Integrated Planning of Sustainable Tourism and Mobility: An Exploratory Study

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Abstract

Emerging tourist market trends are pushing destinations to consider mobility an essential strategic component of sustainable tourism planning. Destination Management needs to use tourism mobility analysis systematically if it wants to seize the opportunity and face the challenge of implementing effective strategies for sustainable transport and tourism. This paper introduces an innovative methodology for the analysis of tourist traffic components which can be used to assess their environmental impact and develop appropriate measures to manage mobility. The methodology has been implemented in South Tyrol, a province with the capacity to pioneer sustainable tourism initiatives and mobility measures. These measures seem to be having a positive effect on tourist flows, both through the encouraging of sustainable behavior (carrot measures) and the discouraging of unsustainable behavior (stick measures).

Keywords: Sustainable mobility; destination management; tourist and same-day traffic; environmental impact; carrot and stick measures

Introduction

Emerging market trends have prompted the tourist industry, like others, to reshape its development model in line with the sustainability paradigm (Dwyer, Edwards, Mistilis, Roman, & Scott, 2009; Weaver, 2011; Gössling, 2009). An appropriate balance between the economic effects of tourism and the non-renewable resources of tourist production (Inskeep, 1991; Swarbrooke, 1999) has to be found if destinations are to retain their competitive advantage in terms of visitor flow attractiveness, differentiation from competitors, quality of tourist experience and local citizen wellbeing. Mobility is a vital component in the restructuring and re-qualifying of a destination's tourist strategy since it

strongly impacts on the area's economic, environmental and social sustainability. Without mobility infrastructure and services there cannot be any tourism. Technological improvements in the transport sector, both in infrastructure and means of transport (Hernández Luis, 2008), have led to a significant rise in actual and potential tourist mobility (Segretariato Permanente della Convenzione delle Alpi, 2007), improved destination accessibility and a widened tourist offer (Dwyer et al., 2009), and have thus increased the economic impact of tourism. However, transport "democratization" (HernándezLuis, 2008) has also multiplied the environmental and social externalities of tourism (Dolnicar, Laesser, & Matus, 2010; Martín-Cejas & Ramírez Sanchez, 2009; Patterson, Nicolucci, & Bastianoni, 2007; Peeters & Dubois, 2010). A growing sensitivity and awareness of these issues in the modern consumer society (Pine & Gilmore, 1999), means that more and more tourists (and residents) are choosing ethical consumption and eco-friendly solutions, in transport as elsewhere (Kelly, Haider, Williams, & Englund, 2007; Yeoman, 2005). The offer of sustainable mobility may therefore be an opportunity to differentiate a destination from its rivals (Schiefelsbusch, Jain, Schäfer, & Müller, 2007) and attract emerging and increasing segments of sustainable demand.

The above factors point to the fact that planning and offering sustainable mobility infrastructure and services, which add value to the travel and tourism experience, is both an ethical imperative from the sustainability perspective, and an opportunity and challenge for Destination Management. This is especially true in community-type destinations, where the diverse interests, aims, competences and values of a wide range of stakeholders result in a lack of coordination and make it difficult to establish the critical mass a destination needs for effective decision making (Bieger, 1998 and 2005; Flagestadt & Hope, 2001; Kaspar, 1995; Keller, 1998; Laws, 1995; Murphy, 1985). Despite the strategic links between sustainable tourism planning and mobility management, they tend to be treated as separate issues, both in the literature and in practice (Page, 2005).

In this context, the paper proposes a case study on the South Tyrol, as an example of a pioneering alpine destination in Italy which integrates sustainable tourism and mobility into its destination planning. The paper describes an innovative methodology for the analysis of tourist flows and same-day visits, the assessment of their environmental impact and the development of measures which can steer destinations towards sustainable visitor mobility. The first section of the paper introduces sustainable tourism mobility and places it between Mobility Management and Destination Management studies. The second section describes the innovative methodology for the analysis of tourist flows applied to the case of South Tyrol, i.e. the Province of Bolzano (Italy). The third section presents the main results of the analysis and the final section includes a discussion of the results and the management implications of the study.

Theoretical reference context

Managerial studies on tourism and transport have traditionally been kept separate. In fact, mobility used to be considered a prerequisite for, rather than an integral part of, tourism development. Therefore visitor movement has had a marginal role in tourist planning and in mobility planning their needs have been considered mainly in terms of minimizing access costs. When the sustainability paradigm was introduced, both disciplines agreed in acknowledging it as an inspiring principle to aim towards, in order to achieve goals such as environmental protection, efficiency and fairness. For this reason both disciplines focus on s*ustainable tourist mobility* as a way of minimizing the negative impact of tourism on the environment, economy and society, while still aiming to satisfy visitors' needs. Such conceptual convergence allows the study of sustainable tourist mobility from a perspective positioned between Mobility Management and Destination Management. Sustainable tourism mobility planning thus becomes an integral part of sustainable tourism and territorial planning. In fact, transport is not only significant as an impact of tourism: tourist transport also accounts for an increasing share of all transport globally (Dubois et al., 2010). The integration of sustainable mobility in strategic destination choices cannot be achieved instantly. The efficiency of the process depends on the evaluation of the impact of transport and the development of measures to counterbalance it, which should be viable and appropriate to the destination.

The multifaceted structure of tourist transport can be analysed through the concept of the *tourist transport system* (Page, 2005), a complex system combining the physical movement of visitors using one or more forms of transport – the logistical component – and the travel experience – the experiential component. These two components also have a complex structure: the *logistical* one includes communication routes, means of transport and flows. *Communication routes* include arterial roads and internal distribution, specialized trails (e.g. bike and hiking trails), routes to peripheral areas and pedestrian paths (Berardi, 2007). The *means of transport*, traditionally referred to as means of destination access, may be the actual location where an entire holiday is spent (Page, 2005). The *flows* that are generated on communication routes through the use of different means of transport determine different mobility forms: *transit* or *access* flows are defined as the direct flows between origin and destination regions; *internal mobility* is the internal tourist movement during a holiday; *travel itineraries* are a sort of imaginary travel chain (*Reisekette),* where different means of transport are linked to one another, (Schiefelsbusch et al., 2007). Junctions – the locations where tourists change from one means of transport to another – play a fundamental role in travel itineraries and allow the development of *intermodal travel*, i.e. the use of multiple means of transport.

The complexity of the *experiential component* of travel depends on the user. Firstly, transport reserved only for tourists – known as *exclusive transport* – differs from that shared with other users, such as the host community or tourism sector workers (Hall, 1999). In the case of *non-exclusive transport* the travel experience largely depends on the level of competition among users for means or routes. A second distinction is made between *sedentary tourists/same-day visitors,* who use a means of transport in order to get from their region of origin to their tourist destination and *itinerant tourists/same-day visitors,* for whom the heart of the tourist experience lies in the journey (Berardi, 2007). According to Schiefelsbusch et al. (2007), an itinerant holiday with stops, changes of means of transport and visits to minor attractions increases the experiential value of travelling. *Reiseketten* transcend the merely instrumental concept of transport chains and become a tourist product integrating tourism and transport in a single package (Schiefelsbusch et al., 2007).

Both components of the *tourist transport system* demonstrate the system's unavoidable environmental, economic and social impacts. However, some types of impact are often overlooked or considered inevitable in destination tourist planning. This is confirmed by the fact that the literature focuses mainly on the environmental impact of tourist transport systems – greenhouse gas emissions, localized pollution caused by particulates and noise, the energy and space consumption of the vehicles. However, tourist mobility impact analyses also reveal implications for the social and economic aspects of transport. For instance, the energy consumption patterns of tourist mobility or specific means of transport can be used to select a destination's target segments (Becken, 2002; Becken & Simmons, 2002; Becken, Simmons, & Frampton, 2003a and 2003b). The impact of tourist transport, the biggest impact factor of tourism from the point of view of its ecological footprint[1] (Patterson et al., 2007; Dolnicar et al., 2010; Martín-Cejas & Ramírez Sanchez, 2009; Gössling et al., 2002), can also be used to distinguish tourists' and residents' resource consumption. The environmental impact of different means of transport can also be expressed in terms of costs for society, or externalities (Peeters, Szimba, & Duijnisveld, 2007). Finally, it is possible to envisage different emission management policies based on the environmental impact of different scenarios for the development of flows and transport technologies (Dubois et al., 2010; Peeters & Dubois, 2010). Despite the clear connections between different impact types, social and economic impact analyses of tourist transport systems – are still rare (Schiefelsbusch et al., 2007). However they show travellers' willingness to make eco-compatible planning choices (Kelly et al., 2007) and the attractiveness for tourists of destinations where vehicle access is limited (Holding, 2001).

[1]Synthetic indicator which estimates the amount of productive land necessary to supply a population's consumption and assimilate associated waste (Patterson et al., 2007).

The complexity of the transport system and the current gaps in the measurement of its impact must be considered in the planning and development of sustainable tourist mobility. To make this process effective, Destination Management needs to be inspired by the same principles of strategic planning and stakeholder participation in decision making that are prerequisites for the sustainability of tourism development (Godfrey & Clarke, 2000). The adoption of a participatory approach to tourist mobility planning (Gronau & Kagermeier, 2007) can develop sustainability awareness and encourage the sharing of responsibility for the strategic choice of alternative traffic management. Destinations can balance the impact of tourist mobility through pull or push strategies which relate to measures defined by Stradling, Meadows & Beatty (2000) as *carrots* and *sticks*. *Carrots* are incentives to use means of transport other than private vehicles (e.g. public transport, the hiring of electric or low-impact means, zero impact holidays and mobility cards). Usually, travellers – whether tourists or not – prefer *pull* strategies (Stradling et al., 2000), as *stick* measures are mostly disincentives – limits or costs imposed on the use of private vehicles (e.g. traffic restrictions, access tolls, fee parking). Assuming the same destination and governance model, the choice of one strategy over another and the effectiveness of its implementation depend directly on tourist mobility analyses designed to support traffic management decision processes. The success of a strategy also depends on effective communication policies that promote the mobility alternatives available for potential users (Van Exel & Rietveld, 2009).

Case studies and research methodology

The issue of tourist mobility within the framework of sustainable choices available to Destination Management is analysed in the case of South Tyrol. The choice of this destination was motivated by its status as an autonomous province, able to make its own decisions around tourism and mobility planning. In addition to this, tourism in South Tyrol based on the appeal of nature and folklore, is open to sustainable tourism. It also focuses on mobility, having integrated transport modes and increased intermodal transport, and supports pioneering local initiatives.

Public transport in the Province of Bolzano is an example of an integrated system, with fares managed through a common ticketing system. Mobility cards also include access to some recreational activities and the use of different means of transport, not only those belonging to the integrated transport system itself. There is an free phone information service which provides details of the transport alternatives available and timetables. Among the initiatives in which South Tyrol is involved, two projects stand out. They exemplify the application of *carrot* and *stick* measures in tourist mobility management. The “Alpine Pearls” project has

created a network of 24 alpine locations[2], in which seven South Tyrol municipalities participate. It promotes eco-friendly holidays using mainly *carrot* measures. Each "Pearl" destination has developed ways in which locations within it can be accessed by public transport or alternative transport services – shuttle buses, taxis, free ski buses, electric vehicles, e-bikes, electric hire cars, some of which are even available on call. Areas where traffic is limited have been given over to nature-based leisure and sporting activities, thus making restricted traffic a particular tourist experience. In contrast to the "Alpine Pearls", the Alpe di Siusi initiative involves a single area in the Castelrotto municipality. It includes the villages of Compatsch-Compaccio, Saltria and Piz and is situated on the Sciliar, one of the largest European plateaus. Local mobility is mainly managed through *stick* measures. Since 2003 access to the plateau has been closed to traffic in the peak season[3] and alternative transport is provided - buses, shuttle buses, cableways. The integrated transport service tickets are valid on these services, as are *ad hoc* mobility cards. In addition, the Alpe di Siusi tourist board explicitly follows the principles of sustainable tourism development and has placed alternative mobility management within the wider framework of tourism planning.

The first tourist traffic analysis assessed in the paper regards the total number of visitor flows into South Tyrol. The first step of the analysis divides *inbound* traffic into its various components. The second step assesses the environmental impact of tourist vehicles. Finally, the third step explores the effects of *carrot* and *stick* measures of traffic management on tourist flows in pilot cases.

The first stage started with the integration of traffic databases recording incoming vehicles – both tourism-related and not – with databases of *inbound* tourism, recorded by accommodation facilities. These databases contain secondary information resulting from census or sample surveys carried out by the different institutions[4], including the Institute of Statistics of the Bolzano province (ASTAT), which provided these data. Data from the tourist year 2007/2008 (November 2007 – October 2008) was used for the analysis. Flows are

[2] Seven South Tyrolean municipalities are part of the network (Moso in Passiria, Nova Levante, Nova Ponente, Moena, Tires, Racines and Funes), as are six other Italian municipalities (Chamois, Cogne, Forni di Sopra, Moena, Sauris, Valdidentro), two Swiss locations (Arosa, Interlaken), two French locations (Les Gets and Pralognan-la-Vanoise), two German locations (Bad Reichenhall and Berchtesgaden), four Austrian locations(Hinterstoder, Mallnitz, Neukirchen am Großvenediger, Werfenweng) and a Slovenian location (Bled). The project links destinations situated far from one another which have collaborated to develop traffic management measures and other initiatives, provide tourist packages on a single web-based platform and encourage same-day trips from one location to another in the network.

[3] From May to October and from December to April.

[4] Census data sources are: ISTAT, http://www.istat.it/it/archivio/turisti (Visitor movement to accommodation facilities); ASTAT, http://www.provinz.bz.it/astat/it/mobilita-turismo/traffico-trasporti.asp (traffic flows over State and province roads) and Autostrada del Brennero S.p.A (motorway traffic flows). The sample survey data sources are ASTAT (2009c) (tourist expenditure in the Bolzano province); ISTAT http://www.istat.it/it/archivio/turisti (Journeys and Holidays of the Italians) and the Bank of Italy http://www.bancaditalia.it/statistiche (International Tourism).

estimated following the *residual method* (Vaccaro, 2007), in which a phenomenon is the result of a number of complementary components acting simultaneously. In order to understand a phenomenon it is necessary to isolate its components and evaluate them one by one. In this case the phenomenon thus subdivided is light daily *inbound traffic* (IT). It includes the inbound passages of vehicle (motorbikes, cars and vans) detected on state and provincial roads and motorways gates and the outbound passages on motorway registered upon their return to the province. Therefore, light daily inbound traffic not only includes inbound tourist flows, but also the outbound tourist flows which generate inbound traffic when they return to South Tyrol (Table 1). Based on the fundamental thesis of the residual method, the paper introduces some original hypotheses to help find and assess the single components of tourist mobility, which make the application of the method more effective. The central hypothesis is that flows can be converted into vehicle flows by using parameters known and recorded in specific contexts – e.g. the Bolzano province – which cannot be generalized elsewhere. These parameters concern the composition of the *tourist nucleus* – i.e. the average number of people using one vehicle – and the percentage of *own transportation inbound arrivals* –i.e. the ratio of own transportation arrivals to the total arrivals[5]. A second hypothesis is that non-tourist traffic is a constant element whose intensity is halved during holidays in comparison with working days because of the high number of commuters.

Starting from these two hypotheses, the breakdown of light daily *inbound* traffic (IT) using the residual method is carried out as follows:

- the identification and quantification of daily IT components converting annual data into daily data through appropriate distribution when daily data are not available;
- the progressive removal from the IT of the components thus obtained;
- the evaluation of the residual component.

The result of the breakdown is synthesized by the following identity, according to which light daily inbound traffic (IT) is the algebraic sum of different components.

$$IT = (TTI + TTSI) + (TTO + TTSO) + (TEI + TEO + TET) + TNT + R8 \quad (1)$$

In total, eight TI components were detected: two are related to inbound tourist flows into the province (TTI and TTSI); two are related to outbound tourist flows recorded on their return to the province (TTO and TTSO); three are linked to same-day visits (TEI, TEO and TET); and one is linked to non-tourist traffic (TNT) (Table 1).

[5] In the Bolzano province the tourist nucleus amounts to 2.94 people and the percentage of inbound arrivals by own transportation to 88.5% of the total arrivals (ASTAT, 2009c).

Flow typology	*Component*	*Definition*	*Sources*
Non tourist	**TNT** Non Tourist Traffic	Traffic generated by non tourist activities. Mainly composed of commuter flows	*Estimated component*
***Inbound* Tourism**	**TTI** Traffic for *Inbound Tourism*	Traffic generated by *inbound* tourist arrivals in hotels, complementary and free accommodation	Census: "*Visitor movement to accommodation facilities*" by ISTAT Sample surveys *"Journeys and Holidays of the Italians"* by ISTAT *and "International Tourism"* by Bank of Italy
	TTSI Traffic for *Inbound* hidden Tourism	Traffic generated by *inbound* tourist flows not officially registered by accommodation facilities (hidden)	*Estimated component*
	TEI+R8* Traffic for *Inbound* and residual same-day visits	Traffic generated by *inbound* same-day visitor flows	Sample surveys "Journeys and Holidays of the Italians" by ISTAT and "International Tourism " by Bank of Italy"
***Outbound* Tourism**	**TTO** Traffic for *Outbound* Tourism	Traffic generated by *outbound* tourist flows, registered upon return to the province	Census: "*Visitor movement to accommodation facilities*" by ISTAT Sample survey "Journeys and Holidays of the Italians" by ISTAT
	TTSO Traffic for *Outbound* hidden tourism	Traffic generated by *outbound* tourist flows, not officially registered by accommodation facilities (hidden), measured upon return to the province	*Estimated Component*

	TEO + R8** Traffic for *Outbound* and residual same-day visits	Traffic generated by *outbound* same-day visitor flows registered upon return to the province	Sample survey "Journeys and Holidays of the Italians" by ISTAT and "International Tourism " by Bank of Italy"
	TET Traffic for same-day tourist visits	Traffic generated by *inbound* tourists on same-day trips outside the province, registered upon return to the province	Census: "*Visitor movement to accommodation facilities*" by ISTAT Sample surveys: ASTAT research on tourist expenditure

Table 1 – Components of light daily Inbound Traffic (IT)
Source: our elaboration

After the progressive removal of these components the *residual* (R8) remains. It explains the potential errors of underestimation of known components. Such errors mainly concern components related to same-day-visits as estimated by sample sources. Therefore the third hypothesis that is introduced is that the residue (R8) is entirely made up of residual same-day visits. As a consequence, it is added to the known *inbound* and outbound same-day visit components (TEI) and (TEO) in a measure proportional to the incidence that each of these components has on the total same-day visits. R8* and R8** are therefore the residual amounts R8, added to TEI and TEO respectively.

The second stage of the research estimates the environmental impact of the traffic components for the *inbound* tourism (TTI and TTSI) and *inbound same-day* visits (TEI + R8*) identified and estimated in the first stage. The estimate starts from the hypothesis linking tourist flows to vehicle flows and goes backwards, turning vehicles into people by applying the previously used parameters (*tourist nucleus* and percentage of own transportation *inbound arrivals*)[6]. Next, environmental impact coefficients are applied to people, which allows us to estimate emissions and energy consumption per kilometre (Peeters, 2007; UITP, 2003). The environmental impact of *inbound* mobility is estimated per kilometre , while the impact of internal mobility is estimated as an absolute value. Besides being used to estimate the environmental impact of tourist traffic, the transformation of vehicle flows into people is

[6]The conversion parameters are also applied to same-day trip vehicle flows.

a significant half-way result: the method allows us to estimate same-day visits – a widely neglected subject – and to evaluate their environmental impact.

The third stage is exploratory. It assesses the effect of tourist traffic management measures on tourist flows. These measures were introduced by areas in South Tyrol which are involved in pioneering sustainable mobility initiatives. The pilot cases are the Alpe di Siusi area in the municipality of Castelrotto, and the seven South Tyrolean municipalities of the "Alpine Pearls" network[7]; the latter choosing predominantly carrot measures, the former predominantly sticks. The *proxy* used to estimate the effects of these measures is the arrival time series [8] in these locations which covers the periods before and after the introduction of the measures. The evaluation of the effects of alternative traffic management on tourist flows is based on the hypothesis that each pilot location has only adopted one type of measure. The results of the analysis must be understood as preliminary, providing synthetic indications. Each location is using a mix of measures which are having simultaneous effects which cannot be measured separately. Furthermore, although arrivals are a good proxy for assessing the impact of these measures on the consistency of tourist flows, they do not allow us to evaluate the sustainability of all the aspects of tourist demand. A mass destination which makes a strategic choice to attract sustainable segments may see a general decrease in flows, but also experience an overall improvement in sustainability if these segments are willing to pay for an alternative, sustainable tourist offer, based on ethical consumption choices and behaviour.

Main results

This analysis of South Tyrol tourist mobility has led to three types of result. First, an estimate of tourist and same-day visitor flows and their annual, seasonal, monthly and daily distribution. Second, an evaluation of the environmental impact of vehicles connected with these incoming destination flows for *inbound* tourism. Third, an exploratory analysis of the efficiency of traffic management measures aimed at sustainable mobility.

Own transportation for tourist purposes

Over half (51.2%) of the almost 14 million light vehicles on the roads in South Tyrol in the 2007/2008 tourist year are related to tourist traffic. The residual method allows us to break this traffic down into its different elements (Fig. 1). Inbound tourism (TTI + TTSI) and same-day visits (TEI + R8*) account for almost one third (30.7%) of the overall traffic flows, i.e. the

[7] Castelrotto and Fié allo Sciliar for Alpe di Siusi; Cornedo, Tires, Racines, Nova Ponente, Nova Levante, Moso in Passiria and Funes.

[8] For Alpe di Siusi the data history includes the1998-2010 period, for the "Alpine Pearls" the 2003-2010 period. Source: ASTAT, http://www.provinz.bz.it/astat/it/service/dati-online.asp.

largest amount after non- tourist traffic (TNT). An interesting result is that the number of vehicles in each of these components is almost the same. On the other hand, overall outbound traffic accounts for little more (17%) than inbound traffic and in this case there is far more same-day visit traffic than tourist traffic. In fact, tourism outside the province (TTO + TTSO) accounts for only one sixth of the outbound same-day visits (TEO + R8**) and is even lower than the traffic generated by inbound tourists' same-day visits (TET) outside the province.

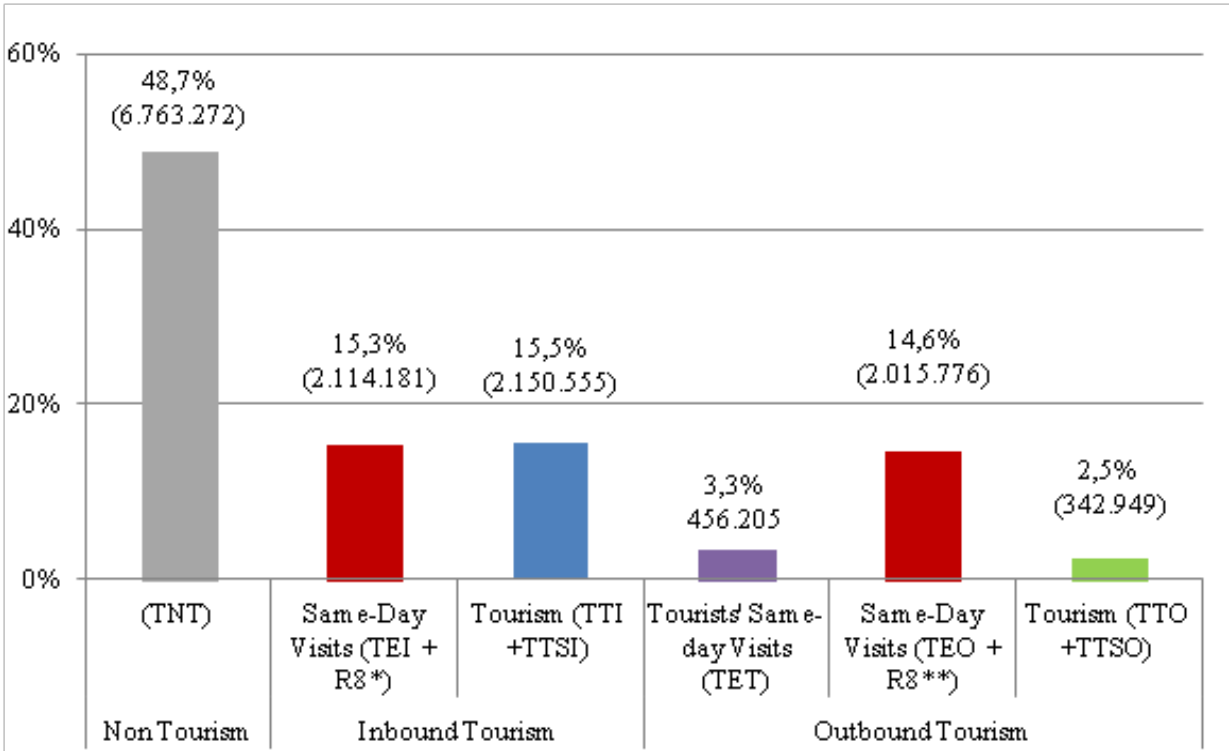


Figure 1 – *Light inbound traffic components (TI) – Vehicles*
Source: ASTAT, our elaboration.

The monthly percentage distribution of yearly traffic shows very high scores during the summer for all its components (Fig.2). About two thirds of *outbound* tourism (67%) and over 60% of *inbound* tourism occur between May and October and *inbound* (and *outbound*[9]*)* same-day visits in the summer totals about 65% of the overall same-day visit flows.

Same-day visits of *inbound* tourists outside the province (TET) take place almost exclusively in the summer (78.4%). June is the peak month for movement out of the province. This month concentrates 17% of the traffic flows generated by the return of *outbound* tourists.

[9]The same distribution is hypothesized for inbound (TEI + R8*) and outbound (TEO + R8**) same-day visits.

Inbound tourism and same-day visits reach their peak in August, but the number of same-day visitors (over 20%) in this month is higher than that of tourists (about 16%). In the summer the concentration of tourists and same-day visitors in South Tyrol is more or less the same. During the winter months of January, February and March there are more tourist than same-day visits.

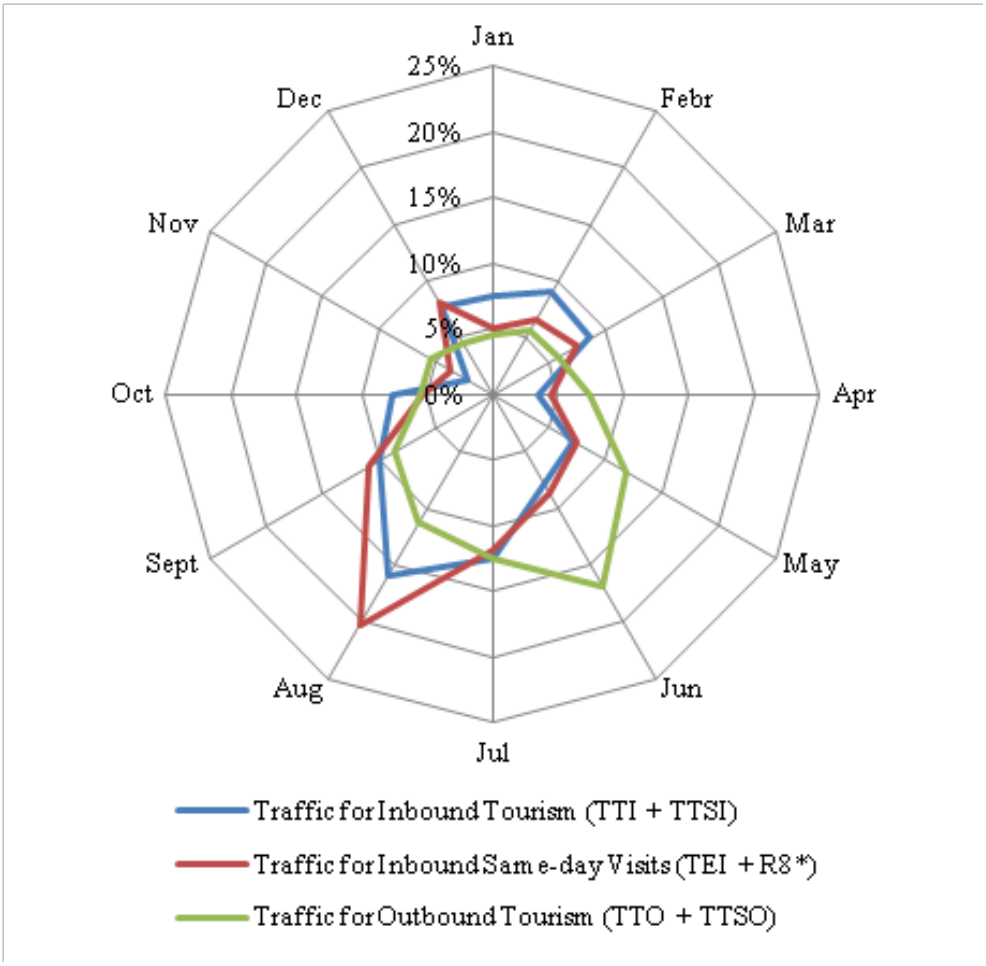


Figure 2 – *Monthly traffic flows. Percentage composition*
Source: ASTAT, our elaboration.

Finally, the *daily analysis* shows the typical trend of traffic components during the week. Same-day visits are concentrated on week-ends and peak tourist flows are usually recorded on Saturdays, while returning *outbound* flows are most intense on Sundays. These trends determine the differences between *holidays* and *workdays* in the intensity of tourist traffic. *Inbound* same-day visits are concentrated mainly during holidays, when there are on average twice as many passages (about 10,000 as on workdays (about 5,000). The differences are less marked for *inbound* tourism: there are roughly 30% more passages on holidays than on

workdays (c.7,000 vs c. 5,500). The daily analysis of tourist and same-day visit traffic around particular festivals shows a decrease in the flow at Easter and Christmas, which are traditionally celebrated with the family. In contrast, on days traditionally dedicated to same-day trips - May Day, or Pentecost - flows record sudden increases, particularly for same-day visits. The Festival calendar in German-speaking countries also explains traffic peaks on the public holiday celebrating the Unification of Germany or at Corpus Christi.

Environmental impact of vehicles for inbound tourism and same-day visits

Over 4 million (4,264,736) tourist and same-day visitor vehicles arrived in South Tyrol in the tourist year 2007/08. (Fig.1). This means a daily circulation in the province of holiday makers of over 35,000 vehicles (36,430) [10], which are added to the vehicles belonging to residents in the province [11] - c. 300,000 units per year (294.608)(ASTAT, 2009b). If we assume that these vehicles circulate freely in the province every day, in 2008 tourist mobility and same-day visits caused a 12.4% daily increase in the number of vehicles in Alto Adige. The environmental impact of this additional traffic has been estimated by applying energy consumption (UITP, 2003) and emission coefficients (Peeters, 2007) to people using these vehicles (about 12 million people for 4 million vehicles). The energy consumed by tourists and same-day visitors who accessed the destination in 2007/2008 using their own vehicles would therefore amount to 40 million Mj for every kilometre covered. It is estimated that for every kilometre covered by these vehicles they produced almost 1,600 tons (1,580) of carbon dioxide (CO_2), emitted an amount of greenhouse gases equivalent to 1,660 tons of CO_2 and introduced 267 kg of particulates and 5,943 kg of nitrogen oxides into the atmosphere.

Even though they provide an evaluation per kilometre and per person of the environmental impact of tourist and same-day visitor traffic in South Tyrol, these estimates do not allow us to quantify their overall impact in absolute terms. We do not have data on the kilometres covered by tourist and same-day visitors between their homes and the provincial border. Our only data is on movements within the destination. It is therefore estimated that internal mobility consumed 694.3 million Mj of energy, produced 29,313 tons of CO_2 and 30,790 tons

[10] The hypotheses referring to the daily estimate of vehicles for inbound tourism and same-day visits are formulated on the basis of visitors' average length of stay in the province (ASTAT, http://www.provinz.bz.it/astat/it/mobilita-turismo/turismo.asp). It is therefore hypothesized that vehicles on inbound same-day visits only stay for the day on which their access is recorded. On the other hand , it is assumed that inbound tourist vehicles remain for a period corresponding to the average stay of tourists in the destination, amounting to 5.2 days. The average daily number of tourist vehicles and same-day trips can therefore be obtained by comparing the annual flows for 365 days and later multiplying the average daily flows obtained for the days of stay of each type of visitor (i.e. annual flows*1/365 in the case of same-day visits and annual flows *5,2/365 for tourism). The vehicles belonging to provincial residents are assumed to be present in the province for 365 days a year.

[11] They are equivalent categories to those of tourist vehicles, i.e. cars and motorbikes.

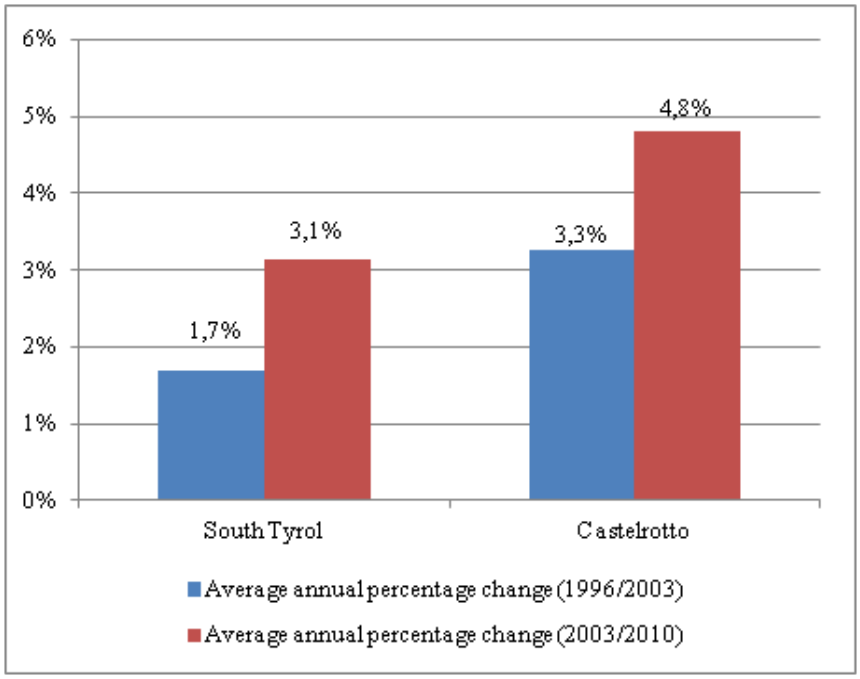
of CO_2 equivalent gas and introduced 4,959 kg of particulates and 110,200 kg of nitrogen oxides into the atmosphere.

Effects of traffic management measures on tourist flows

Alpe di Siusi and the South Tyrol municipalities involved in the "Alpine Pearls" network took pioneering action on sustainable mobility with the aim of limiting the significant impact of tourist traffic and same-day visits, as has already been demonstrated. Although both projects have adopted a mix of measures, Alpe di Siusi mainly chose traffic disincentives (*stick* measures), closing access to certain locations during peak seasons. In contrast, the South Tyrolean "Pearls" mainly chose *carrot* measures to encourage the use of means alternative to private vehicles.

The arrival time series analysis in the locations involved in the two pilot projects produced encouraging, although still exploratory results. Figure 3 shows the variations in arrivals in the periods before and after the introduction of traffic management measures by comparing them to corresponding variations in the province. In order to compare projects in which traffic management measures were initiated at different times (2003 in Alpe di Siusi and 2006 in the "South Tyrolean Pearls"), variations are expressed in terms of average yearly percentages. As the measures were introduced at different times and the intervals used to calculate the mean variations do not coincide, the size of the variations cannot be directly compared. In the Castelrotto municipality, where the hamlet of Alpe di Siusi has been closed to traffic since 2003 and can only be reached by cable car, increases in arrivals were recorded both before and after the introduction of traffic management measures. In line with figures recorded in the province, the most meaningful increases took place after 2003, demonstrating that traffic management has not had a negative impact on tourist flows in these locations. The average annual increase after access was denied to traffic actually exceeds the provincial average (+4.8 vs +3.1%).

Alpe di Siusi (stick measures)



South Tyrolean Alpine Pearls (carrot measures)

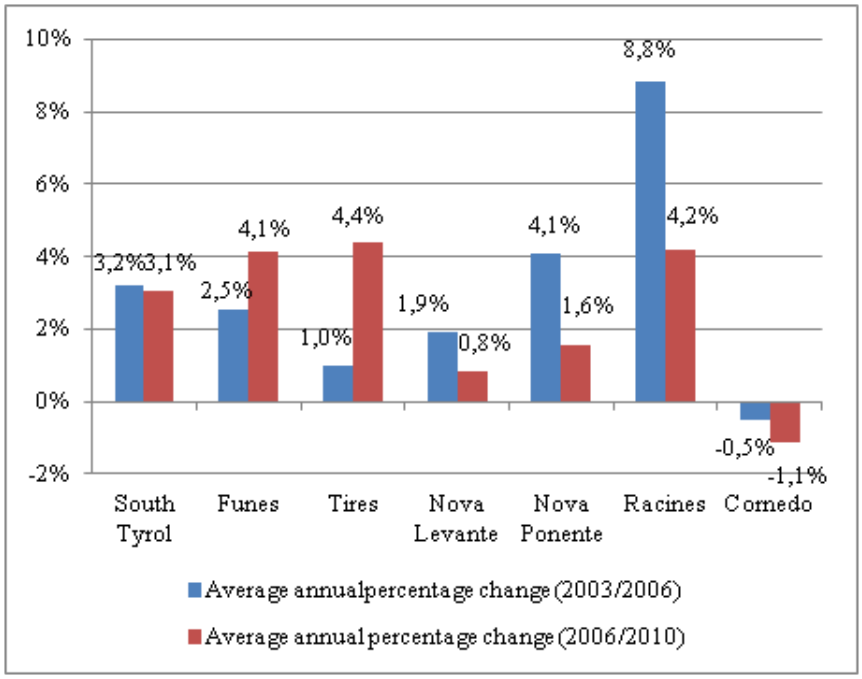


Figure 3 – *Mean yearly percentage variations of arrivals in pilot area municipalities*
Source: ASTAT, our elaboration.

In the seven South Tyrol municipalities belonging to the "Alpine Pearls" network, the data analysis before and after the introduction of traffic management measures performed in 2006 does not provide uniform results. Two locations (Funes and Tires) show a significant average increase in the period after the introduction of the measures. However, the opposite is true in three other locations (Nova Levante, Nova Ponente and Racines), where traffic management seems to have had a negative impact on flows. The Cornedo municipality recorded a decrease in arrivals in each period, most noticeably after 2006. Moso in Passiria must be excluded from the analysis as it has only been involved in the project since 2010. The size of the arrival variations is not uniform either. Funes and Tires, which seem to have been affected positively by the introduction of the measures, show increases in arrivals after 2006 exceeding the provincial average (+4.1 and +4.4% respectively, against +3.1%). Even in Racines, which seems to have been negatively affected by traffic management, the mean variation in arrivals after 2006 exceeds that of the province (+4.2%). In contrast, Nova Levante and Nova Ponente are well below the provincial average (+0.8 e +1.6%). Cornedo recorded a 1.1% decrease in arrivals.

There are probably three different reasons for the contrasting results obtained through the arrival analysis in the two projects. Firstly, Alpe di Siusi and some of the areas which participated in the "Alpine Pearls" network are villages within a municipality; therefore the recorded arrivals in their municipalities are not sufficiently accurate *proxies* for assessing the impact on tourist flows of measures taken by certain areas within these municipalities. Secondly, the "Alpine Pearls" project has only been running since 2006 and, even though six out of the seven South Tyrol villages joined the network at the very beginning, the observation span is still too short for a spillover analysis of the project. Thirdly, the mobility management measures adopted by the "Alpine Pearls" have been promoted on the network's official website, but they are not very visible on the websites of the South Tyrol partners and are weakly integrated into the local tourist offer. Therefore many tourists are not aware of the alternative traffic management options before setting off on holiday.

Independently of the measure adopted, the exploratory analysis of the effects on mobility management of arrivals shows that the outcome in both cases is positive or only slightly negative. A more accurate evaluation of the extent of the impact and the effectiveness of single measures could be obtained by combining quantitative analysis limited to arrivals in restricted traffic areas over longer spans with research on tourist behaviour through qualitative analysis.

Conclusions

Mobility integration into tourism planning requires the development of approaches to, and analyses of, tourism mobility. This paper has illustrated an innovative methodology in traffic

component analysis which allows us to calculate the impact of traffic on the environment and to develop mobility management measures to reduce this impact. This methodology has been implemented and tested in South Tyrol. Because of its autonomous status this destination has become a front-runner in tourism and transport, focusing on the issue of mobility as a strategic component of sustainable tourism development.

The traffic analysis methodology is based on an original application of the residual method, which has allowed us to identify and estimate different traffic components. The same-day visit component and the observation of same-day visitor behaviour linked to mobility is an original result. Such phenomena are still largely neglected, both in terms of absolute and relative flow consistency in comparison with tourist flows, and in qualitative terms. In this study, *inbound* same-day visits to South Tyrol show a similar consistency to that of tourism. In addition, same-day visits are more concentrated in the summer – mainly in August – and in holiday periods than are tourist visits.

In the second set of results the traffic component analysis was used to estimate the environmental impact of the province's tourist and same-day visitor inbound mobility in terms of energy consumption and emissions. Estimates show a significant environmental impact which justifies the pioneering steps taken towards sustainable mobility by two villages in South Tyrol. Even though both locations adopted a mix of measures, Alpe di Siusi opted for traffic disincentives – i.e. *stick* measures – by closing its access road for ten months of the year. In contrast, the South Tyrolean municipalities belonging to the "Alpine Pearls" network chose to boost the use of means other than private vehicles – i.e. *carrot* measures – and to limit the flow of vehicles to restricted areas. An exploratory analysis illustrates the positive impact of both measures, as after their introduction arrivals showed an upward trend in seven out of eight cases and the rates of arrival have seen a greater increase than the provincial average.

The paper makes both managerial and methodological contributions. As regards methodology, the paper puts forth an original, innovative variation of the residual method which improves the breakdown and analysis of traffic flows and the accuracy of estimates. The application of this method to the case studies has produced accurate estimates of tourist mobility, which would suggest its wider applicability, after some adaptations to specific contexts. Moreover, a mobility analysis method which quantifies neglected factors like same-day visits and hidden tourism may also be used to integrate the economic impact analysis of tourism with the spillover generated by same-day visits, thus leading to more accurate impact estimates. From a *managerial* viewpoint, tourist mobility analysis of traffic components and their environmental impact can support strategic decisions on sustainable mobility and be used when monitoring the effects of these decisions over time. The exploratory analysis of the effects of *stick* and *carrot* management measures has produced

encouraging results for all the measures adopted. It does not appear to matter to tourists whether traffic measures encourage sustainable behaviour (carrot measures in the Alpine Pearls) or discourage unsustainable behaviour (stick measures in Alpe di Siusi). These outcomes suggest the need to plan mobility and tourism jointly and provide strategic indications for a suitable mix of mobility management instruments, for their integration within the tourist offer and for effective communication policies.

Over the next few years *mobility management* will undoubtedly play a bigger part in the process of destination management. Increasing importance will be given to issues such as integrated public transport management, mobility within and across cities, villages and valleys, the creation of pedestrian areas with high tourist potential and the compatibility between tourist flows and same-day visit flows. *Mobility management* choices will inevitably have an impact on destinations' marketing and management policies, especially where they have developed integrated offer systems and tourists' wish for sustainability is seen as a strategic opportunity. From this perspective, a preliminary competitive analysis of a destination's offer, matching benchmark and SWOT analysis, is vital to finding the most suitable mobility management measures (*sticks* or *carrots*) for that particular destination and its sustainability level, both actual and hoped for (Weaver, 2000 and 2011). Market segmentation must then be used to identify those segments which are consistently motivated by issues of sustainability (Franch et al., 2008). The information on the intensity, distribution, composition, seasonality and impact of tourist flows which mobility analyses presented in this study can provide makes the identification of these segments much easier and allows us to include same-day visitors among potential targets. Consequently, offer and communication policies aimed at these segments must consider their mobility requirements. In this sense, *Reiseketten* (Schiefelbusch et al., 2007) are good examples of travel itineraries planned to satisfy both the wishes of tourists and their mobility needs.

In conclusion, mobility and transport-related decisions will need to be integrated into both the planning of tourism development and territorial planning. This integrated policy requires the implementation of an adequate portfolio of management and monitoring tools, sustainable measures, and performance or satisfaction indicators addressed to operators and to tourist demand, in order to be effective.

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