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**Title:** Need for applying GIS methods for registering and evaluation of the impact of tourism on the natural environment, landscape and spatial management : outline of problems

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**Citation style:** Myga-Piątek Urszula. (2008). Need for applying GIS methods for registering and evaluation of the impact of tourism on the natural environment, landscape and spatial management : outline of problems. W: M. Gajos, M. Styblińska (red.), "Geoinformation challenges" (S. 171-180). Katowice : Wydawnictwo Uniwersytetu Śląskiego



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**NEED FOR APPLYING GIS METHODS FOR  
REGISTERING AND EVALUATION OF THE IMPACT  
OF TOURISM ON THE NATURAL ENVIRONMENT,  
LANDSCAPE AND SPATIAL MANAGEMENT**  
**Outline of problems**

POTRZEBA ZASTOSOWANIA METOD GIS DO REJESTRACJI  
I OCENY WPLYWU TURYSTYKI NA ŚRODOWISKO  
PRZYRODNICZE, KRAJOBRAZ I ZAGOSPODAROWANIA  
PRZESTRZENNE  
Zarys problematyki

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**Keywords: tourism, GIS methods, tourist demand and capacity**

Słowa kluczowe: turystyka, metody GIS, chłonność i pojemność turystyczna

**Introduction**

Tourism is becoming a common social phenomenon nowadays. At the same time, it is the most intensely developing service sector with large economic significance. Tourist traffic is also a global phenomenon with huge consequences for the natural environment, landscape and the processes of spatial management. Until recently, the scope of interest of sciences dealing with tourist traffic, like geography of tourism or economic sciences, included hardly anything else than analyses of financial profits coming from the growth of this sector of economy, both in regional and global terms. After the period of stable growth, tourism is experiencing a real boom. That is happening for several reasons, analysis of which would fall out of the contents of this article.

The aim of this article is to point to real threats brought about by developing tourist services, and the need to register and make widely available the data concerning the impact of tourists on the environment in the form of Internet databases.

**Impact of tourism on economy, natural environment and landscape**

Tourism generates domestic income in most countries of the European Union, Asia and both Americas; it is also becoming more and more profitable in African countries (Table 1).

After the period of great fascination resulting from favorable financial analyses, we have to face a sad problem, unnoticed until recently, of the need to control, or even intentionally limit, the tourist traffic in some of the most attractive regions (Hall, Sharples, Smith 2003; Hali 2005). This is happening because besides numerous benefits in the economic aspect, tourist traffic also brings about huge, often irreversible, negative changes in natural environment and landscape (Table 2). Sadly, favorable economic data has dimmed our carefulness in that respect. The condition of research and analyses regarding monitoring of environmental effects of tourist pressure is still in its initial stage and could be described as very far behind in relation to the needs (Benson 2005; Burns, Figueroa 2005; Czyżewska, Kostarczyk 1989).

**Table 1.** Visits of foreign tourists worldwide and in Europe

	Visits of foreign tourists (in mln)						Market share (in %)		Growth rate (in %)	
	1990	1995	2000	2002	2003	2004	2000	2004	03/02	04/03
<b>World</b>	437.8	539.5	686.7	706.4	693.2	763.9	100.0	100.0	-1.9	10.2
<b>Europe</b>	263.6	313.1	393.8	404.8	405.0	422.9	57.3	55.4	0.1	4.4
<b>Northern Europe</b>	30.8	39.4	44.6	43.8	44.5	48.4	6.5	6.3	1.8	8.6
<b>Western Europe</b>	108.6	112.2	139.7	138.0	136.1	138.8	20.3	18.2	-1.4	2.0
<b>Central &amp; Eastern Europe</b>	30.3	58.8	68.8	75.4	77.6	86.3	10.0	11.3	2.9	11.2
<b>Southern Europe</b>	93.9	102.7	140.8	147.6	146.8	149.4	20.5	19.6	-0.6	1.8

Source: [www.mg.gov.pl](http://www.mg.gov.pl) from World Tourism Organization, 2006

**Table 2.** Predicted volume of traffic in international tourism in 2007-2020 in the world and in selected regions

Region	Visits of foreign tourists in mln					Mean yearly growth rate in % in years 2004-2020	% growth in years 2004-2020
	2006	2007	2010	2013	2020		
<b>Europe</b>	458	472	494	540	664	3.0	60.4
<b>East Asia and Pacific</b>	167	180	224	272	423	6.5	176.5
<b>Americas</b>	136	139	156	175	229	3.9	84.7
<b>Other regions</b>	81	85	91	102	126	4.8	82.6
<b>World total</b>	<b>842</b>	<b>876</b>	<b>965</b>	<b>1089</b>	<b>1442</b>	<b>4.1</b>	<b>89.7</b>

Source: [www.intur.com.pl](http://www.intur.com.pl), GUS report: Predicted tourist traffic, from [www.gremium.pl](http://www.gremium.pl)

**Table 3.** Influence of tourist industry on ecological issues

<b>Influence</b>	<b>Results</b>
<b>Increasing number of tourist population</b>	
Increased number of travelers. Increasing number of trips to developing countries.	Increased competition for natural resources Increased pressure on the natural environment
<b>Loss of quality and accessibility of water resources</b>	
Increased travel to places with shortage of water Large use of water in golf courses, hotels, pools Insufficient water-treatment facilities. Inappropriate water/sewage management.	Shortage of water in many regions of the world. Poorer quality of water, which may result in increased number of cases of illnesses. Decreased diversity of water life Less sites for the tourist market Competition for water resources between tourists and locals.
<b>Desertification and degradation of land resources</b>	
Excessive consumption Wrong land management Lacking control over tourists' activities Tourist centers in ecologically sensitive regions.	Less area suitable for the tourist market. Devaluation of existing tourist sites Decreased biodiversity. Creation of illegal landfill sites Rising prices, which may lead to economic instability. Threats to infrastructure.
<b>Acid rains</b>	
Emission of SO <sub>x</sub> i NO <sub>x</sub> from fuel burnt in transportation (increased aircraft and car transport)	Decreased resistance of afforested areas, bringing risk especially to national parks and nature reserves. Deteriorated condition of flora and fauna in water bodies. Soil erosion.
<b>Ozone hole</b>	
Emission of gases containing F, Cl, CFCI. Emission NO <sub>x</sub> from airplane engines.	Increased numbers of skin and eye infections, which may lead to decline in tourist attractiveness of sun-exposed sites. Reduced resistance In people and animals. Reduced photosynthesis efficiency Ozone hole may result in climatic changes.
<b>Climatic changes, greenhouse effect</b>	
Forest clearing for new tourist center Fuel burnt for transport.	Changes in weather conditions and increased occurrence of extreme climatic phenomena (droughts, fires, heavy rains), decline in attractiveness of e.g. the Mediterranean region in summer. Rising levels of seas and oceans, which may severely affect near-shore areas and island locations. Increased activity and intensity of atmospheric phenomena (hurricanes, tornadoes, storms, heavy rains). Spread of tropical diseases, which may cause the number of tourist in a region to decrease.

*Source: Own compilation*

### **Internet databases of tourist space resources**

Tourist space can be divided into space of tourist exploration, penetration, assimilation, colonization and urbanization (Law 1996; Liszewski 2005). The latter two are associated with the highest degree of influence of tourists on the environment and landscape. Key notions for the discussed matter include tourist absorption and capacity, tourist resources, values and attractions, and tourist product.

Tourist attractiveness of regions is determined by factors including the quality of tourist values, accessibility, or supply of services related to management of visited areas (i.e. so-called tourist infrastructure). The notion, therefore, integrates elements which determine the growth of tourist traffic (Warszyńska, Jackowski 1978).

Tourist values are a component of tourist attractiveness. It is a certain set of elements of the geographic (natural and cultural) environment which could be a subject of tourist interest and a deciding factor as a reason for going to a particular region or location. More and more frequently, a tourist value is created by the landscape as a whole, perceived with multiple senses, rather than individual objects of animate or inanimate nature or individual architectural objects. Attractiveness of an area can be complemented with special, unique qualities of the region. Attractiveness of various places can also be determined by the local tourist product, which is often created for the needs of visitors. From the point of view of this paper, the most essential parameters of tourist traffic control in regions attractive for tourists are tourist capacity and absorption. These are the notions for which some parametric criteria of evaluation should be set.

Tourist capacity is a maximum number of people that can stay in a given area at the same time, after its adaptation for these purposes, with all the needs being appropriately satisfied, without causing negative impact on the values of the natural environment (Lijewski, Mikułowski, Wyrzykowski 1985).

Tourist absorption expresses natural resistance of the natural environment to degradation caused by tourist traffic. This is determined by a maximum number of people (participants of tourist traffic) who can stay in a given area at the same time, without causing the processes of natural environment degradation to start for a specific period of time (Kostrowicki 1970).

The tourist space information system presented until recently included registration, catalogization and making available data regarding tourist resources and values (compare Myga-Piątek, Pytel 2006). It should be stated that both Polish and European Internet systems of information and data on tourist space resources include extensive information about particular attractive regions. The system is characterized by common features, accessibility and easy operation. Activities including catalogization, classification and valorization of tourist areas are taken for the needs of making available and promotion of tourist information. Regional, national, European, etc, databases about tourist space resources are being gradually enhanced and diversified.

At the same time, we are facing the urgent need to construct and popularize the system of spatial information regarding the impact of tourists on particular

(endangered) components of the environment and landscape in each region. The extent of such impact is not recognized nowadays. Detailed research in that respect is in its initial stage and usually concerns selected, particular components of the environment, or, to a less extent, evaluates the whole influence of tourist traffic on the natural features of selected (most usually small, thus easily controllable) areas, e.g. those of national parks. The extent of these influences is large and increases dynamically, often in a totally uncontrolled manner.

The need to face this challenge should be a common aim among decision-makers determining the directions of spatial management of tourist regions, as well as specialists issuing so-called *Assessments of influence on the environment* for subsequent tourism investments. GIS methods can provide means for working out particular, measurable procedures to facilitate an objective assessment of described influence.

### **Database of tourist traffic and human impact**

Increasing tourist traffic requires rational management of resources of the natural and cultural environment which are tourist attractions. For the needs of planning and marketing of tourist services, as well as in order to protect environment and landscape values, it is necessary to work out and continuously update a complex database functioning on the GIS platform. The geographic information system is based on a database and numeric maps on which location of particular objects can be visualized (Chybiorz, Nita 1999; Kraak, Ormeling 1998). Such a system collects comprehensive information about the terrain and at the same time allows for its continuous verification. The starting point for each numeric compilation is collecting information and construction of a database spreadsheet containing a set of parameters and criteria which univocally describe a given region (Nita, Waga 2000). In case of tourist resources, MapInfo software, working with Excel XP spreadsheet, was selected. Data concerning cataloguing of natural, cultural and landscape values, as well as data on tourist traffic control in the tourist regions, has been and is still being collected. Advantages of so prepared information cards include being accurate (typically of the 1:10,000 scale), up-to-date, verifiable, easily understood, thematic and univocal (Nita, Waga 1997).

**Table 4.** Selected (exemplary) parameters of comparative assessment of actual tourist traffic, tourist capacity and absorption as the basis for construction of databases

No.	Actual values for selected parameters of assessment of tourist traffic volume [n]	Maximum allowed values for selected parameters of assessment of tourist traffic that guarantee the functioning of the self-regulation mechanism in the natural environment system [ $n_{max}$ ]
1	Total number of cars, including those parked outside marked areas (e.g. along roads and in clearings)	Number of parking places in marked parking lots
2	Volume of water used (hostels, campsites) [ $m^3$ ]	Yield of local springs and wells [ $m^3$ ]
3	Volume of sewage produced (e.g. mobile toilets), "wild toilets" reported in the area [ $m^3$ ]	Efficiency of local water treatment plants [ $m^3$ ]
4	Volume of waste produced (e.g. number of litter bins, wild garbage dumps, discarded waste) [ $m^3$ ]	Efficiency of the waste collection, removal and recycling system [ $m^3$ ]
5	Volume and distribution of noise levels along ecological routes and wildlife refuges [db]	Area and number of places determined as silent zones, max. allowed noise level [db]
6	Number of places used spontaneously for relaxation	Number and capacity of marked camping sites
7	Number and length [km] of paths and roads used by tourists (including shortcuts and unauthorized extreme routes)	Number, length [km] and transferability of authorized tourist trails, including walking, skiing, cycling routes etc.
8	Total daily number of visitors to caves	Maximum number of visitors whose influence will not cause any disturbances in the cave environment
9	Time [h] electric lighting used in caves	Maximum time [h] of use of artificial lighting that has no negative effect on the cave microclimate
10	Total actual daily number of visitors to the national park, based on the number of tickets sold at the entrance	Total recommended volume of tourist traffic determined based on all the above criteria = TOURIST QUOTA (maximum number of tourists per day allowed to enter the park)

Source: Own compilation based on issues arising in the Tatra Mts and Ojców National Parks

### Index volume assessment [n]/[ $n_{max}$ ]

- < 1 – no threat to the environment has emerged yet – the area is at the tourist exploration or penetration stage,
- = 1 – the state of equilibrium, monitoring of the influence of tourism on the environment is recommended, this is the stage of tourist space colonization,

- > 1 – tourist capacity and absorption exceeded – it is necessary to introduce tourist quotas – tourist accessibility limits.

### **Summary**

By 2020, natural resources of some exceptionally precious areas of the world will have been destroyed by global warming, among other factors, and many widely visited resorts will have been diminished as a result of overpopulation, deformation of the natural environment and increasing spatial chaos. Increased mass tourism will cause popular resorts to be literally swarmed by incalculable crowds of holiday-makers. Some of particularly attractive places will be forced to apply limitations in the number of tourists; the need to limit the number of visits may arise even before 2020. These restrictions might be based on increased entry fees and higher fees for using the natural environment. The highest prospects nowadays, therefore, are those for so-called balanced tourism (ecotourism) with minimum impact on the natural environment.

In the light of the above facts, it is essential to plan the tourist management in a rational manner. Full control over tourist absorption and capacity of holiday regions is necessary. Tourist capacity is relatively easy to control. Comparison of tourist facilities which are actually available with observed tourist interest, assessed e.g. basing on transport permeability (parking places, traffic jams) or use of accommodation or catering facilities, could point to clear disturbances regarding this parameter. We are able to create comparative analyses of seasonal distribution of actual tourist interest compared to tourist absorption. Basing on these observations, it is possible to plan further tourist investments and forecast the regional growth.

The situation is much worse concerning the monitoring of tourist absorption. Being a very sensitive yet inert system, the natural environment sends out signals concerning disturbances with much delay. The delay may often be too high to ensure our effective reaction. The volume of tourist traffic in areas of high environmental value must be managed, taking into consideration the actual volume of tourist traffic compared to the tourist capacity and absorption of the area determined by the condition of its infrastructure. A decision to restrict tourist accessibility to park areas to the volume determined by a tourist quota might not be popular, but be necessary.

This is why the computer database comprising information about tourist pressure (both direct and indirect) on particular elements of the natural environment (surface and ground waters, soils, air, plant cover and animals) as well as on elements of spatial management is so important.

It is necessary for the system of tourist service planning to work out databases of the quantitative influence of tourist activities on particular components of the environment and the whole megasystem. Those databases should be available for and used by local government authorities, institutions of legal protection of regions of natural and cultural value, and strategic investors.



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### **Abstract**

Nowadays, tourism is becoming a common social phenomenon. At the same time, it is the fastest developing service sector. Tourist traffic is also a global phenomenon with huge impact on the natural environment and processes of spatial management. Until recently, the scope of interest of sciences dealing with tourist traffic, including tourism geography or economic sciences, hardly covered anything more than matters related to analysis of financial profits coming from that economic sector, both in regional and global terms. Following the period of stable growth, tourism is currently thriving on a real boom. That is happening for numerous reasons, analysis of which falls far beyond the contents of this paper. Besides multiple advantages in economic aspect, tourist traffic also causes large, frequently irreversible, negative changes in the natural environment and landscape.

This paper discusses the possible use of GIS methods for recording and evaluating the influence of tourism on particular components of the natural environment, and analyzes the advantages of the way these changes are mapped for tourist traffic management. Numeric databases and their compatibility, availability and accessibility over the Web could be a way of control and regulation, and maybe even of limitation, of tourist traffic in many regions where visitors' traffic has exceeded its tourist demand and capacity.

### **Streszczenie**

Turystyka staje się obecnie powszechnym zjawiskiem społecznym. Jest to jednocześnie najbardziej prężnie rozwijający się sektor usług. Ruch turystyczny jest także zjawiskiem globalnym o ogromnych konsekwencjach dla środowiska przyrodniczego i procesów zagospodarowania przestrzennego. Do niedawna w polu zainteresowania dyscyplin naukowych zajmujących się ruchem turystycznym m.in. geografii turystyki i nauk ekonomicznych znajdowały się prawie wyłącznie treści związane z analizą korzyści finansowych płynących z rozwoju tego sektora gospodarki, zarówno w ujęciu regionalnym jak i globalnym. Po okresie stabilnego wzrostu turystyka przeżywa obecnie prawdziwy boom. Oprócz wielu dobrodziejstw w sferze ekonomicznej, ruch turystyczny wywołuje wielkie i często nieodwracalne, negatywne zmiany w środowisku przyrodniczym i krajobrazie.

Niniejszy artykuł omawia możliwość zastosowania metod GIS do rejestracji i oceny wpływu turystyki na poszczególne komponenty środowiska naturalnego oraz analizuje korzyści płynące ze sposobu kartowania tych zmian dla zarządzania ruchem turystycznym. Numeryczne bazy danych, ich kompatybilność, powszechność i dostępność w sieci może być sposobem na kontrolę i regulację, a może nawet ograniczenie ruchu turystycznego w wielu regionach, w których ruch przyjezdnych przekroczył zarówno pojemność jak i chłonność turystyczną.

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