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Impacts of tourism and sport activities on the surface of the Earth: An Anthropogenic Geomorphological Approach

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Abstract: Within the system of natural environment, the transformation of any elements, such as relief has an impact on the operation of the whole system, and can trigger several, mostly unfavourable transformations. Although, the extent of the impacts on environment, and within this on relief, related to recreation activities, compared to that of other sectors (e.g. industry, agriculture) is rather small. However because of the continuously growing popularity of these sectors, more attention should be paid to the planning taking the complicated relations of environment and activities into account, due to the discovering new destinations. In case, those looking for leisure and still intend to enjoy the natural environment, they will also have to become environmentally sound users. The impact of recreation activities on relief can come into force in many ways. Whether we talk about a study carried out at a given area or a comprehensive one also using previous results, the demand for a multidisciplinary approach resultant from the characteristics of this topic represents a great challenge to the experts.

Keywords: outdoor recreation, infrastructure, environmental impacts, winter sports, coastal tourism.

1. INTRODUCTION

The demand for recreation, pleasant passing of free-time of mankind can be traced back to the Ancient times. Based on the attractiveness of emerging from everyday routines, a service network has been built up through most of the world in the 20th century, being indispensable to the development of mass tourism driven by motivation, discretional incomes and free-time, as well as sports becoming mass phenomena. Due to our accelerated lifestyle associated with increased stress, from the last third of the 20th century, tourism and sport with their immense development have become two of the most requested free-time activities of the citizens in the developed countries. Considering the complexity of the factors influencing the development of these two sectors, various estimations can be heard in connection to the future of tourism and sport. It can not be argued, however, that the conjuncture of the need for recreation, which can be considered as the basic and most popular motivation of travelling and sport, is undiminished. Recreation conventionally means the refreshment and the reproduction of working ability of mankind. Based on the characteristics (and means) of the activity, intellectual and physical recreation can be distinguished. Intellectual recreation is a mostly active (participatory, generative), however consequentially passive (viewer, recipient or receptive) activity involving the matter of culture, entertainment and civilisation. Physical recreation means a (physical, manual) work (activity) carried out during the one's free-time (voluntarily) (Kovács, 2002). The international literature emphases the fact that all these activities (figure 1) have serious impacts on the environment surrounding us.

This chapter analyses the impact of outdoor activities of tourism and sport within the domain of physical recreation as well as that of the building-up of infrastructure necessary when performing any of these, on the relief.

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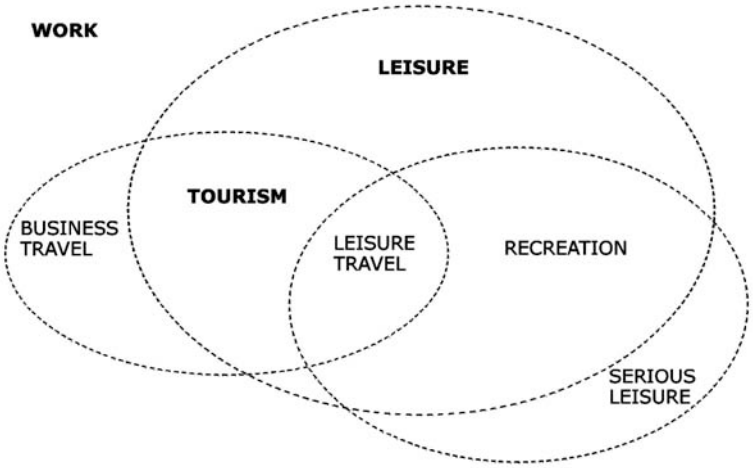

Figure 1 – The relationship among leisure, recreation and tourism (after Hall & Page, 2002).

Research into the impact of tourism and sport on the natural environment, in addition to these two sectors becoming multitudinous, is essential as nowadays outdoor, sport-orientated travels are gaining more and more grounds. For example, in Germany 55 % of all travels (32 million citizens) is motivated by sport whereas this ratio in the Netherlands is 52% (7 million citizens). Sport is a less significant motivation to travels of the French, although still 23% of the travels (3.5 million citizens) is related to some kind of sport activity (Richie & Adair, 2002). This remarkable trend is characteristic not only in Europe.

Apart from the travels based on the attractions of nature and related to sport, the range of destinations and that of the outdoor activities as well as the length of the time spent on them are also increasing (Strasdas, 1994). Moreover, the number of travel organisers offering free-time sport programs to their travellers is also increasing (Standeven & Knop, 1999). According to the investigations by the World Tourism Organization, the most popular physical activities among recreational travels are skiing, snowboarding, climbing, touring, water sports and cycling (WTO, 2001). The popularity of outdoor activities in certain fields may lead to the high concentration of the participants regarding both time and space, resulting in significant development in the infrastructure altering the environment and also causing an increased loading of environment.

Impacts of recreational tourism and sport in the areas affected, which can be traced in the natural environment, depend on several factors (figure 2).

Consequently, although the types of impacts are similar in all affected areas, there are differences in their exact way of appearance, extent and bulk (Puczkó & Rátz, 2002). Meanwhile, it should be referred that the sites for recreational tourism and sports are more complex and susceptible environments (e.g. small islands, coastal areas, mountainous areas).

The exploration of the whole physical impact system of recreational tourism and sport activities is a rather difficult task. Factors rendering the impact assessment more difficult are the followings:

- The consequences are often present joined by those of other (industrial, agricultural, transportation, etc.) activities and they are hardly separable.
- Researchers do not have sufficient knowledge on the conditions of the environment of the target area prior to the appearance of tourism and/or sport activities; therefore lack the basis for comparison.
- The direct impact is often coupled by indirect or long-term transformations.

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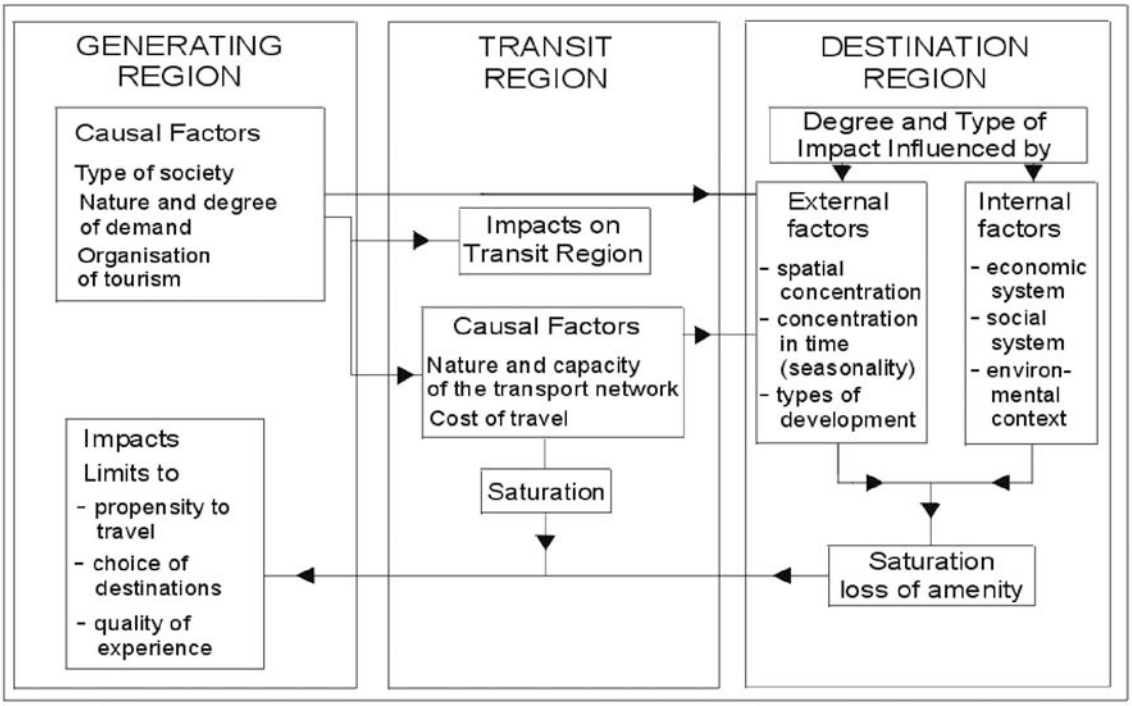

Figure 2 – The relation between the causal factors and impacts with the generating, transit and destination areas (after Pearce, 1989 after Thurot, 1980).

- As a result of the complicated network of linkages, consequences are not always observed at places where the impact itself is present.
- During comparative evaluations or preparing comprehensive systematic approach studies, the various impacts originating from the difference in the supply and demand factors represents a great difficulty (Martonné Erdős, 2001).

Processes, links related to the activities mentioned above, causing the transformation of landforms of the Earth's surface, creating new landforms as well as altering or removing old ones, are presented below.

2. THE IMPACT OF FREE-TIME TRAVELS AND SPORTS ON THE RELIEF

The mostly negative impacts of tourism and sport on natural environment have been studied by several researchers. Based on the results these, it can be concluded that these activities play a primary role in landscape and relief transformation related to the establishment of infrastructure and in the accelerated erosion related to each activity in many ways.

2.1 Impacts related to the establishment of the infrastructure of travels and sports

Most outdoor tourism and sport activities would not be accomplished without suitable infrastructural investments (transportation infrastructure, quarters, caterings, sport fields, the construction of various service facilities). Thus, the establishment of infrastructure results in significant transformations in the environment of the target area via the transformation of relief. The load of intervention is aggravated, at many times untouched natural areas become cultivated (the establishment of recreation complexes, golf courses, ski runs), when creating target areas.

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As seen on figure 3, there are only very few outdoor activities of which infrastructural background does not require intervention into the landscape on a higher extent.

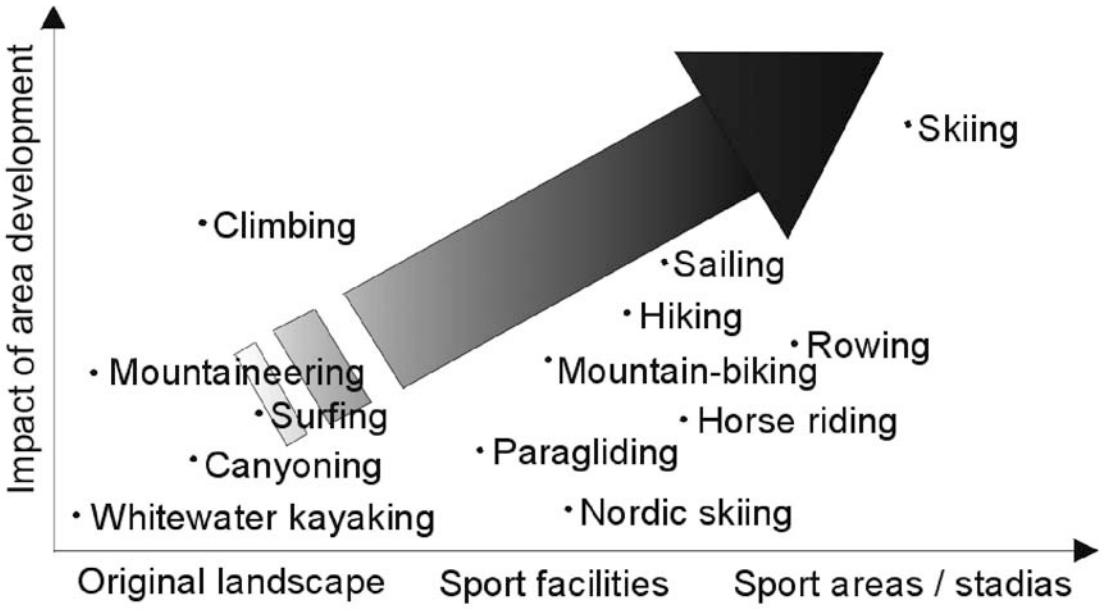

Figure 3 – The relation between the area, the features of activity and the intensity of impacts (after Türk et al., 2004).

Impacts on the target areas of the winter sports

The favourite destinations of winter sports with worldwide popularity are the Alps, the Pyrenees, the Scandinavian Mts., the Carpathians, the Andes, the Rocky Mts., the Himalayas, the Caucasus and the Southern Isle of New Zealand. At the earliest, skiing had become a mass phenomenon in the Alps, as well as its undesired impacts were first observed there, too. The snow-covered areas of these ranges are visited annually by about 40−50 guests being slaves of the passion of various kind of downhill skiing. The pleasurable amusement for the sportsmen is provided by about 15,000 ski-lifts and 40 000 ski-trails (with a total length of about 120 000km!) (Martonné Erdős, 2001). During the establishment of ski-trails, first the affected area is deforested followed by the steep slopes cut back by bulldozers or via blasting whereas the gentle ones elevated or elsewhere the landscape made even. The deforestation results in a cease of the water retaining capacity of the vegetation and in increasing soil erosion. Rills or, in extreme cases, erosion channels are cut into the surface of the bare slopes by meltwater and rainwater running off fast, although there are frequent sheet washes taking place on the evened, compacted surfaces. With the winter passing, water running down unobstructed on the slopes without trees may frequently cause floods coupled with landslides threatening facilities and even human lives. For example, in Tirol in July 1987, 60 had died as a result of a disastrous landslide, and 7000 citizens of 50 settlements had become homeless (Romeril, 1989). Mass movements due to the establishment of tourist infrastructure have been described from Italy, Switzerland and Nepal (Holden, 2000). As a consequence of the intensive tourism, the Alps have become the most susceptible mountains in the world. Due to construction and presence of hotels and that of the infrastructure of ski-runs and restaurants, the landscape has undergone dramatic changes and has been fragmented. According to Mosimann (1985), the rate of tourism-induced transformed areas in the Swiss Alps may be up to 15%. During his research on ski-trails in Switzerland he found

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that the rate of erosion is mainly determined by the shape of slope, the moisture content of soil, the frequency of run-offs and the extent of catchment area.

Alterations due to winter sports may be present elsewhere rather than in the nature only. Often, urban environments are transformed in order to fulfil the demands of visitors. For example, in Oslo, the ski-jump is basically a dominant feature of the townscape. Figure 4 indicates how the original slope has become steeper during a decade. The urban ski-trail and the complex surrounding it, attract several thousands of tourists each year (Bale, 1989).

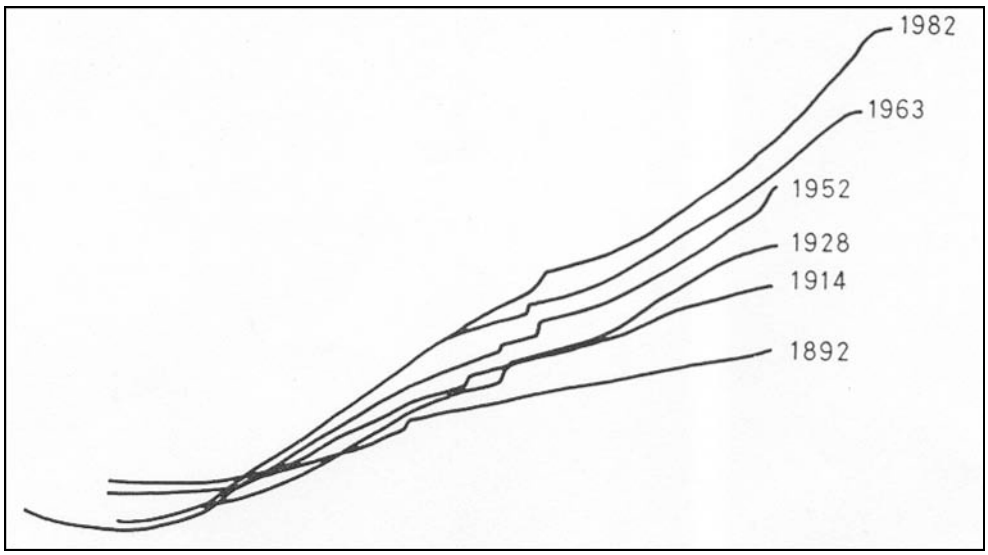

Figure 4 – The change in the steepness of the ski-jump 'Holmenkollen' between 1892 and 1982 (after Bergsland et al. 1983).

Positive experiences, of fulfilling developments taking landscape protection aspects into consideration, are also known by experts. E.g. on the slopes of the Cairngorm Mts. in Scotland, on which new chair ski-lifts have put into operation, the rate of soil erosion has been significantly dropped due to planting grass and timber the areas of the former outdated ski-lifts as well as building-up water trenches (Bayfield, 1974).

Despite itself not being a winter sport, grass-skiing is originated from them. The fans of skiing, nowadays, do not settle for short winter skiing seasons, therefore this variation of skiing without snow has become more and more popular. Tivers (1997) describes that the establishment of trails in England is often taken place by the recultivation of coal mines or other industrial areas. Only in Sheffield nine grass-ski trails can be found, with their total length being nearly 1000 km-s. As a consequence of the direct, intensive pressure on the vegetation and the sloped surface, grass-skiing has even more impacts, as far as landscape destruction is concerned, than the traditional way of skiing.

Impacts present at watersides

Apart from mountainous areas, natural water environments offering ground for tourism and sports in many ways are the most popular ones. At the time of the evolving mass tourism, summer holidays brought the highest trade of which most important destinations were, due to the '3 S' (Sea, Sand, Sun), sea-shores, secondly lakes and river banks.

A remarkably great amount of coastal areas suitable for bathing has been the victims of having them built in by various service facilities. During the construction works, sand dunes and protective coastal vegetation are removed and with the decreasing stability of the coast there is

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increasingly effective coastal erosion as well as abrasion taking place. Environmental experts claim that mangrove forests of South-East Asia, that have been deforested to provide ground for coastal paradises for tourists, among others, might have helped to restrain the tsunami of 26th December 2004 demanding several hundreds of thousands of human lives and causing huge damages. Since this catastrophe, mangrove forests are regarded as protected ones in many Asian countries, as well as the natural coastal dikes are attempted to revive by re-planting. Similar phenomenon was described in connection to the destruction of coral reefs (figures 5 and 6) at the coastal areas of Kenya (Holden, 2000), providing a complex outline not only on the problems caused by erosion but also those due to tourism developments.

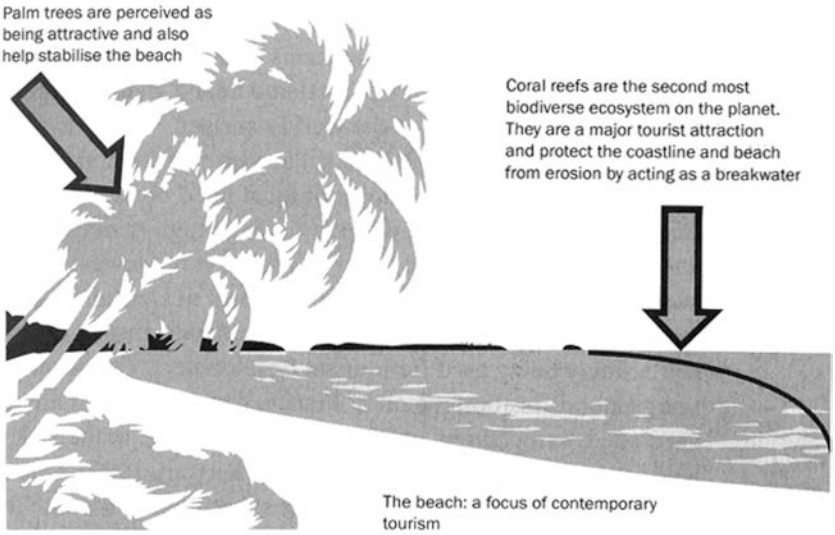

Figure 5 – Pre-tourist development stage at the coasts (after Holden, 2000)

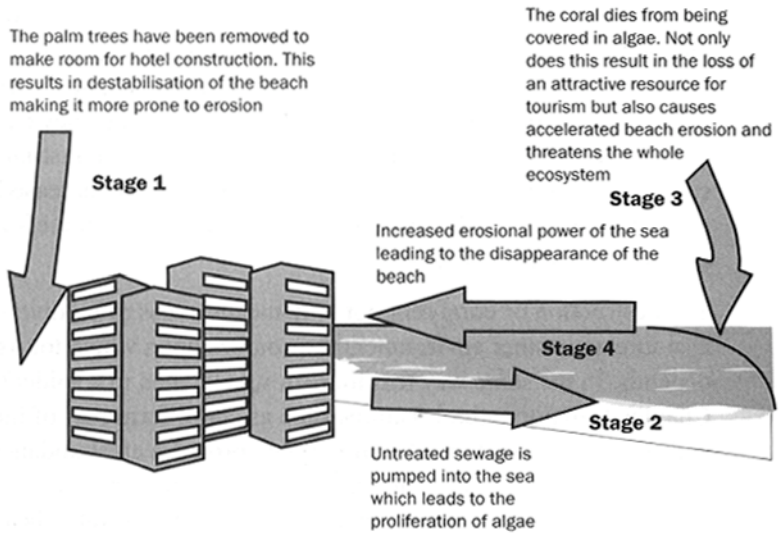

Figure 6 – The impact of tourist developments on the coasts (after Holden, 2000).

Since 1960, almost three fourth of the sand dunes in the near-shore areas between Spain and Sicily has been disappeared (ECOSOC). As seen from table 1, coastal erosion affects a significant percentage of shores in the Mediterranean. Destruction of the foreshore is major problem for 18% (in average) of the coastal areas with a total length of 18 000 km. Coasts of

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islands are especially susceptible to devastating forces. The rate of abrasion is indicated by an estimation according to which Greece has a loss of one island each year.

Coastal area	Total shoreline (km)	Stabilisation	Erosion	Sedimentation	No information available	Unsuitable for recreation
Balearic Islands	2,861	68.8%	19.6%	2.4%	0.5%	8.7%
Gulf of Lion	1,366	46.0%	14.4%	7.8%	4.1%	27.8%
Sardinia	5,521	57.0%	18.4%	3.6%	16.0%	5.0%
Adriatic Sea	970	51.7%	25.6%	7.6%	3.9%	11.1%
Ionian Sea	3,890	52.3%	22.5%	1.2%	19.7%	4.3%
Aegean Sea	3,408	49.5%	7.4%	2.9%	37.5%	2.6%

Table 1 – Development tendencies of the Mediterranean shorelines. Source: CORINE Coastal Erosion (1998).

In the course of time, as a result of coastal erosion tourist facilities themselves require protection, thus protective walls are be built causing further damage to the landscape. Protection facilities are very common e.g. on the coasts of the Northern Sea. Another, frequently applied way of protection is the filling up of coastal areas. Figure 7 below shows the amount of sand and gravel (in m^3) mined in Belgium, used for the filling up of coastal areas.

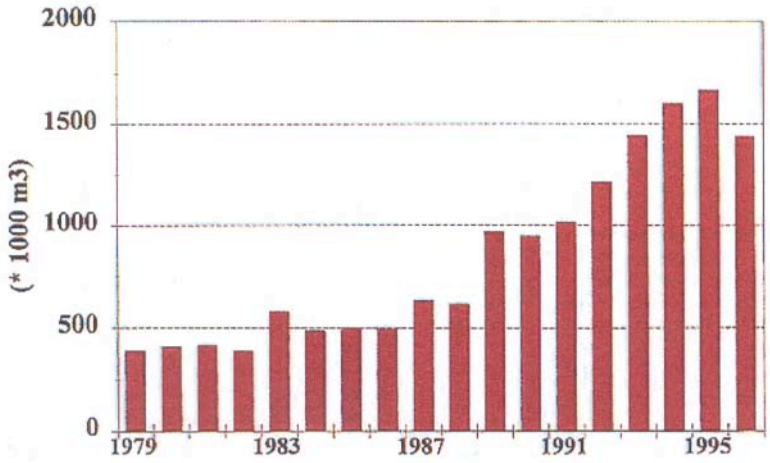

Figure 7 – The amount of sand and gravel used for the filling up of coastal areas in Belgium (after Haelters & Jacques, 1996).

There have been several investments starting recently of which owners, in order to increase the incomes from tourism, have artificial archipelagos built into the sea that encroach the complicated system of natural environment to an extent never seen before. In the area under the domain of the United Arab Emirates, an artificial archipelago called 'The Palm, Jumeirah' will be raised on the coast. On its trunk, 8 km-s in length, luxury hotels, shopping centres, cinemas and pleasure grounds will be found, so will dwelling houses and offices on its 17 palm-branches.

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Completion of the construction is expected in 2006. However, the most exclusive holiday resort of the Emirates will be a project consisting of 250 artificial islands, located 5 km from the coasts of Dubai, and representing the globe. Services of the archipelago called 'The World' will be available for guests from 2008 (http://www.palmsales.ca) (pictures 1 and 2).

Pictures 1 and 2 – The artificial archipelagos of The Palm, Jumeirah and The World, located in Dubai (Internet).

At the Lake Balaton, bathing had started in the second half of the 19th Century that, as a result of the loss of the sea and mountain holiday resorts, had been growing following World War I. Fulfilling the demands, land owners parcelled their lands, and by the construction of villas which can be seen even today, building-up of the shores of the Lake Balaton began in the first half of the 20th century. By the mid-1970s building-up was 80 % in the 300 m wide zone along the shoreline. The level of human interference is indicated by the fact that only 70 km of the shoreline, being 195 km after the millennium, have remained in their near-nature conditions (Martonné Erdős, 2001). When purchasing some of the properties 20 to 30 years ago, a marsh area could be found in the area of today's ground plots, of which filling-up was carried out under strict supervision and based on the plans worked out by authorities. There were, however, many land-owners intending to enlarge their ground-plots along the shore illegally, by filling-up the Lake Balaton. According to the regulations of the Lake Balaton Act in 2000 (62/2000 Act) on the acceptation of the Lake Balaton Primary Recreational Area territorial organization planning and the definition of the Balaton territorial organization regulations), protection is given to the living world of the lake on the one hand by drawing a new shoreline (at some places by the filling-up of areas along the shore whereas by bulldozing areas along the shoreline at others), and to the stopping of the degradation of water levels threatening the tourist attractiveness of the Lake Balaton.

Impact related to the establishment of golf courses

Golf originally coming from Scotland has become a beloved and popular sport, which however, due to its several advantageous impacts on economy (e.g. longer staying time above the average, reduction of the seasonality, high specific expenditures by tourists) is becoming a more widespread product of tourism. Approximately 60 million plays golf annually on about 30,000 golf-courses worldwide with their total area exceeding that of Belgium (Hodson, 1996). At its early stages, natural relief had been used to create smaller courses. The ideal environment was represented by hilly landscapes, natural bunkers, pillowy lawn and sufficient drainage conditions. With the technical development and market prosperity, the number and extent of courses kept on increasing, thus mountainous and coastal areas with extremely valuable

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ecosystems, deserts, areas once being outcast mines as well as plough-lands had become victims (Bale, 1989). Unlike traditional courses, when building modern ones, the landscape undergoes considerable transformation due to the modification of the surface associated with materials handling to a great extent among others. For example, during the establishment of the Mária Valley golf-course (at Alcsútdoboz) in Hungary, opened in 1997, 300 000 m^3 of soil was removed (Varga, 1999). According to Wheat (1995) there are only few ways for recreation being more environmentally sound than golf. Although, he admits the growing concerns with this sport gaining ground because of the large extent of land use. The question of reducing environmental impacts due to the allocation, establishment and operation of the courses (e.g. creating artificial landscapes, increased fertilisation and water use) was treated as an accentuated issue in some European countries already in the 1980s, resulting in the intention to reduce the size of the courses, to developed techniques in order to the management of the natural environment in a sustainable way (picture 3).

Picture 3. A golf course enriched in artificial landscape elements, located in Florida (Internet).

Impacts related to the establishment of parks

Shaping of the landscape, surface modification of diversified ways and extent can be associated with the establishment of parks offering various ways of recreation. Just recall, for example, the public parks found in every city, set out by artificial water surfaces and humps.

Another type of parks resultant from human interference is Olympic parks being under significant loading during sport events, too. For example, in Munich, the hump of Schuttberg 60 m in height was built for recreation purposes from the ruins of World War II. In 1972, an area of 270 hectares surrounding it was developed and became the site for the 20th Summer Olympic Games, since then being a popular sport park of the city.

On the world's tourism market, theme parks offering all-day family entertainment are basically sweeping on. Even the establishment of these amusement parks alone can have a considerable impact on the landscape by transforming the relief. In the meantime, due to the landscape reconstruction associated with archaeological parks, nature conservation areas, protected natural values, advantageous changes can also take place regarding the landforms of the Earth's surface.

In cases of developments for recreational purposes, now the implementers and planning experts are aware of the fact that in long-term an indispensable base for recreation in the nature is an attractive landscape more preserved in its originality. To this, landscape planning based on the basic principles of sustainable development is unavoidable for both fulfilling the demands of visitors and protecting the natural environment. As a widespread practice throughout the world investments aiming the restoration of the original natural environment are executed. A good example from Hungary, on the habitat reconstruction with relief transformation, is the area of the

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Hortobágy National Park, where in 2002, the possibility was given, supported by a European Union's LIFE-Nature tender, to reconstruct the natural state of the diversified, continuous system of arid saline barren and marsh habitats. Within the framework of this landscape rehabilitation programme affecting nearly 8000 hectares, dams and channels restraining the natural surface water movements have been removed and flattened into the natural surface by grading (http://www.hnp.hu).

As part of the landscape rehabilitation following the hydro-power project, on the banks of the River Danube in the area of Visegrád, apart from the 20,000 m^3 land already filled up, a further 100,000 m^3 is planned to be filled up for recreational purposes (http://www.visegrad.hu).

Short-eyed economical interests sometimes even today predominate over environmental protection, as in Hévíz instead of landscape rehabilitation, a monster hotel with 10 swimming pools are planned to be built. It was evincible earlier that discharge of the lake source had been drained by the pumps of the hotels.

2.2. Impacts related to recreation activities

Recreation activities triggering or increasing erosion

The impacts of recreation activities regarding natural environment to their attractiveness are usually associated with several groups of activities. On grounds, pathways and areas not affected by designated routes, treading is a universal problem leading to the soil's compaction, finally to its erosion. As a result of compaction, porosity and permeability of the soil is reduced, leading to a higher amount of water running on the surface. Water can easily entrain soil particles by which triggering erosion. Meanwhile, as an effect of high pressure, herbaceous vegetation cover protecting the soil gets damaged very soon, and as a result of time periods with precipitation, surface of the soil can become muddy. By walking round the sections wrongly passable, widening of the paths starts on the one hand whereas soil erosion quickens up to a significant extent on surfaces without protection, on the other (Figure 8). This, in many cases, leads to creating a covered road surface.

An equation 'generally' applicable was developed by Wischmeier (1978). With the help of this, soil loss of areas affected by recreation activities can be calculated.

$$\text{Mean annual soil loss (t ha-1 year-1)} = R \text{ X } K \text{ x } (L \text{ x } S) \text{ x } C \text{ x } P,$$

where
R = rainfall erosivity index (t ha-1 year-1),
K = soil erodibility,
L = topographical factor depending on the length of the slope,
S = topographical factor depending on the gradient of the slope,
C = plant cover factor,
P = a factor of specific erosion control practices.

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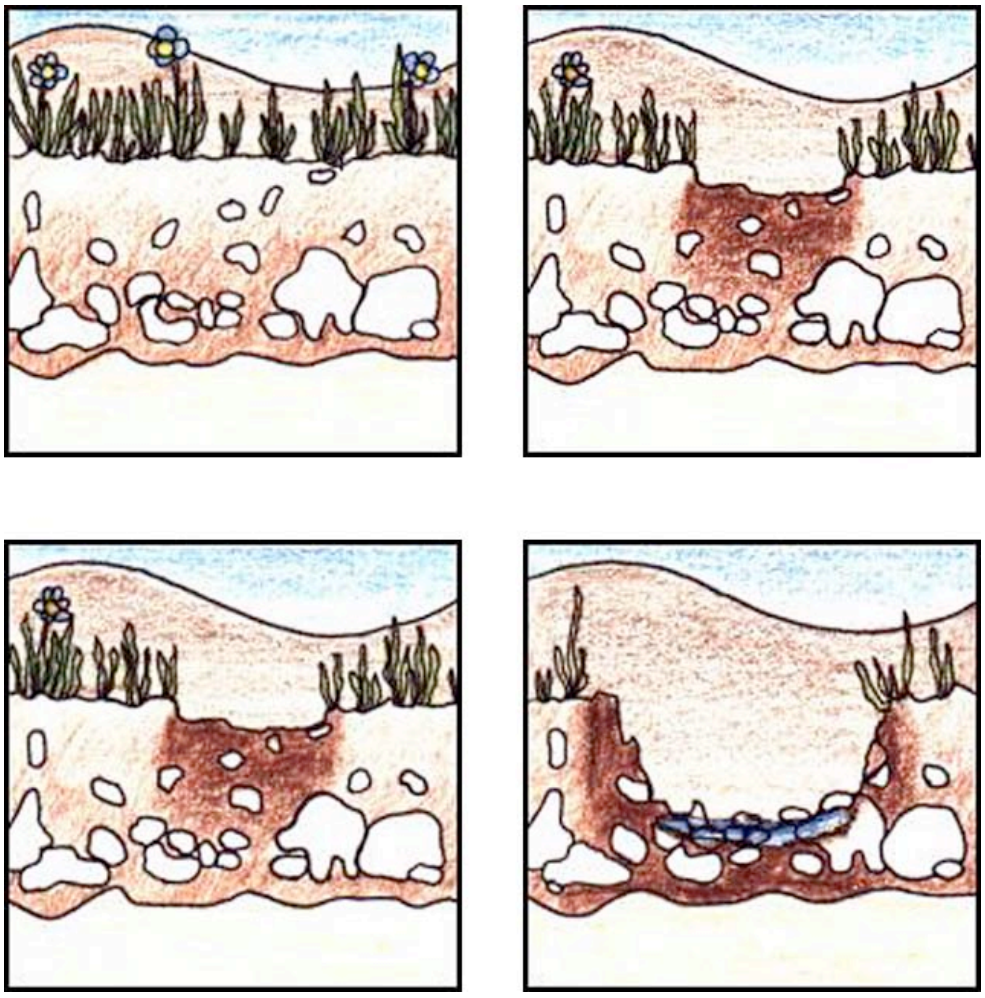

Figure 8 – The process of footpath erosion (http://www.maridadi.com/dofe/feros.htm).

The authors precisely described the method for determining the value of each variants, however, each parameter of the equation must be adopted to the given region. It should be noted that the equation do not take the type and intensity of the recreation activity, the attitude of the person carrying out the activity into consideration, and this fact makes its application without some modifications inaccurate. To a more exact measuring of the mean annual soil loss resultant from recreation activities, extension of this equation is necessary. Links among the factors included has not yet been described by the experts. Leung & Marion (1996) extend the factors influencing soil erosion to some extent, and classify them according to the rate of their influence. They claim that the rate of erosion is primarily determined by the climate, geological, lithological settings and the type and intensity of the recreation activity, whereas topography, characteristics of the soil, vegetation cover and the attitude of users play only a minor role in the process. The importance of reviewing the type of activities is illustrated by the table 2, indicating the level of pressure on soils triggered by the most characteristic ways of recreation from the aspect of treading.

Most experts (e.g. Dale & Wever, 1974; Deluca et al., 1998) agree that the most significant footpath erosion is caused by horse-riding, as the heels of horses put much more pressure on the soil surface (total weight of the horse and horseman can be up to 500 kg-s), than skis, boot-soles of hikers or the wheels of a bicycle. Phillips, (2000), based on his investigation in the

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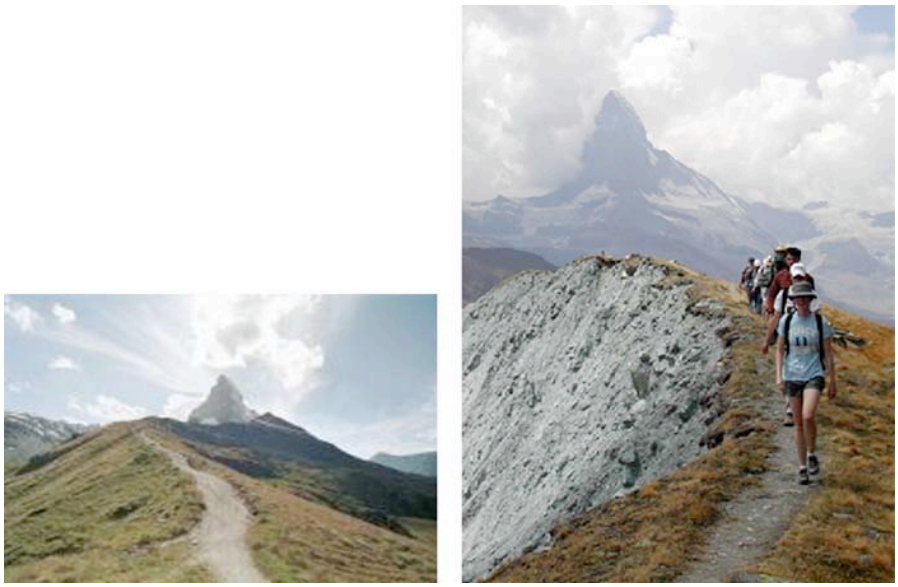
D'Entrecasteaux National Park in a West Australia, claims that the rate of bare soil surface has grown from 5.2% to 31% following the crossing of 300 horsemen. In case the trace is the same, horse-riding rather deepens the path than widens it (Harris, 1993).

Activity	Pressure on soil (g/cm^2)	Source
Skiing	28	Liddle, 1997
Touring (on foot)	297	Liddle, 1997
Mountain biking	2,008	Eckert (ed.), 1979
Horse-riding	2,800	Lull, 1959

Table 2 – Impact of recreation activities on the soil.

The most remarkable impact of erosion caused by recreation activities can be observed in highlands. These areas, because of their steep slopes, shallow soil cover, especially at regions receiving more precipitation are extremely susceptible. Under a colder mountainous climate at a higher elevation above sea level, the vegetation is more susceptible and tends to have a slower revival. Despite these unfavourable endowments, mountainous areas are under enormous demand. Following the melting of snow it becomes visible that long, bare soil strips without vegetation run on the slopes serving as downhill courses. Damage caused by grass-skiing not taking snow conditions into account is not significant yet.

In mountainous areas footpath erosion caused by hikers is an increasingly relevant environmental problem. Karancsi (2000) claims that in the nature conservation area of the Lake District attracting approximately 14 million visitors each year, footpath erosion often leaves behind huge scars observable even on satellite images in the landscape. According to observations carried out in several national parks in Britain, when the angle of slope of a tourist route reaches 10º, following the destruction of the natural vegetation cover, soil erosion starts on the surface. Other highland areas suitable for hiking are obviously exposed to similarly great effects (pictures 4 and 5).



Pictures 4 and 5 – Pathway leading to the Zermatt (Internet).

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According to the measurements of Hartley (1976), 5−10 tourists weekly can cause the reduction of the diversity of species by 10%, a potential increase in the extent of bare soil surface by 10 to 20% and in the compaction of the soil by 10 to 40%.

Footpath erosion is a problem not only for slope areas. Results of the research in the Great Forest Park in Debrecen well indicated the paths treaded from the direction of dwelling areas as well as the widened and new routes to make shortcuts (figure 9 – Kerényi, 1997, Martonné Erdős, 1997).

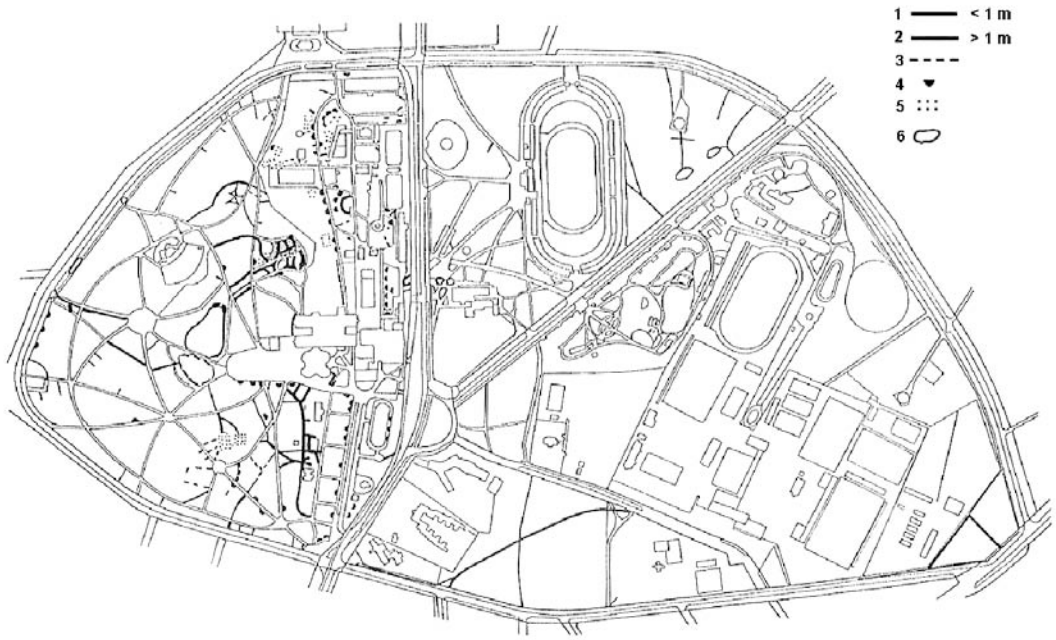

Figure 9 – The 'treading' map of the Great Forest Park in Debrecen (after Martonné Erdős, 1997, Kerényi, 1997). 1: Treaded path with a width less than 1 m; 2: Treaded path with a width exceeding 1 m; 3: Evolving treaded path; 4: Desolation patch around bench; 5: Small desolation patch; 6: Large desolation patch.

Recently, motorisation (also mentioned as Toyotarisation in the English literature – pictures 6 and 7) has been also seen as triggering sand and dust storms becoming more frequent in desert areas, as safari programmes with jeeps can also contribute to the disruption of the surface (Goudie, 2004).

Pictures 6 and 7. Toyotarisation in the Sahara (Internet).

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Over the past 50 years, the number of dust storms originating in the Sahara, where wind can move 65 to 220 million tonnes of fine sediment each year, have increased ten fold. Andrew Goudie (University of Oxford) claims that up to 3 billion tonnes of dust is blown around the world annually. The number of dust storms emanating from the Sahara have increased tenfold in 50 years and one major cause is the replacement of the camel by four-wheel drive vehicles as the desert vehicle of choice. Goudie blames the process of Toyotarisation - a coinage reflecting the near-ubiquitous desert use of Toyota Land Cruisers - for destroying a thin crust of lichen and stones that has protected vast areas of the Sahara from the wind for centuries. Four-wheel drive use, along with overgrazing and deforestation, was the major causes of the world's growing dust storm problem, the scale of which was much bigger than previously realised. Taking the whole Sahara, and the Sahel to the South, dust volumes had increased four to six fold since the 1960s. Countries worst affected were Niger, Chad, Northern Nigeria, Burkina Faso, and Mauritania, the research found (Goudie, 2004).

Erosion impact induced by hikers, mountain bikers, horsemen and motor-cyclists were studied by Wilson & Seney (1994) in one of the forested areas of State Montana, in the United States. According to their findings, motor-cycling, horse-riding and walking, in some cases have more erosion impacts than mountain biking. Chiu & Kriwoken (2003) also claims that there is no considerable difference between the footpath erosion impacts of hiking and mountain biking, however, the attitude of cyclists (e.g. side-slips), a humid or even too arid and less compact surface, a younger path increases the erosion impact caused by mountain bikers without any doubt. Thurston & Reader (2001) claim that the surface damaging impacts of mountain biking do not exceed the distance of 30 cm-s measured from the centre-line of the path (picture 8).

Picture 8 – Widening the path for mountain biking (Internet).

With the developing techniques and the growing popularity of healthy lifestyles, new tools are available for sportsmen of which use in most cases worsens the severe damage associated with the activity. Nordic walking originating from Finland in 1997 (picture 9), has become a popular fitness activity both in Europe and in the United States of America within a very short period of

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time. In order to achieve more efficient efforts and to exercise the bust, 'Nordic walkers' are helped by two sticks, furthering the disruption of vegetation and soil.

Picture 9 – Nordic walking in Tirol (Internet).

Camping is a very popular way of living with nature both in coastal and mountainous areas. Due to the high concentration of land use, the campers have significant treading and compaction impacts on the soil and vegetation on-site (Hammitt & Cole, 1998). Damage caused by those sleeping rough at susceptible areas with more valuable vegetation can be even worse.

Treading is also a permanent problem associated with launching watercrafts and coastal recreation (e.g. fishing, sun-bathing), that by becoming more intensive can lead to the devastation of the vegetation, and further to coastal erosion characteristic at coastal areas or even can quicken up this process. Madey (1994), studied the coast destruction activity of the River Merced in America's most visited national park, i.e. in the area of the Yosemite National Park, by earlier photos, aerial photographs and by measuring channel width and coastal erosion and found that recreation activities make a significant contribution to the reduction of the stability of the river bank. According to this, he described extremely high coastal erosion from campsites. Based on his research carried out in the Warren National Park in West Australia, Smith, (1998) came to the conclusion that in the surroundings of pathways leading from the camping sites to the bank of the River Warren, due to the destruction of vegetation cover, coastal erosion has become visually more significant.

The role of waves generated by the engines of watercrafts in coastal erosion was studied by Liddle & Scorgie (1980). Waves generated by watercrafts wash out the roots of coastal vegetation, leading to a decrease in the stability of the river bank, and erosion resulting in the further loss of coastal vegetation.

At coastal areas attracting a large number of visitors, not only the destruction of the vegetation should be blamed for the appearing or quickening abrasion. Disruption of the coastal sand dunes (e.g. as a result of motor-cycling, the use of sand-cruisers, pedestrians) reduces their puffer capacity also leading to denudation. Meanwhile, at the coastal areas of Barbados as a consequence of the various impacts of recreation, the protective features of corals do not predominate, also quickening up the process of abrasion (Archer, 1985).

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Damage to landforms, picking rocks

Climbing is a popular sport and free-time activity of those who like challenge and creativity. Determined cliff-climbers break up the rocks by their bindings knocked into the hillside. This may lead to the destruction of landforms in two ways. On the one hand, it may directly cause stone-falls, and on the other, due to the scars of the surface, it makes an indirect contribution to wind, frost and precipitation to have the cliff disrupted (Puczkó & Rátz, 2002).

Due to their unique landforms, archaeological relics, mysterious animal life, caves are popular destinations of tourism. The number of those visiting caves has increased during the last decade (Baker & Gentry, 1998). For example, the limestone cave of Derbyshire in Britain has 40,000 visitors each year, whereas the Baradla Cave, being a part of the world heritage from 1995 has approximately 200,000 (Székely, 1998). The Mammoth Cave in State Kentucky annually has about 2 million visitors. According to his survey, a total of about 20 million guests are registered in about 650 visitable tourist caves worldwide in one year. Deliberate damages are not common, although curiosity may make visitors touch the features resulting in their breaking-off. This damage to stalactites that may be seen insignificant can cease the growth of them for good, as it is hindered by the wax-like material found on human skin (Puczkó & Rátz, 2002).

Interested tourists often pick rocks for private collections or as a keepsake. At many occasions, even protected exposures are not favoured. Limestone blocks from the 'Great Plateau' in the Bükk National Park have been removed in great quantities in order to have them used as garden trim-stones (Martonné Erdős, 2001). Decay of corals also occurs due to the avocation of tourists.

3. DISCUSSION

Within the system of natural environment, the transformation of any elements, such as relief has an impact on the operation of the whole system, and can trigger several, mostly unfavourable transformations. Although, the extent of the impacts on environment, and within this on relief, related to recreation activities, compared to that of other sectors (e.g. industry, agriculture) is rather small. However because of the continuously growing popularity of these sectors, more attention should be paid to the planning taking the complicated relations of environment and activities into account, due to the discovering new destinations. In case, those looking for leisure and still intend to enjoy the natural environment, they will also have to become environmentally sound users. The impact of recreation activities on relief can come into force in many ways. Whether we talk about a study carried out at a given area or a comprehensive one also using previous results, the demand for a multidisciplinary approach resultant from the characteristics of this topic represents a great challenge to the experts.

4. CONCLUSIONS

In the past few decades interest in the environment has reached a peak as popular opinion has become aware of the extent of the human impact on natural systems (figure 10).

A proliferation of degrees has followed this wave of 'environmentalism', their focus has been on natural areas and the damage caused by human impacts. Environmental geomorphology is a special interaction of humans with the geographical environment which includes not only the physical constituents of the Earth, but also the surface of the Earth, its landforms and in particular the processes which operate to change it through time.

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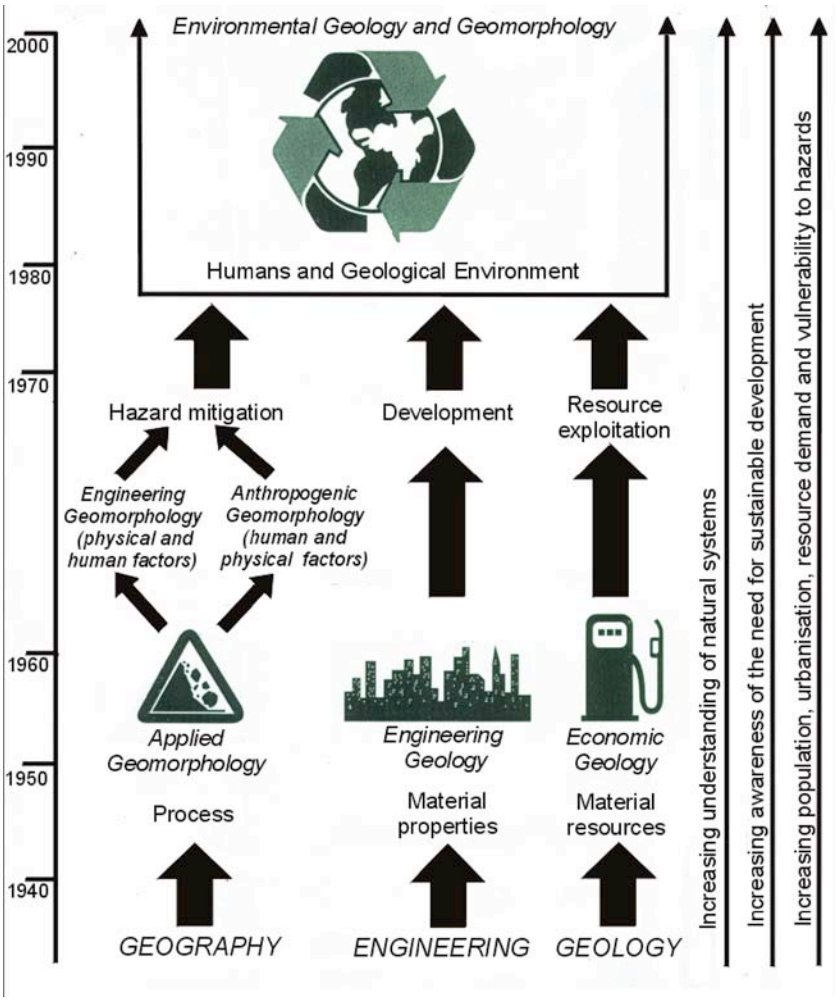

Figure 10. Development and differentiate of Earth Sciences (including Anthropogenic geomorphology) and its connection with the environmental problems (Bennett et al. 1999, modified by Dávid et al. 2006).

Since the 1970s in the research of the physical environment two, frequently intertwining trends are prominent. One of them investigates the changes in the natural environment induced by human economic intervention (which are often undesirable) along with their counter effects. The other aims at the quantitative and qualitative survey of the resources and potentials of the physical environment and the evaluation of also regionally varying geographical potentials. Anthropogenic geomorphology is a new approach and practice to investigate our physical environment, because in the eighties the more and more urgent demands from society against geography - ever more manifest due to the scientific-technical revolution - underlined the tasks to promote efficiently the rational utilization of natural resources and potentials, to achieve an environmental management satisfying social requirements and opportunities. At the same time, anthropogenic geomorphology is a new challenge for geomorphologists, since environmental problems have an effect on several branches of science. Anthropogenic geomorphology studies the huge – and more and more increasing – number of landform associations of extreme variety depending on the given way and aim of their creation, which have been made by the human activity (for example tourism and sport activities). The discipline also studies the surface changes induced by these forms; moreover, predicts the consequences of disturbance of the natural equilibrium, and makes recommendations for preventing damages. Therefore,

anthropogenic geomorphology can be also regarded as applied discipline, which helps to solve both social-economic as well as environmental and natural protection problems.

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