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Carrying Capacity of Tourism System: Assessment of Environmental and Management Constraints Towards Sustainability

Valentina Castellani and Serenella Sala
University of Milano-Bicocca, Department of Environmental Science, Italy

1. Introduction

The tourism sector accounts nowadays for about 10% of world GDP (source: World Travel & Tourism Council – WTTC) and it is widely acknowledged that tourism activities depend highly on the quality of natural resources (see, among others, Inskeep, 1991). Thus, the aim of sustainable tourism development plans, in order to reach sustainable development goals, should be the decoupling of economic growth from natural environment depletion, through the definition of more sustainable patterns of production and consumption in tourism activities, as also stated by international and European resolutions about sustainable development (see, for instance, the Reviewed Strategy for Sustainable Development, the Integrated Product Policy, the Action Plan on the Sustainable Consumption and Production and Sustainable Industrial Policy, the Renewed EU Tourism Policy).

Considering that to reach this goal and to set targets for improvement the basic requirement is to investigate the physical and managing limits of the system, carrying capacity evaluation seems to be a useful concept to support the definition of local management strategies and plans for sustainable tourism.

Moreover, sustainable development, and particularly the development and application of indicators able to measure sustainability of specific activities, require a multidisciplinary approach, that allows us to obtain results for specific aspects (Farrell & Twining-Ward, 2004). As underlined by some authors when referring to the triple bottom line approach (Buckley, 2003; Elkington, 1997), it is necessary to develop new methodologies, which are able to widen and to integrate analysis in a systemic vision, through instruments that allow the evaluation of different aspects in a comprehensive manner. An accurate evaluation of the tourism sector, for instance, necessarily involves aspects related to productive activities (production of goods and services for tourists), the construction and management of tourist facilities (hospitality and leisure structures, management of mobility), consumption of resources (energy consumption, water consumption and wastewater treatment, waste management) and the effects of tourism activities on the quality of life of the local community (availability of services, crowding, pollution). All these aspects are covered by a recent study by the authors (Castellani & Sala, 2012), in which the relevance of integration of

methodologies (e.g. Life Cycle Assessment and Ecological Footprint) in order to answer different planning enquiries is highlighted.

Starting from these considerations, the present research focuses on the evaluation of sustainability in the tourism sector with the aim to develop a method for assessing the physical and environmental carrying capacity of tourism destinations, as a tool to analyze the sustainability of the current situation and to determine to which extent a rise in visitors number could affect the quality of the environment, the availability of resources and the quality of public services. The final aim of the study is to provide results supported by quantitative data, overcoming the qualitative approach, which is more common in tourism carrying capacity evaluation (Prato, 2001).

2. Tourism and sustainability

Tourism can generate both positive and negative effects on the areas where visiting and leisure activities take place. It can be a positive element for the local economy of the tourist destination, but it can also generate some externalities (positive or, more frequently, negative) that are not included in the local economic balance and that can affect the quality of the visitors' experience (Casagrandi & Rinaldi, 2002; Gössling & Hall, 2005; Mathieson & Wall, 1982; Saarinen, 2006). Therefore, it is important that tourism planning, carried out by local decision makers, assures a good level of conservation of natural resources and mitigates the impacts that tourism necessarily entails.

If managed in a responsible and sustainable way, tourism can be a motivating force for the conservation of local heritage; on the other hand, if the strategy adopted for tourism development has the sole aim of getting large and immediate economic results through the uncontrolled growth of the tourist flow, it will lead to a rapid exploitation of the destination, which, after a short period, will become spoilt and no longer attractive (Khan, 1998; Manning, 2002).

Impacts related to tourism activities can be divided into two main categories (May, 1991).

1. Impacts due to the building of hospitality structures (hotels, restaurants, camping sites) and the production of goods and services for tourists; which can be summarized as the:
   a. loss of soil previously used for agriculture, pasture or other activities;
   b. necessity to build new roads to connect new tourist structures or to improve and enlarge existing roads to enable them to cope with an increased level of traffic. It is important to consider that these kinds of impact are persistent, because tourist structures, often built on a scale to cope with a wider tourist flow, remain in the territory, even though it is almost empty, during the rest of the year;
   c. resource consumption and pollution (emissions, waste water and solid waste production).
2. Impacts due to the presence of tourists and, generally, to their activities in the area. The presence of tourists can generate two main kinds of problem: the production of solid waste and wastewaters (which imply a cost for the collection and disposal systems, which is paid for by the local community and the need for the organisation of a service of collection scaled to the maximum volume generated during the year, i.e. at the peak of the tourist season); and the possibility of conflict between residents and tourists in

the use of local resources and services (use of drinkable water and wastewater treatment plants, air pollution, noise pollution, traffic, crowding, etc.). Furthermore, when natural and protected areas are involved, the presence of a high number of visitors can cause disturbance to fauna and flora, especially when visitors are not well informed about the proper way to behave in such a context.

In addition, it is necessary to consider that the impact generated by tourism activities is strictly dependent on the type of tourism which is predominant in the destination and on tourist behaviour. Each tourist visiting the destination generates a different amount of impact (waste production, energy and water consumption, land use, etc) which is dependent on numerous factors, such as the type of activities undertaken during the holiday, the length of stay, etc. Nevertheless, it has to be considered that the type of tourist services available for tourists influence the possibility for them to adopt sustainable behaviours: tourists make consumption choices which are limited by the effective availability of sustainable products and services and are determined by their environmental consciousness and responsibility. This implies that it is not possible to assess the sustainability of a destination in an absolute manner, but it is more useful to define scenarios for the evaluation, considering possible patterns regarding the production (tourism offer) and the consumption (tourism demand) sides.

Moreover, considering that even eco-tourism activities generate, undoubtedly, some impact on the area where they take place, to assure a sustainable development of the tourism sector it is necessary that the planning of tourism development of a destination takes into consideration the relationship between tourism activities and the local environment (from natural, economic and social points of view). Therefore, it should be based on a robust analysis of environmental, social and economic conditions of the area and on an evaluation of existing physical, economic and social limits to current and potential development of tourist activities, i.e. an assessment of the actual carrying capacity of the destination.

3. Carrying capacity of tourist systems

As illustrated in section 2, tourism, like every kind of human activity, causes changes in environmental conditions. In order to evaluate the consequences of the impact of tourism activities it is necessary to know the characteristics of the environment where they take place and especially its resilience, which is the magnitude of disturbance that a system can experience before it shifts into a different state of equilibrium (Holling, 1973). Indeed, carrying capacity concept is linked with resilience and rises from the necessity to establish what is the maximum acceptable level of impact for the environment or for one of its components and the capability of recovery back to the previous condition.

From an ecological perspective, carrying capacity is "the maximum number of individuals of a given species that a given habitat can support without being permanently damaged" (Odum, 1989). If we consider the application of this concept to the relationship between natural and social (or human) systems, we can also define carrying capacity as the ability of natural and man-made systems to support the demands of various uses without degrading the natural, cultural and social environment (Abernethy, 2001; Godschalk & Parker, 1975; Oh et al., 2002).

In order to provide useful support to operational approaches oriented to decision-making, carrying capacity should be the scientific concept that helps to identify the maximum

acceptable level of human activities, population growth, land use and physical development that can be sustained by the area under investigation without causing irreversible damage to the environment. In the field of sustainable development strategies and in spatial planning processes, as it is for sustainable tourism planning, this implies that the evaluation is made considering not only the availability and quality of natural resources, but also the characteristics of the existing infrastructures, land use and tourist facilities (Oh et al., 2005).

Indeed, the purpose of the evaluation of the carrying capacity of a destination is the measurement of the threshold over which alteration due to tourism activities becomes unacceptable for the entire system (composed by natural and man-made resources). The World Tourism Organization has defined Tourism Carrying Capacity as "the maximum number of persons which could visit a location within a given period, such that local environmental, physical, economic, and socio-cultural characteristics are not compromised, and without reducing tourist satisfaction" (WTO, 1999).

This definition of the carrying capacity of a destination led to some attempts to develop quantitative carrying capacity assessment by defining a number of tourists which represents the limit beyond which the degradation of the destination occurs (see, among others, Brown & Turner 1997; Saveriades, 2000).

Nevertheless, this kind of approach highlighted some flaws linked to the concept of tourist carrying capacity intended as a mere application of an ecological carrying capacity concept to tourism destinations, some of which were pointed out by McCool & Lime in 2001:

1. Tourism destinations are complex systems, which include objective (e.g. availability of resources) and subjective variables (e.g. tourist and local community perceptions) (Bimonte & Punzo, 2005).
2. The definition of the maximum number of tourists that can visit the destination without causing permanent damage should entail the possibility to limit access to the destination (but this can be true only for a few kinds of places – e.g. nature reserves and historical sites), otherwise it remains only a theoretical exercise, with no operational meaning (Hof & Lime, 1997).
3. The extent of the impacts caused by tourism activities is not uniquely dependent on the number of tourists that visit the area, but also, and maybe in more considerable ways, on their behaviour (Ioannides & Billing, 2005; Wagar, 1974) and by the characteristics of the local offer.
4. Tourist destinations don't have a unique carrying capacity, but multiple carrying capacities, determined not only by the availability of natural and physical resources, but also by the characteristics of the management system, by the type of tourism that characterises the area, by stakeholders' perceptions (e.g. perception of crowding) and other local conditions (Ioannides & Billing, 2005). Therefore, some authors (see, for instance, Lindberg et al., 1997; McCool & Lime, 2001) suggested a shift from the question "How many is too many" to "How much change from natural conditions are acceptable given the goals and objectives of an area", starting from the Limit of Acceptable Change (LAC) model (Stankey & Cole, 1985). This approach suggests setting the tourism carrying capacity assessment method not just as a scheme aimed at obtaining a unique value, but rather as a framework composed by a set of standards able to quantitatively define acceptable changes (Ahn et al., 2002).

In the research literature there are only a few attempts to make the carrying capacity concept operational, defining a framework in order to obtain numerical standards for the destination, as a management tool that enables decision makers to implement the results of the assessment in the planning process (Clivaz et al., 2004; Huges, 2002; Trumbic, 2005). Moreover, there are several models such as Visitor Impact Management (VIM) (Graefe & Kuss, 1990), Visitor Experience and Resource Protection (VERP) (US Department of the Interior, 1997) and Tourism Optimization Management Model (TOMM) (Manidis Roberts Consultants, 1997), that, even though they represent an attempt to combine scientific expertise and public-held knowledge, to give a quantitative evaluation of the limits existing to tourism development in the destinations, they are more decision-making frameworks rather than scientific theory.

Thus the challenge in tourism carrying capacity research is the definition of a conceptual model that could be applicable to all kinds of tourism areas and that allows to select indicators and to define standards that are relevant for each specific destination. As highlighted by the guidelines developed by UNEP - PAP/RAC (1997), a good method for carrying capacity assessment should be able to: 1) consider the priorities of the area under investigation (e.g. involving decision makers and local experts in the definition of indicators and standards at a local scale); 2) identify local constraints to tourism development, balancing the demand of new tourist infrastructures and the necessity to protect local environment, also because it could represent an important attraction factor; 3) select a set of indicators that can be useful to all tourism sector managers and that can be easily applicable, with well defined sources (i.e. the availability and quality of data should be checked, to assure the possibility of monitoring through time); 4) define scenarios for the development of the destination.

According to these recommendations, the present study suggests a methodology for tourism carrying capacity assessment focussed on environmental and management issues, applied to two tourist areas in northern Italy, which are characterized by the presence of protected areas.

4. Methodology

The methodology developed for this study is based on an evaluative procedure inspired by the DPSIR model (Drivers, Pressures, State, Impacts, Responses), as it is useful to underline which are the drivers of impacts and to define which is the most useful dataset to describe current and future scenarios for the area under investigation. The conceptual DPSIR model, developed by the European Environmental Agency (EEA, 1999), highlights causal links and relationships between human activities, pressures on the environment and impacts on ecosystems and human health. In order to address local policies, the model also includes the responses, i.e. promising measures to reduce the extent of drivers and pressures and improving the state of ecosystems and mitigating impacts. It is possible to identify several kinds of responses involving different actors: planning strategies defined by decision makers, technical solutions (e.g. BAT); education and communication strategies among stakeholders and, finally, the involvement of all local actors in a participatory process, with the aim of defining a commonly shared planning strategy and of building a network of subjects working on sustainable solutions.

The analysis of tourism sector based on the DPSIR model allows the identification of the main issues related to tourism activities and enables us to address the definition of a framework for tourism carrying capacity assessment (Table 1 shows an analysis of tourism sector based on the DPSIR model).

DRIVERS	Construction and management of hospitality structures and facilities, presence of tourists, road traffic.
PRESSURES	Emissions of air pollutants, use of groundwater resources, emission of pollutants in surface waters, production of solid urban waste, land use and soil erosion, energy consumption, presence of tourists in protected areas.
STATE	Concentration of pollutant in air and water, groundwater availability, quantity of solid urban waste, level of urbanization, level of crowding in natural sites.
IMPACTS	Loss of biodiversity, disturb of wild species, adverse effects on human health.
RESPONSES	Promotion of sustainable tourism: reduction of water and energy consumption, reduction of waste production and increasing of separated waste collection, promotion of public transports, use of renewable energy, promotion of ecotourism activities.

Table 1. DPSIR model for tourism sector

In the conceptual framework presented in this article, the main environmental and socio-economic aspects of the area are separately taken into account to evaluate the tourism carrying capacity of the destination. The environmental and managing issues related to the daily life of residents and to tourism activities (air quality, water quality and disposability, waste management, land use) are considered and included in the evaluation.

One of the main aims in developing this methodology is to attempt to define thresholds for each indicator which compose the framework: indeed, even if the definition of thresholds is necessarily a choice that implies a certain level of subjectivity, the evaluation of indicators becomes meaningless in absence of reference targets and standards. Some authors highlighted the necessity to link indicators to policy standards and targets to strengthen their role in supporting decision makers (see, for instance, Hammond et al., 1995; Pinter et al., 2005); nevertheless, standards derived from professional norms or regulations are frequently non-existent for some topics, so there is the need to find alternative solutions (PAP/RAC 1997). The methodology presented in this study considers some alternatives for defining reference values when law constraints' standards are not available:

- policy targets (e.g. a target for the recycling of solid urban waste production in European countries);
- objective physical limits (adopting the precautionary principle, the current structure of the tourism system is taken as a baseline to ensure that no additional impact is generated through the construction of new tourism infrastructures (there are some physical limits that cannot be overcome, e.g. the number of beds available in the system, the capacity of wastewater treatment plants, etc.);

- benchmark values coming from data at national or regional level and values derived from literature (e.g. hospitality density).

In addition, when it is not possible to find reference values following the previous methods (e.g. for the biodiversity issue, which is quite controversial), the evaluation is made by expert judgement, involving local experts (e.g. park managers), to ensure that indicators (i.e. issues) are not excluded from the evaluation due to methodological problems.

The methodology consists of a preliminary analysis of the area to identify existing data sets and to define the typology of the tourist destination; the final aim of this phase is the identification of issues that are more relevant for the development of the tourist destination. Then, for each issue identified, the following steps are implemented:

1. the analysis of the issue and characterization of the drivers related to it and the identification of activities which are more relevant in the local situation;
2. the selection of drivers relevant for the issue referring to the tourism system, from the set of drivers identified in step 1;
3. the identification of the main pressures generated by the selected driver/s.
4. the definition of quantitative indicators for identified pressures, to measure the (state of the area under investigation with reference to that issue. In the selection of indicators, priority is given to indicators already existing and commonly implemented for tourism activities' analysis and to the availability of data on a local scale to assure the possibility of monitoring results through space (comparison between different destinations) and time (evaluation of trends in the same area); furthermore, for each indicator included in the evaluation scheme, the source of data has to be indicated, to help the collection of updated data in the future;
5. the definition of standards for the indicators, considering benchmark values, minimum and maximum, and for the definition of classes of carrying capacity (high, medium and low) for the result. As explained before, the selection of reference values is based on:
   a. standards determined by international, European and national laws or policy targets
   b. physical limits
   c. benchmarking with the regional or rational situation
   d. literature
   e. expert judgement (for which the use of standardised method is required, such as the Delphi method);
6. the collection and processing of local data;
7. the evaluation of the carrying capacity of the issue, based on benchmarking among considered variables. For the evaluation, a precautionary principle is adopted, the worst case is taken into account and if one of the variables is near the limit, low carrying capacity is attributed to the entire issue;
8. the responses development: processing the results to provide descriptive information about the local situation to decision makers, with the aim of enabling them to select appropriate short or long term solutions for the main problems identified, which can be performed by public and private administrators and by tourists themselves, in a shared responsibility perspective. The development of responses is part of the process but it stands as a separate stage. In fact the development of responses is composed by two steps: the first is the identification of possible actions (from technological solutions to

communication actions) based on the results of scientific assessment; the second is the policy development, based on a participatory process that should involve all stakeholders, aimed to choose adequate actions, providing objectives and targets for each of them. This process encompasses both descriptive, scientific, assessment and policy making, using scientific results as guidelines for action, bridging the gap between science and policy (for a deeper discussion about how to integrate scientific assessment results in the development and monitoring for sustainable tourism development strategies see Castellani & Sala, 2009).

Table 2 shows an example of a detailed scheme, developed for "air" issue in Oltrepo Mantovano area.

DPSIR	METHODOLOGY	LOCAL RESULT
1) DRIVERS	Analysis of datasets of emissions sources aimed to identify which sources / activities are most relevant in the area object of the investigation.	Analysis of data from Inemar Lombardy Region inventory of emission sources: main drivers for Oltrepo Mantovano are: electric power generation (electric power plants), non industrial combustion (heating) and urban traffic, which cause emissions of PM_{10}, CO_2, COV, NO_x, SO_2 and CO.
2) DRIVERS AND VARIABLES RELEVANT FOR TOURISM SECTOR	From the drivers set identified in step 1, selection of drivers which are most relevant for tourism sector.	The emission source most relevant for tourism sector evaluation in Oltrepo Mantovano is emissions due to road traffic, because electric power generation is an industrial activity, not strictly linked with local consumption and heating becomes not relevant during high tourist seasons (spring-summer).
3) PRESSURES	Selection of main pressures generated by identified driver/s.	Urban traffic generates emissions of $PM_{10,}$ CO, COV and NO_x. Regional Environmental Agency (ARPA) monitoring network registers periodically the values of concentration of $PM_{10,}$ CO and NO_2; data of COV concentrations are not available.
4) INDICATORS	Selection of appropriate indicators to measure state. Indicator used by European and Italian legislation to evaluate air pollution level is the number of daily overcoming of limit concentration during a year.	a. number of overcoming for PM_{10} concentration in Oltrepo Mantovano; limit value: 35 days of overcoming/year. b. number of overcoming for NO_2 concentration in Oltrepo Mantovano; limit value: 35 days of overcoming/year. A limit for CO is not fixed because this pollutant is no longer a problem in Italy.

DPSIR	METHODOLOGY	LOCAL RESULT
5) STATE CLASSES	On the basis of indicators and limit identified in the previous step, classes of carrying capacity are fixed.	a. nr of overcoming for PM_{10} <10: HIGHcarrying capacity nr of overcoming for PM_{10} =35: LIMIT of carrying capacity nr of overcoming for PM_{10} >35 and < 50.: LOW carrying capacity nr of overcoming for PM_{10} >50: VERY LOW carrying capacity b. nr of overcoming for NO_x <10: HIGH carrying capacity nr of overcoming for NO_x =18: LIMIT of carrying capacity nr of overcoming for NO_x >18 and < 30 LOW carrying capacity nr of overcoming for NO_x >30: VERY LOW carrying capacity
6) LOCAL RESULT	Analysis of local data about indicators identified.	nr of overcoming for PM_{10}: 108 nr of overcoming for NO_x: 1
7) CARRYING CAPACITY	Carrying capacity assessment, based on classes identified and data collected; carrying capacity level of the entire compartment is assigned according to precautionary principle.	a. PM_{10}: **VERY LOW** b. NO_x: **HIGH** Carrying capacity of the issue: **VERY LOW**
8) RESPONSES	Processing of the results and discussion among stakeholders to plan responses, based on scientific assessment, that can be included in the local strategy for sustainable tourism development.	To promote public transport and tourist offers for discouraging use of private car by tourists: improvement of existing bike-routes (included in Eurovelo 7 and 8) and establishment of facilities for bikers along the trails (hotel with special services for bikers, renting stations, etc.) to promote bike tourism and to encourage the use of bicycles for local connections).

Table 2. Example of assessment for the issue "air" in Oltrepo Mantovano area

5. Areas of study

The methodology developed was implemented in two areas of the Lombardy region: Oltrepo Mantovano and Alpi Lepontine Mountain Community (Italian Mountain Communities are administrative clusters of municipalities in mountain areas); the study was performed in order to support these two destinations in the implementation of the European Charter for Sustainable Tourism in Protected Areas (Europarc, 1995).

The European Charter is a process promoted by Europarc (the European Federation of Parks), with the aim of ensuring environmental conservation and promoting economic and

social development through the definition of a strategy for sustainable tourism development of the area. Assessing carrying capacity in these areas aims, therefore, to provide a useful tool for decision makers who have to define tourism development policy for the future, while aiming to promote sustainable development and preventing adverse effects on the environmental, economic and social systems of the destinations.

The protected areas of Alpi Lepontine and Oltrepo Mantovano applied to the European Charter in 2006 and were awarded with the Charter certificate in 2008. They are now at the second stage of the process, which is the implementation of the strategy and action plan, and that will be followed by an evaluation by Europarc in 2012, which is necessary to renew the certificate for the following 5 years.

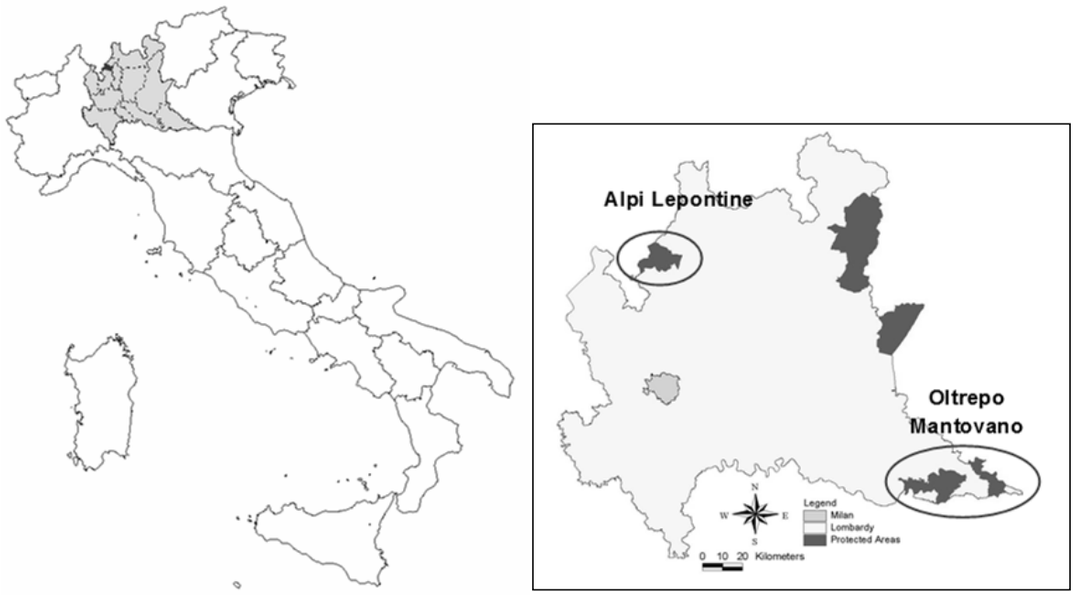


Fig. 1. The two areas of study in Lombardy Region, northern Italy

It is interesting to compare the tourism carrying capacity assessment in the two areas because even if they are now involved in the same planning process, they represent two different stages of the life-cycle of the destination model (Agarwal, 1994; Butler, 1980; Miossec, 1977). Oltrepo Mantovano is a newly emerging destination, not yet well structured, with few tourists arriving in the area, whereas Alpi Lepontine is a more mature destination, even if it shows contrasting aspects (e.g. in the summer season the number of tourists is high in some municipalities near the lakes, but very low or zero in mountainous ones).

The case studies show that the evaluation of the tourism carrying capacity can support the planning process and provide useful information to decision makers both in the case of a newly emerging destination and of a more mature destination. In the first case, it can draw the guidelines for more conscious planning, helping to prevent over-exploitation of resources and a rapid decline of the destination; in the second case, carrying capacity assessment can help to evaluate the possibilities of rejuvenation policies (e.g. investments for promoting a new type of tourist for the destination), to avoid the stagnation and decline phases that can occur when the depletion of natural and physical capital of the area make

the destination less attractive for new tourists (Farrell & Twinning-Ward, 2004; Hernandez & Leon, 2007; Prideaux, 2000).

6. Results and discussion

Following our methodology, we first carried out a comprehensive analysis of the area, to identify existing data sets and to define the typology of the tourist destination, the general characteristics of the area and its development (Castellani et al., 2007; Trentini et al., 2008).

Then, from the results of the analysis, the main environmental and physical aspects of the area were separately taken into account in order to evaluate tourism carrying capacity of the destination, following the steps illustrated in section 4.

Table 3 illustrates the indicators which were considered for the evaluation of the two destinations and the carrying capacity classes defined for each indicator.

As explained in section 4, classes of carrying capacity were defined for each indicator in order to allow the comparison of local results with reference standards and to assess the tourism carrying capacity of the destination based on quantitative evaluation. The following paragraphs illustrate in more detail the references considered for the definition of the classes. For the following issues, classes were defined referring to legal limits and policy targets:

- Quality of fresh water – People served by wastewater treatment plants, the ecological state of fresh water and the ecological condition of lakes: 2000/60/EC, "Water framework Directive";
- Waste management – Separate waste collection: Regional Law 26/2003 (which defines the target of 40% by 2010 for separate waste collection);
- Waste management – Per capita daily production: classes defined considering the average urban solid waste production per capita in Europe (about 600 kg/d per capita in 2008) and the target of the European Campaign for Waste Reduction, which is 100 kg/d per capita.
- Air quality: 96/62/EC, "Air quality framework Directive".

Indicator	State - classes		Indicator	State - classes	
Drinking water supply and consumption			**Biodiversity**		
1. water balance (WEI: consumption / availability) (L*residents^{-1}*d^{-1}) /(L*residents^{-1}*d^{-1})	H	WEI < 20%	**13. loss of species, disturb** (total nr of visitors in protected areas*year^{-1})	no classes, expert judgement	
	M	20%<WEI <40%			
	L	WEI > 40%			
2. daily consumption (L*residents^{-1}*d^{-1})	H	< 150 L*res^{-1}	**Land use**		
	M	150-250 L*res^{-1}	**14. hospitality density** (beds*1000 residents^{-1})	H	0-100
	L	> 250 L*res^{-1}		M	10-300
3. withdrawal / recharge of ground water (m^3*d^{-1})/(m^3*d^{-1})	H	< 1		L	> 300
	M	= 1	**15a. tourist buildings** (non-hotel structures/total hospitality structures)	H	> 20%
	L	> 1		M	10%-20%
Quality of fresh water				L	< 10%

Indicator	State - classes		Indicator	State - classes	
4. people served by water purifier (people served*people resident^{-1}) *100	H	100%-75%	**15b. tourist buildings** (houses not used by residents/total nr of houses)	H	< 20%
	M	74%-50%		M	20%-50%
	L	< 50%		L	> 50%
5. potential H.E./actual H.E. (H.E. = habitant equivalents)	H	> 1	**16. crowding of natural sites and paths**	no classes, expert judgement	
	M	= 1	**17. daily visitors** (V = nr daily visitors / nr resident tourists)	H	V < 1
	L	< 1		M	1 < V < 2
6. ecological state of fresh water (LIM index)	H	optimal, good		L	V > 2
	M	sufficient	**Economic efficiency of tourism sector**		
	L	bad, poor	**18. use of tourist structures** [(overnights*beds^{-1}) *365]*100	H	< 20%
7. ecological state of lakes (correspondence to natural condition)	H	current state = natural state		M	20% - 40%
	L	current state ≠ natural state		L	> 40%
Energy consumption			**Mobility**		
8. local energy consumption/national mean energy consumption (MWh*residents^{-1}) / (MWh*residents^{-1})	H	< 1	**19. % of tourists reaching the destination by private car**	H	< 40%
	M	= 1		M	40%-70%
	L	> 1		L	> 70%
Waste management			**20. nr of cars in the area/residents**	H	0-0.3
9. per capita daily production (kg* residents^{-1}*d^{-1})	H	0.27 Kg*res^{-1}*d^{-1}		M	0.3-0.5
	M	0.28 – 1 Kg*res^{-1}*d^{-1}		L	0.5-0.8
	L	> 1Kg*res^{-1}*d^{-1}	**21. railway service** (nr of municipalities with railway station/total nr of municipalities)	H	0.8-1
10. residual capacity of waste collection system (C = volume of waste collected daily/ volume of waste collectable daily)	H	C < 0.7		M	0.4-0.7
	L	0.7<C<1		L	0-0.3
11. % Separate waste collection	H	> 45%	**22. nr of vehicles in tourist season** (nr vehicles in peak hour)	H	< 100
	M	35-45%		M	100-300
	L	< 35%		L	> 300
Air quality			**Tourism intensity**		
12. nr of days exceeding law limits per year	Law limits: 35 days of exceeding/year PM_{10}, 18 exceeding/year NO_2		**23. tourist intensity in high season** I = (overnights high season*d^{-1})*residents^{-1}	H	I < 0.5
				M	0.5 < I < 1
				L	I > 2

Table 3. Indicators selected for Tourism Carrying Capacity assessment (Classes: H = high c. capacity; M = medium c. capacity; L = low c. capacity; LL = very low c. capacity)

Classes defined with reference to the physical limits of the system include:

- Drinking water supply and consumption – the ratio between abstraction and recharge
- Quality of fresh water – designed capacity/actual capacity used;
- Quality of fresh water – capacity of wastewater treatment plants;
- Waste management – residual capacity of waste collection system.

Benchmark values coming from data at national or regional level and values derived from literature were used to define classes for the following indicators:

- Drinking water supply and consumption – Water balance: the classes are defined considering the Water Exploitation Index (WEI) and its warning threshold of 20%, which distinguishes a non-stressed, from a stressed region, while a threshold of 40% identifies a region where severe stress occurs (source: EEA, Europe's environment, fourth assessment, 2007);
- Drinking water supply and consumption – daily consumption: classes defined considering that the average domestic water consumption in Europe is around 150-200 L/d per capita, while a tourist can consume on average 300 L/day (source: Freshwater in Europe - Facts, Figures and Maps, UNEP/DEWA, 2004);
- Energy consumption: comparison with the national average of energy consumption;
- Land use - Hospitality density: EEA classification in "Indicator Fact Sheet Signals 2001 – Chapter Tourism", 2001;
- Land use - Tourist buildings, a and b: classes defined on the basis of the situation existing in some of the major tourism destinations in Italy; (under 20% of second houses in low density destinations, over 80% in high density destinations such as Alpine ski areas; source: Dossier about second houses in the Alps by Legambiente (2009) and the 3rd report about the state of the Alps by CIPRA (2008);
- Land use - Daily visitors: estimation based on previous studies about the impacts generated by residential tourists and visitors;
- Use of tourist structures: classes defined considering the average occupancy rate in Italy (which is around 30%; source: Eurostat, year 2008);
- Mobility - ratio of tourists reaching the destination by private car: classes defined starting from European figures about car use for tourism purposes (61% of tourist travel by road, source: EEA, Europe's environment, third assessment, 2003);
- Mobility – number of cars in the area/residents: classes defined considering the average car ownership in Europe-15 (0,50 passenger cars/inhabitant; source: Eurostat, year 2006);
- Mobility – number of vehicles in the tourist peak season: the classes have been defined considering a monitoring study carried out by the Province of Parma on the traffic on roads which are similar to the ones in the two destinations considered ("Analisi sui flussi di traffico in provincia di Parma", Province of Parma, 2001);
- Tourism intensity: the classes are defined considering that the two destinations under evaluation are nature-based destinations, that cannot afford to sustain high-intensity levels of tourists (high density destinations in the Alps have a current level of tourist intensity of around 8, while international, mass-tourism, seaside resorts, such as the Balearic islands, can reach a peak level of tourist intensity of 50).

Finally, expert judgement from local experts helped to evaluate the carrying capacity of issues for which it was not possible to identify suitable carrying capacity classes:

- Biodiversity – loss of species, disturb caused by tourism activities
- Land use – crowding of natural sites and paths.

The application of the methodology to the two areas under investigation provided an overall evaluation of the tourism carrying capacity of the two destinations. Table 4 compares the results for Alpi Lepontine and Oltrepo Mantovano (data refer to year 2005). The table of results also contains some issues for which local value and carrying capacity scores are not mentioned: they were included in the model because they emerged as relevant according to the DPSIR evaluation, but it was not possible to evaluate the carrying capacity for them, because of the lack of available data at local level. The choice of including these issues in the results arises from the consciousness that there is the risk of measuring "what is measurable rather than what is important" (as highlighted by White et al in their review about sustainable indicators for tourism, 2006), thereby providing misleading information for decision makers. On the contrary, our aim was to make decision makers aware of the importance of these topics and the necessity to deepen the current investigation and to provide a collection of data about them.

Indicator	Unit	Oltrepo Mantovano		Alpi Lepontine		Source of data
		Value	Carrying capacity	Value	Carrying capacity	
1. water balance (consumption / availability))	$(L*residents^{-1}*d^{-1})/(L*residents^{-1}*d^{-1})$	n.a.	--	n.a..	--	
2. daily consumption	$L*residents^{-1}*d^{-1}$	280.2	L	229.3	M.	ISTAT, National Statistic Institute (1999)
3. withdrawal / recharge of ground water	$(m^3*d^{-1})/(m^3*d^{-1})$	1.3	L	n.a.	--	Lombardy Region
4. people served by water purifier	(people served*people $resident^{-1}$) *100	75%	H	95%	H	Local water resources plan
5. potential H.E./actual H.E. (H.E. = habitant equivalents)	potential H.E./actual H.E.	>1	H	1	M	Local water resources plan
6. ecological state of fresh water (LIM index)	Score of LIM index	sufficient	M	Good	H	Province authority
7. ecological state of lakes	Correspondence to natural condition	Not applicable (there are no lakes)	--	current state ≠ natural state	L	Province authority
8. mean energy consumption in municipalities / national mean energy consumption	$(MWh*residents^{-1})$ / $(MWh*residents^{-1})$	0.8	H	1.4	L	Terna - owner of the National high-voltage Electricity Transmission Grid (2003)

Indicator	Unit	Oltrepo Mantovano		Alpi Lepontine		Source of data
		Value	Carrying capacity	Value	Carrying capacity	
9. per capita daily production of waste	kg* residents^{-1}*d^{-1}	1.6	H	1.1	H	Provincial waste monitoring office
10. residual capacity of waste collection system	C = volume of waste collected daily/ volume of waste collectable daily	n.a.	--	n.a.	--	
11. % Separate waste collection	%	39.8%	M	12.4%	LL	Provincial waste monitoring office
12. nr of days exceeding law limits per year	Nr of days	PM_{10}: 108 NO_x: 1	LL	PM_{10}: 0 NO_x: 0	H	ARPA (Regional Agency for env. protection)
13. loss of species, disturb	Total nr of visitors in protected areas*year^{-1}	4 000-5 000	H	"Area rilev. Amb": 4 000-5 000	H	Local experts
				"Riserva Lago di Piano": > 50 000	LL	Local experts
14. hospitality density	beds*1000 residents^{-1}	13.7	H	419.0	L	Provincial tourism office, ISTAT
15a. tourist buildings	non-hotel structures/total hospitality structures	54%	H	60%	H	ISTAT
15b. tourist buildings	houses not used by residents/total nr of houses	8%	H	29%	M	ISTAT
16. crowding of natural sites and paths	Level of crowding	low	H	low	H	Local experts
17. daily visitors	V = nr daily visitors /nr resident tourists	>2	L	n.a.	--	Local experts
18. use of tourist structures	[(overnights* beds^{-1})*365]*100	30.7%	M	7.5%	L	Provincial tourism office
19. % of tourists reaching the destination by private car	%	>70%	L	>70%	L	Survey
20. nr of cars in the area / residents	Nr of cars/inhabitants	0.6	L	0.6	L	ISTAT

Indicator	Unit	Oltrepo Mantovano		Alpi Lepontine		Source of data
		Value	Carrying capacity	Value	Carrying capacity	
21. railway service	nr of municipalities with railway station/total nr of municipalities	0.6	M	0	L	Ministry of Transports
22. nr of vehicles in tourist season	nr vehicles in peak hour	n.a.	--	360	L	Estimation
23. tourist intensity in high season	I = (overnights high season*d^{-1})* $residents^{-1}$	$0.2*10^{-3}$	H	0.1	H	Provincial tourism office

Table 4. Results of Tourism Carrying Capacity evaluation in Alpi Lepontine and Oltrepo Mantovano

The analysis of results enables researchers and decision makers to comprehensively evaluate the tourist carrying capacity of each area and then to compare the carrying capacity of a newly emerging destination (Oltrepo Mantovano) with the carrying capacity of a more mature one (Alpi Lepontine). This difference is also underlined by the ratio of employees involved in tourism activities. The comparison between the value for Alpi Lepontine (13% in 2005, according to the Regional Statistic Office data), with the value for Oltrepo Mantovano (3% in 2005, according to the Regional Statistic Office data), shows that in the first area tourism is already an important activity for the local economy, while in the second one it is still a marginal activity. The differences about land use are also representative of the different level of development of the two areas: the hospitality density in Alpi Lepontine is considerably higher than in Oltrepo Mantovano, while the difference in the ratio of houses not used by residents (considered as a proxy for the number of second houses, which are not officially recorded) is negligible. Nevertheless, the value of "tourist intensity" puts Alpi Lepontine in the high class of tourism carrying capacity; though it also has to be underlined that the indicator considers the whole area, creating a compensation between the municipalities near the lakes, which have higher tourist intensity, and the mountainous ones, where the intensity is very low. Therefore, to obtain more precise and useful information, it would be necessary to deepen the investigation at the municipality level.

The analysis of tourism carrying capacity regarding natural resources and infrastructures allows for an evaluation of the possibility of development for the destinations in the future; the evaluation is made considering the capacity of the current system of facilities and infrastructures, in the perspective of avoiding new buildings (i.e. excessive urbanization and land use). Data about water availability and consumption, even if not complete, show a problem about abstraction from groundwater sources in Oltrepo Mantovano. The situation is already unsustainable, and could be worsened by an increase in the number of tourists visiting the area. In Alpi Lepontine, however, there is a problem about the capacity of wastewater treatment plants, which are already near their capacity limit and would not be able to assure continuity and quality of service if the volume of water to be treated increased (e.g. in case of an increase in the number of tourists).

Another critical issue in Alpi Lepontine is the separate waste collection system, which includes only 12.4% of the total amount of waste generated in the area. This value is lower than 35%, which is the minimum ratio that was fixed by European and national regulations as a target for 2003 (chosen as a reference because the data refers to the year 2005) and this could be a serious problem, especially in the summer season, when the presence of a lot of visitors causes an increase in the volume of waste to be collected and processed.

Mobility is a problem for both the destinations; firstly because the number of cars owned by residents is high and, secondly, because, due to the scarcity and the inefficiency of public transport services, most of the tourists reach the areas by private car. This situation affects the quality of the tourist experience and the quality of life for the residents, causing street congestion , noise (that could especially disturb protected areas) and, in Oltrepo Mantovano, a high level of air pollution.

From the methodological point of view, the most critical issues to be evaluated for the tourism carrying capacity assessment seem to be water availability and energy consumption (for which there is a lack of data in the Italian statistic dataset at local level), and the impacts on biodiversity. Available Italian data for local energy consumption refer to 1997, because this was the last year of national management of the energy market. From 1998 there have been various energy suppliers, so the collection of data is now very difficult and a detailed national dataset on consumption is no longer available.

Besides, measuring the impact of tourism activities on biodiversity requires specific study of the areas under investigation, because every situation has specific characteristics. The assessment of biodiversity loss due to tourism activities requires the definition of a representative species for each kind of impact, considering a multiple stress condition. This information is not yet available, so a periodical, detailed monitoring campaign on the flora and fauna of protected areas should be promoted in order to have reliable data sets at national and local level and investigations on the number and characteristics of tourists should be carried out to obtain more data, which would be useful to measure the disturbance caused by tourism activities and to assess the carrying capacity of the areas. Moreover, it would be interesting to perform a detailed investigation into the seasonality of tourism impacts, measuring indicators with monthly scaled data: the amount of waste generated, for instance, is largely variable between the high and the low season and this can be a problem for decision makers who have to scale the waste management system in a way that ensures the most efficient service (and environmental protection) in both conditions.

Although not completely exhaustive, the results of tourist carrying capacity assessment allow for a comprehensive evaluation of the situation in the destinations and are useful for underlying critical issues to be considered for the definition of policies for sustainable tourism in the areas.

The results of the carrying capacity assessment were opened to feedback from the stakeholders: they were presented in a forum for consultation involving decision makers, tourism operators and residents and were taken as the basis upon which some responses to the main problems identified were planned. The responses, commonly shared by local administrators, local stakeholders and experts, compose the Action Plan, included in the "Strategy for sustainable tourism" presented at the end of the first phase of the

implementation of European Charter for Sustainable Tourism in Protected Areas process (Tarelli et al., 2008, Trentini et al., 2008).

The identification of responses to issues, including those which currently have a good carrying capacity score, was carried out in order to prevent possible damages coming from an excessive and uncontrolled tourist development and to address the planning of the entire sector towards sustainability. Clearly, actions developed to be included in a tourist management plan cannot address all the drivers that influence the state of the environment in the destination (e.g. energy generation in Oltrepo Mantovano area). The tourism carrying capacity assessment is intended to support the development of sustainable tourism activities, in order to decouple the economic growth of the tourism sector from its impact on the natural environment in the destination.

7. Conclusion

The most critical aspect associated with carrying capacity assessment of tourism destination is the complexity of making the carrying capacity concept operational and of providing quantitative results, compared to established thresholds. The present study represents an attempt to quantify the current state of every compartment involved in tourism management and to give a quantity perspective on present and future scenarios of destination development, with the aim of addressing future policies for sustainable tourism.

The application of the methodology to the two destinations in northern Italy highlighted some critical aspects which should be further considered for research; the following paragraph lists some reflections about them:

- there is the need to define thresholds of sustainability, to be able to evaluate the results of the indicators selected for the assessment, even though in some cases (e.g. when commonly recognized values are not available), it could entail a certain degree of subjectivity;
- in the definition of thresholds, a good solution seems to be the use of legal limits, but these are not available for all issues, so further research is required, especially in the field of ecological issues (e.g. biodiversity);
- the use of multiple sources for data collection and of different methodologies for thresholds' definition, implies a certain degree of uncertainty in the final results that should be validated in order to ensure the repeatability of the assessment through space and time and the comparability of the outcomes;
- the integration between physical carrying capacity and managing carrying capacity supports decision makers in the planning process, providing useful information about the interaction between physical limits determined by the characteristics of the natural environment and limits of the existing structures of the local tourism system (e.g. the number of beds or the capacity of local wastewater treatment plants), all of which can influence the feasibility of some responses.

The choice of not aggregating the indicators to compose a final index of the tourism carrying capacity of the area comes from the consciousness that it is not feasible (or useful) to set a limit to the number of tourists (due also to the fact that not every tourist determines the

same impact, see sections 2 and 3) and that having a set of information about single issues, to be considered in a comprehensive manner, helps to avoid compensation between different aspects. For instance, considering the indicator "Economic efficiency of tourist structures", it could be argued that increasing the number of beds in the destination (i.e. increasing the number of tourists that can be accommodated) could be a good solution to improve the performance of the system, because it would lead to an increase in the carrying capacity in that issue, but, if we also consider the other aspects, such as "Land use" or "Waste management", it becomes evident that increasing the number of beds would increase the pressure with respect to other issues, thereby reducing the carrying capacity of the system.

Moreover, to evaluate the effectiveness of the policies for development that are defined resulting from the outcome of sustainability evaluation, it could be interesting to extend the assessment of tourism carrying capacity through time, to have a multi-year period of evaluation. Finally, further development of the research could refer to the development of scenarios considering what the situation would be according to existing plans for development in the areas under investigation (e.g. the local structure plan).

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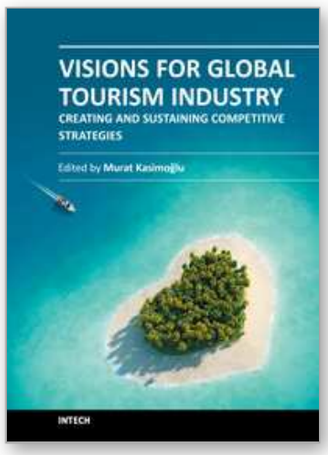
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We have been witnessing huge competition among the organisations in the business world. Companies, NGO's and governments are looking for innovative ways to compete in the global tourism market. In the classical literature of business the main purpose is to make a profit. However, if purpose only focus on the profit it will not to be easy for them to achieve. Nowadays, it is more important for organisations to discover how to create a strong strategy in order to be more competitive in the marketplace. Increasingly, organisations have been using innovative approaches to strengthen their position. Innovative working enables organisations to make their position much more competitive and being much more value-orientated in the global tourism industry. In this book, we are pleased to present many papers from all over the world that discuss the impact of tourism business strategies from innovative perspectives. This book also will help practitioners and academician to extend their vision in the light of scientific approaches.

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中国上海市延安西路65号上海国际贵都大饭店办公楼405单元
Phone: +86-21-62489820
Fax: +86-21-62489821

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