish with a range of choice perspectives.

2.2.2 Climate change

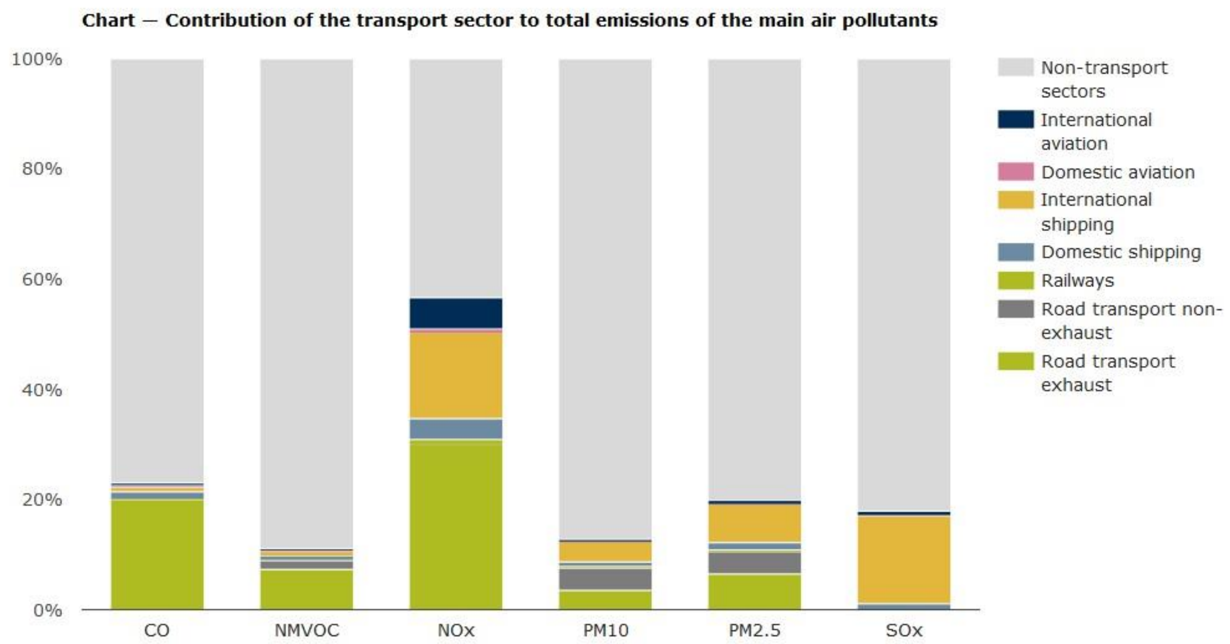
The UN Secretary General recently named climate change 'the most systemic threat to humankind' (Guterres, 2018). Tourism transport's contribution to climate change is largely through CO_2 emissions, as most tourism transport is fossil fuel based. In 2008, the World Tourism Organisation (UNWTO) reported on the effects of climate change on tourism as well as the effects of tourism on greenhouse gas emissions (UNWTO-UNEP-WMO, 2008). The UNWTO report estimated the contribution of tourism to carbon dioxide emissions at approximately 5% in 2005 (UNWTO-UNEP-WMO, 2008). Furthermore, Gössling and Peeters (2015) found the emission to double between 2010 and 2032. More recently, Peeters (2017) assessed the long term development of tourism's carbon footprint and found this to increase by a factor 4.6 between 2015 and 2100. Where currently 22% of tourism trips is based on air transport, the share of air CO_2 emissions is 55%. By 2100 this will have risen to 75%. The strong growth of emissions is in stark contrast with the Paris 2015 Climate Agreement, that seeks to reduce emissions to almost zero by 2100. According to Peeters (2017), almost zero-emissions is only achievable for tourism when all mitigation opportunities are fully implemented. This also includes a physical barrier – cap on airport slots or global aircraft fleet - to unlimited growth of air transport.

Besides CO_2 emissions, other emissions also play a role in global warming. These include gases like nitrogen oxides, CFCs and methane. A common way to add the effects of these other greenhouse gases (GHG) to CO_2 is by converting them into carbon dioxide equivalents (CO_2-eq). To do this, 'global warming potential' (GWP) is used as a conversion factor. These factors vary significantly per type of gas. For instance, the GWP of methane is 25 (see (IPCC, 2007, p. 33). This means that in one hundred years the emission of 1 kg methane has the same effect on the temperature as the emission of 25 kg of CO_2 over the same period. A conversion factor can also be determined for an industry or sector, which obviously depends on the exact mix of emissions. For nearly all tourism components this factor is relatively small (1.05, see Peeters, Szimba, et al., 2007). However, for air travel this is not the case. Airplanes cause additional impacts on climate, as they not only produce additional GHGs like nitrogen oxides, but also because these substances appear in the upper atmosphere, where they cause chemical reactions, and in some cases contrails (condensation trails) and sometimes even high altitude 'contrail-induced' cirrus clouds. This produces a significant net contribution to 'radiative forcing'. In 2005, the total contribution of aviation to radiative forcing accumulated since 1940 was 2.0 (excluding cirrus clouds) to 2.8 times (including cirrus) as large as the effect of all airplane CO_2 emissions (best estimates from (Lee et al., 2009). However, the uncertainty is large: the total contribution of aviation to climate change lies somewhere between 1% and 14%. Unfortunately, as a result of various practical and theoretical objections, these percentages cannot be used as GWP (see (Forster, Shine, & Stuber, 2006, 2007; Graßl & Brockhagen, 2007; Peeters, Williams, & Gössling, 2007). Thus, it is not possible to provide a CO_2-equivalent for air travel.

2.2.3 Air pollution

Transport contributes considerable portions of Europe's (EEA-33) air polluting substances, see Figure 1. Road transport has large shares of CO, NOx, and PM emissions, while cruise ships are a part of international shipping (NOx, PM and SOx). Aviation is mainly visible through NOx, whereas rail travel plays a negligible role compared to these other modes.

Figure 1: Contribution of the transport sector to total emissions of the main air pollutants (EEA-33)



Source: EEA (2017)

2.2.4 Noise

The World Health Organisation (WHO) handles noise as the second largest environmental cause of health problems, just after the impact of air quality (particulate matter) (WHO, 2011). The health of our ecosystems is also at risk. The noise maps of Europe reveal graphically how the extent of even relatively moderate levels of noise such as 55 dB Lden are consuming more and more territorial area outside of urban areas and directly threatening valuable habitats and species that are particularly susceptible to noise (EEA, 2014). Common causes for environmental noise pollution are road, rail and airport traffic, industry, and construction.

Houthuijs, van Beek, Swart, and van Kempen (2014) estimate that at least about 19.8 million adults in Europe are annoyed by noise from road traffic, railways, aircrafts or industry; 9.1 million of them are highly annoyed. They estimate that 7.9 million adults have sleep disturbance due to night time noise, with 3.7 million of them severely sleep disturbed. This exposure to noise contributes to about 910 thousand additional prevalent cases of hypertension and to 43 thousand hospital admissions per year and about 10 thousand premature deaths per year related to coronary heart disease and stroke. About 90% of the disease burden is related to road traffic noise.

Both END data and citizen ratings show that noise from road traffic is the most dominant threat, both due to its geographical extent and by the numbers of people it affects. In addition, while airports do not affect a wide geographical area, the effects of aircraft noise extend beyond the damage to health of those people living nearby airports. It also directly impacts the ability of younger generations to concentrate and learn in schools affected by aircraft flight paths. Although railway noise does not have the same high numbers of exposure that road traffic reaches, the numbers of people affected remain significant (EEA, 2014).

The studies discussed above typically connect health problems to noise levels in excess of 55 decibels (Lden 55 dB - Long-term average indicator designed to assess annoyance and defined by the Environmental Noise Directive (END). It refers to an annual average day, evening and night period of exposure). The WHO (2011) recommends that for a good night's sleep, continuous background noise should stay below 30 decibels and individual noises should not exceed 45 decibels.

2.2.5 Landscape pollution

Aesthetic or landscape pollution by tourism (transport) infrastructure has been noticed for decades, for example in Alpine destinations (Krippendorf, 1975). It relates to tourism urbanisation and the construction of roads, railways, parking lots and airports disturbing or destroying the natural and cultural landscape. In many coastal and Alpine destinations, this largely car-based infrastructure serves a tourism purpose for a very considerable share of its traffic.

2.2.6 Remarks

The difficulty with aforementioned factors is estimating tourism's role. These can (partly) be determined by determining tourist number, mode shares and distances travelled. Peeters, Szimba, et al. (2007) calculated that external costs for all tourism transport within the EU combined are highest for climate change, followed by accidents and air pollution, and subsequently noise and nature/landscape.

2.2.7 Choice perspectives

There are several perspectives to defining suitable key factors for inclusion in the mobility tool:

- Highest external costs perspective. A sub-choice here is between:
  - Costs on a local (destination) level
    - possibly with variations for different types of destinations. E.g. coastal destinations may suffer from cruise ship air pollution, whereas mountain destinations may have problems with road congestion. Landscape pollution due to additional infrastructure will be more felt on the coast and in mountains than in city destinations.
  - Costs on a global level

  At the destination likely factors include air pollution and noise, but might exclude climate change which, from a global perspective generates the highest external costs in tourism (Peeters, Szimba, et al., 2007).
- Consumer vs. citizen perspective. Factors which are most felt by ('costly to') visitors might be different from those felt by destination inhabitants. For example, from an external cost perspective, air pollution is not a real issue for visitors, whether for inhabitants it is.
- Data access perspective. Choice based on which factors have the best data access and detail on a (European) destination level.

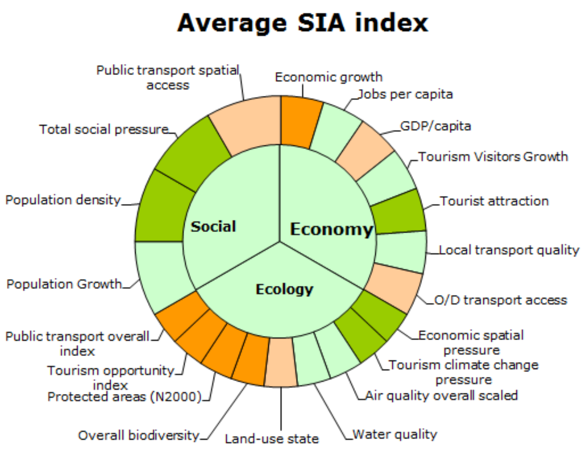
2.3 Examples of tourism-environment benchmarks

2.3.1 Sustainability Impact Assessment Lake destinations

Project SlowTour developed a Sustainability Impact Assessment (SIA) tool for European lake destinations, combining data from many sources and calculating indicators for all three main sustainability components (ecological, economic and social). It is based on 123 'raw' data entries that are condensed into 20 indicators distributed among the three main components of sustainability. The raw data were obtained from geographical information system (GIS) data from the European Environmental Agency (EEA), a visitor questionnaire and a multitude of local and European databases that were accessed by the destination management. The data were divided among 12 groups, amongst others air quality, energy, and transport (Canalicchio et al., 2011). SlowTour used the DPSIR environmental assessment system as a guideline to choose a relevant mix of data. DPSIR is an acronym for Drivers--Pressures--States--Impacts--Responses. The main outcome of the SIA tool was a SIA pie diagram, showing 20 sustainability indicators that are calculated using the 100--plus data entries.

Figure 2 shows an example of such a diagram and presents the results for the metric average scores of all 12 Slow tour lake destination areas. It shows the three main sustainability components – economy, ecology and social – and the indicators that are part of each of these components. The legend to the colours is given in Table 1.

Figure 2: Example of SlowTour SIA pie diagram



Source: Canalicchio et al. (2011, p. 53)

Table 1: Legend to the SlowTour SIA graphs

Value	Meaning with respect to the sustainability component	Color
0	Insufficient data available	
1	Not at all good	
2	Not good	
3	Slightly below neutral	
4	Slightly above neutral	
5	Good	
6	Very good	

Source: Canalicchio et al. (2011, pp. 53-54)

Table 2 shows SlowTour indicators that might be relevant to the SASTDes mobility tool. Air quality measures were obtained from the spatial data sets on particulate matter (PM10, 36th maximum daily average), ozone (O3, concentration, a combined rural and urban highest daily concentration) and nitrogen oxides (NOx, concentration) that have been made available by the European Environmental Agency. Measurements from the station in or nearest to the lake area for the most recent years were used. The average distance that tourists travel to the lake area was meant to be a proxy for the carbon footprint this travel causes. In addition, the transport mode used also affects the carbon footprint. For origin--destination modal travel weight factors were estimated for different modes, based on the average trip emissions found for Dutch holidaymakers. The same method was used to determine the weight factors for the local transport modes used. Other weights were also applied, e.g. the access distances for the four main transport modes (distance to airport, highway, station, etc.).

Table 2: SlowTour SIA transport-relevant indicators

Code	DPSIR	Description	Index based on ...
Economy			
TRA01	D	Local transport quality	Visitor opinion on local transport
TRA03	D	O/D transport access	Reverse of distance to Intercity and international railway, highway and international airport
Ecology			
ENV11	P	Tourism climate change pressure	Average tourist carbon footprint per head (low → high index)
ENV16	S	Air quality overall scaled	Weighted sum PM10, O_3, and NO_x (low → high index)
LAN02	P	Land-use state	Weighted sum of 10 land-use categories
TRA06	D	Public transport (PT) overall index	Combination of local PT visitor score, PT share of local and travel to destination, and PT access (reverse of distance to bus and intercity and international rail way)
Social			
TRA07	P	Public transport spatial access	PT access (reverse of distance to bus and intercity and international rail way) is considered to be socially desirable

Source: Canalicchio et al. (2011)

2.3.2 Over-tourism diagnostics McKinsey & WTTC

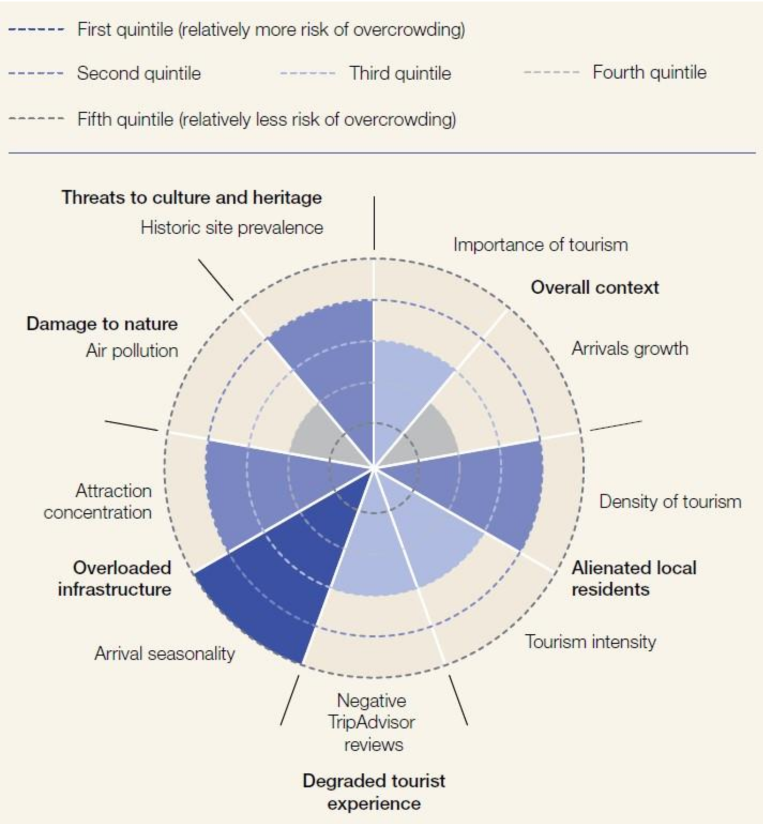
McKinsey & Company and WTTC (2017), in a report on over-tourism, identified five major problems associated with tourist overcrowding: alienated local residents, degraded tourist experiences, overloaded infrastructure, damage to nature, and threats to culture and heritage. It is interesting that McKinsey & Company and WTTC (2017) mention both the European Tourism Indicator System (ETIS) and Green Destinations' Global Destination Sustainability Index (GDS-Index) as examples of databases and indices to assist tourism destinations in measuring and improving their sustainability, but that the 'tourism leaders' the authors spoke with signalled that these did not deliver what they wanted: 'a rapid, easy-to-use diagnostic based on credible, widely available data' (McKinsey & Company & WTTC, 2017, p. 20).

Therefore, McKinsey & Company and WTTC (2017) created a diagnostic for destinations to understand their individual situation, based on nine indicators (metrics) for these five problem areas, limited to such metrics that are available across regions, destination types, and over time periods to ensure they are regularly updated to allow for comparisons over time (see an example for Barcelona in Figure 3). This form of diagnostic is similar to that used by Rockström et al. (2009) and Steffen et al. (2015) for demonstrating the safe operating space for nine planetary systems. The McKinsey report is limited to 68 cities, all over the globe, as the authors wanted to develop a set of benchmarks for one destination type and city-level data was more widely available than data for individual sites. As benchmarks, the 68 cities are broken down into quintiles, or clusters of 20 percent, that indicate a city's relative risk of experiencing a given overcrowding problem (see Figure 4).

For the SASTDes mobility tool, their use of air pollution as a metric for damage to nature is interesting (threats to local health were not included as one of the five problems). Data used for air pollution are annual mean PM10 particulate concentration (micrograms per cubic meter), available through the WHO Global Urban Ambient Air Pollution Database. This database shows the annual mean concentration of PM10 in a (limited number of) cities in most countries for a relatively recent year. The benchmark clusters for PM10 are shown in

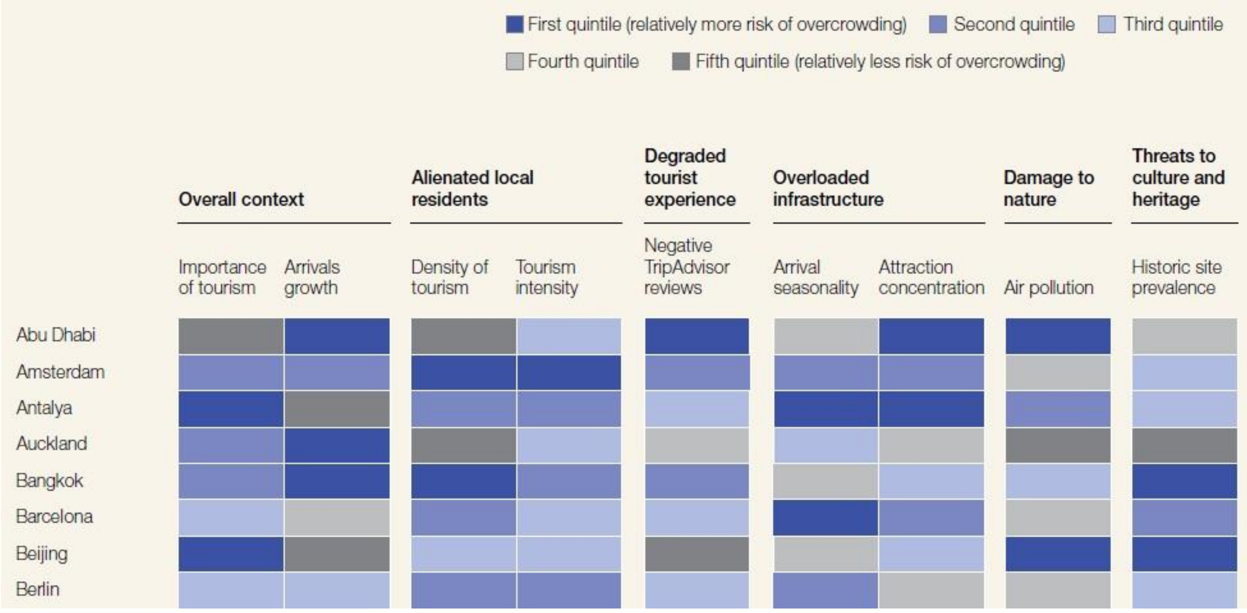
Table 3. An interesting comment by McKinsey & Company and WTTC (2017, p. 23) is that they 'found no consistent sources for tourism-related pollution or energy consumption at the country or city level. The World Health Organization (WHO) measures air pollution, but the metric is not specific to tourism; nor does WHO cover topics such as biodiversity, habitat loss, waste generation, and water consumption. The databases described in this section, such as Green Destinations, offer much more depth in this regard'.

Figure 3: Example diagnostic for Barcelona (McKinsey/WTTC)



Source: McKinsey & Company and WTTC (2017, p. 24)

Figure 4: Examples Heatmap major overcrowding problems (McKinsey/WTTC)



Source: McKinsey & Company and WTTC (2017, p. 54)

Table 3: PM10 benchmarks for cities to assess air pollution (McKinsey/WTTC)

	Top quintile (highest risk)	Second quintile	Third quintile	Fourth quintile	Fifth quintile (lowest risk)
Annual mean PM10 concentration	>74.9	43.1–74.9	26.8–43.0	16.6–26.7	<16.5

Source: McKinsey & Company and WTTC (2017, p. 22)

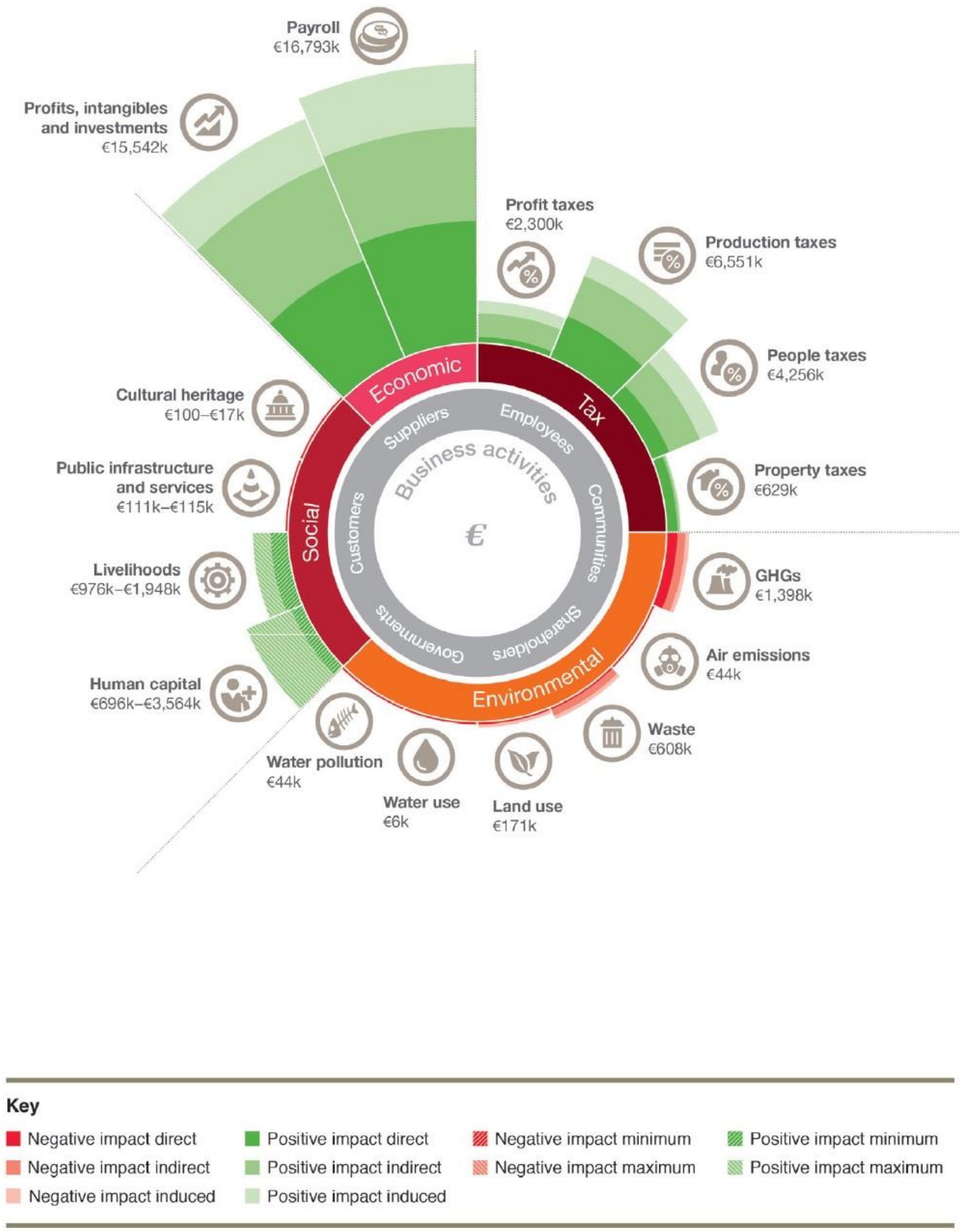
2.3.3 Total Impact Measurement and Management (TIMM)

Aiming to improve impact assessment and valuation in tourism, PwC, the Travel Foundation and TUI Group Plc performed a pilot study in Cyprus (PwC, 2015a). The pilot study used TIMM, an impact measurement and valuation framework developed by PwC, which provides a comprehensive and balanced evaluation of a business' impacts on society, the economy and the environment (see Methodology report: PwC, 2015b). TIMM considers four key categories of impact:

- Economic impact covers the effect of an activity on the economy in a given area by measuring the associated output or value added (and changes in employment);
- Tax impact covers the associated tax contribution;
- Environmental impact measures the value of the impacts on society of the emissions to air, land and water and the use of natural resources; and
- Social impact values the consequences of the activities on societal outcomes such as livelihoods, skills and cultural heritage.

The scope of the pilot study in Cyprus was defined as eight hotels used by TUI Group which are a subset of its operations in Cyprus and cover 60,000 TUI customers travelling to Cyprus, and all impacts accruing in Cyprus as a result of TUI Group's activities in these hotels in 2013. The pilot was a snapshot of one year and excludes (!) travel to and from Cyprus and impacts accruing outside Cyprus (except Greenhouse Gases (GHGs), which have a global impact) (PwC, 2015a). Impacts are shown as positive and negative, and direct, indirect and induced, and are expressed in Euros (see Figure 5).

Figure 5: TIMM output - Summary of total impact of TUI Group's activities in Cyprus, 2013



Source: PwC (2015a, p. 13)

2.4 Benchmarking factors

The next step is to determine how these factors are used, i.e. how to weigh them. There are many options here, varying from benchmarking results for all or a type of destinations, to using widely accepted limits for certain types of impacts, for example from the EU or the WHO.

Tools (to be determined/extended):

- European model/database transport between cities

- Noise – Decibel limits
- CC, air pollution & noise
- Air pollution – limits
- EU or WHO norms
- CO_2? Taken from PhD (Peeters, 2017)? Start with current situation (marktets and transport) per destination, and then reduce per year, to zero by 2100.
- Use Distance decay

2.4.1 WHO Air Quality Guidelines

- Annual mean of PM2.5: 10 µg/m3
- 24-hour mean of PM2.5 (99th percentile of the annual daily series (3 days per year)): 25 µg/m3
- Annual mean of PM10: 20 µg/m3
- 24-hour mean of PM10 (99th percentile of the annual daily series (3 days per year)): 50 µg/m3
- Daily maximum 8-hour mean of ozone: 100 µg/m3
- Annual mean of NO2: 40 µg/m3
- 1-hour mean of NO2: 200 µg/m3
- 24-hour mean of SO2: 20 µg/m3
- 10-minute mean of SO2: 500 µg/m3

2.5 Data sources

2.5.1 WHO

The WHO Global Urban Ambient Air Pollution Database (http://www.who.int/phe/health_topics/outdoorair/databases/cities/en/) covers over 3,000 cities in 103 countries. Air quality is represented by annual mean concentration of particulate matter (PM10 and PM2.5, i.e. particles smaller than 10 or 2.5 microns).

2.5.2 EEA

AirBase - the European Air quality database (http://acm.eionet.europa.eu/databases/airbase) is the public air quality database system of the EEA. It contains air quality monitoring data and information submitted by the participating countries throughout Europe. The air quality database consists of multi-annual time series of air quality measurement data and their statistics for a representative selection of stations and for a number of pollutants. It also contains meta-information on the involved monitoring networks, their stations and their measurements. The database covers geographically all countries from the European Union, the EEA member countries and some EEA potential candidate countries.

A new EEA and European Commission online service is the European Air Quality Index (http://airindex.eea.europa.eu/), which provides information on the current air quality situation based on measurements from more than 2,000 air quality monitoring stations across Europe, both traffic-based ones and non-traffic. The Index consists of an interactive map that shows the local air quality situation at station level, based on five key pollutants that harm people's health and the environment: particulate matter (PM2.5 and PM10), ground-level ozone (O3), nitrogen dioxide (NO2) and sulphur dioxide (SO2).

2.5.3 TourMIS

TourMIS (www.tourmis.info) is a marketing decision support system that supports the tourism industry by collecting, storing, processing, and disseminating tourism related information. The system provides free access to a number of important tourism indicators such as bed-nights, arrivals and capacities in tourism destinations (countries, regions, cities). TourMIS shows market mixes for a few dozen European cities (arrivals, nights), useful for carbon footprint calculations. It also offers estimates of travel distances per city destination. The number of destinations offered is too limited for application in the SASTDes mobility tool though.

2.5.4 Carmacal

CARMACAL is a user-friendly application which allows tour operators and other businesses to measure the complete and detailed carbon footprint of their tour packages, enabling the integration of carbon management into their daily operations. CARMACAL has a unique level of detail, allowing tour operators to measure and manage every carbon footprint aspect of their products in detail. The carbon footprint of flights is specified up to the level of airline and type of plane, for all scheduled flights available. CARMACAL differentiates the footprint for 25 modes of transport, 21 emission-intensive activities, and gives exact distance calculations. Accommodation carbon footprints are calculated on an individual basis for some 550,000 accommodations worldwide. For other accommodations, 20 different types with individual emission factors are available. It is a web-based application with a simple overview screen, enabling product selection by for instance unique codes, product names, countries and product types (CSTT, 2018).

3 The proposed mobility tool

Please note that this part is subject to changes due to the fact that the development of the proposed mobility tool is still work-in-progress.

3.1 Introduction

Tourism and travel today are much inter-related than ever, and there are different levels of an inherent carbon risk emission in travel via different transport modes.
Tourism-related activities are perceived to be a major source of GHG emissions. Therefore, there is a need to measure the role of tourism in generating the environmental impacts (Sun, 2014). More specifically, in regard to travel to and from a destination, the existing measurements, and lack of data hamper a better understanding of environmental impacts (Becken & Shuker, 2019).
The distance, destinations and transport modes tourists use to travel may differ, but what is certain is that all tourist travel leads to the emission of GHGs, mainly CO_2. Existing literature on the environmental impacts of transport to the destination points to its major share in tourism emissions, with a growing share on behalf of air transport (see also section 2.2.2; Gössling & Peeters, 2015; Peeters, 2017; Peeters, Szimba, et al., 2007; Scott, Peeters, & Gössling, 2010; UNWTO-UNEP-WMO, 2008), but quantifying the global carbon emissions related to tourism travel is still challenging for tourism organisations and destinations, if not impossible. To the knowledge of the author, the development of the mobility tool might be the first attempt to quantify the carbon emissions of O/D transport modes for European destinations.
The tool aims to provide destinations with insights into the measurement of environmental impacts of tourism transport modes, and, therewith, enable them to manage their destinations more sustainably. Besides, a benchmark will be developed to assess the sustainability of tourism mobility of a destination.
The mobility tool will be developed in cooperation with different stakeholders.

3.2 Goals of the tool:

1. Provide mobility impacts for a specific destination;
2. Provide a benchmark for how the destination is doing with respect to mobility;
3. Provide a sustainable transport market advise for the specific destination.

3.3 Methodology

The tool will consider measuring the total journeys by different transport modes to the destination. The data from multiple sources will be used to calculate the overall CO_2 emissions of tourists' mobility to and at the destination. Carmacal (CSTT, 2018) may also function as complementary data source. Initially, the tool will be tested based on data received from more than dozens of destinations in Slovenia.

The table below presents an overview of the input variables for the tool.

Table 4: Input variables

Variables	Description	Sources
Destination	Exact location of the destination (geo-coordinates; main city name; country name)	Carmacal & Google map API
Origin	Exact location of the origin (geo-coordinates; main city name; country name)	Carmacal & Google map API
Transport mode	Trips and paxkm travelled per type of transports used by tourists	The destination management organisation provides number of trips & Carmacal the emissions per trip
Accommodation footprint	Current market in terms of total number of visitors and revenues and the shares of visitors and revenues per type of accommodation or accommodation address if available;	The destination management organisation provides the number of guest-nights per type or address, Carmacal the CO_2 emissions in kg/guest-night
Tourism activities	Types of activity undertaken by tourists	The destination management organisation provides the number of high-carbon activities per year and Carmacal the CO_2 emissions per activity per guest-day.

The main outputs generated by the tool include the total CO_2 emission in kilograms. The table below presents an overview of the output variables of the tool.

Table 5: Output variables

Variables	Description
CO_2	Total CO_2 emissions in kilogram sub-divided into transportation, accommodation and activity
Benchmark	Comparing destination's CO_2 output with an average destination of a specific category (we may divide destinations in certain categories like urban, non-urban, remote, island, etc.);
Advice on environmental impacts	Advice for improving environmental impacts;
Advice on sustainable transport markets	Market advice for sustainable transport markets

The market advice will mainly show what markets have good access by sustainable transport modes and/or are closer to the destination. These markets maybe differ from the current markets and that provides an opportunity for both growth and a more sustainable pattern.

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