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UNIFORM TRANSNATIONAL ASSESSMENT OF THE ENVIRONMENTAL INDICES FROM THE ROMANIAN CATCHMENT AREA OF THE TISA RIVER

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ABSTRACT – The uniform transnational assessment of the environmental indices in the catchment area of the Tisa river aims at rehabilitating, protecting and conserving the environmental systems, as well as creating a *commonly strategic demarche concerning a sustainable spatial development*, based on integrated intersectorial approaches of environmental issues, viewed in their territorial dimension. The information necessary in underlining the current situation in the Romanian catchment area of the Tisa has been structured according to the following categories of analysed indices: sources of surface waters, resources of drinkable water and water supply resources, the risk of not reaching the environmental objectives, significant sources of water pollution (*punctual sources of pollution, diffuse sources of pollution, significant hydromorphic pressure*), the quality of water, significant sources of air pollution, soils affected by agricultural and industrial activities, nature protection and waste management.

Keywords: environmental components, water sources, protected areas, waste management, territorial development, ecological risk

1. INTRODUCTION

The Romanian catchment area of the Tisa river is in itself a spatial entity with a territorial structure that is morphoclimatically conditioned and is individualised by the existence of a general hydrographic network that directs energo-material fluxes from East to West. *The hydrologic component* from the analysed area is a favourable factor for the structuring and organising of the territory (habitats, infrastructure, human activities, etc.), with an important role in *the efficient management of the investigated space* (agricultural, industrial and residential exploitation, transportation, etc.) The hydro-morphological, physico-chemical and biological pressure, with final effects upon the structure of the hydro-ecosystems, can be considered, in most cases, a reflection of the manner in which the land is used, with a clear impact on *the quality of the water sources* (on the surface or underground sources).

2. THE REGIONAL CHARACTERISTICS OF THE ENVIRONMENTAL SYSTEM

The Romanian hydrographic area of Tisa river, with a surface of 71,100 km² (approximately 30% of Romania's total surface), which represents over 60% of the entire hydrographic system, covers 13 counties: Alba, Arad, Bihor, Bistrița-Năsăud, Cluj, Harghita (partially), Hunedoara, Maramureş, Mureş, Satu Mare, Sălaj, Sibiu (partially) and Timiş (partially). Its territory is divided into *three development regions* (North-West, Centre and West) and three *euroregions* (the Carpathian Euroregion, Dunăre-Criş-Mureş-Tisa Euroregion and Bihor-Hajdu-Bihár Euroregion).

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The detailed analysis of the territory of the Tisa catchment area revealed that this large area has all the chances for a favourable development, in a more alert or a slower pace, depending also on the exogenous factors. In most of the counties under consideration, the general level of development is superior to the national average. Due to its historical evolution, the area presents cultural diversity, doubled by a strong feeling of regional identity. It can be assessed that the Romanian catchment area of the Tisa river is "more European" than the rest of the country, since it benefited from *the effects of the cross-border cooperation*.

The diversified natural resources, the numerically and qualitatively important human potential (5 million inhabitants), the volume of foreign investments, the privatisation and the economic restructuring, accomplished more thoroughly than in other parts of the country, represent a good support for the future development by the extension of ***the transnational structures of the territorial functional connection*** within the whole hydrographic catchment area, adopted together by Romania, Hungary, Slovakia, Ukraine, and Serbia.

There are also differences between the 13 counties that tend to grow because of the lack of firm regional development policies. The obstacles in the way of the development of the region and of the growth in competitiveness can be surpassed by the elimination of the changes that negatively affect the quality of the environment and by the continuous amending of the state of the environmental factors. While Timiş, Cluj, Bihor, Arad, Sibiu are more dynamic counties, in others (Maramureş, Hunedoara, Alba, Mureş) there is a need for a more concentrated effort towards amending malfunctions and stopping phenomena with a negative impact on the environment.

Development policies cannot be efficient without taking into consideration the *water resources*. The concept of ***integrated management of the water resources*** implies, in contrast with the traditional handling of the water supplies, an integrated approach from a physical and technical point of view to the level of territorial planning and management. The integration level is the hydrographic catchment area, the natural body of the formation of the water resources. From this point of view, the evaluation of the global state of the water sources has been structured at the level of the *three major hydrographic areas* (Someş-Tisa, the Criş rivers and Mureş-Aranca), which allowed for the comparative treatment of the specific indices and the punctual identification of the existent malfunctions, towards an *integrated approach* to the environmental issues, focused on the equilibrium between the environmental components and the promotion of efficient measures for a territorial development:

- ***the analysis of the current state of the territorial system, of the evolution trends for the identification of the environmental risk factors*** and the limitation of any form of pollution of the natural receptors, due to unusual hydro-meteorological phenomena (dispersion of pollutants in the water, the area of extension and the qualitative altering of the natural receptors, including underground waters);
- ***the identification of the most efficient development policies for the environmental rehabilitation, protection and conservation*** and of the lines of strategic development in correlation with the intersectoral approaches viewed locally, regionally, nationally and transnationally;
- ***the identification of the main pollutants which trigger specific environmental problems*** (*eutrophication, heavy metal pollution, organochlorine components*) and defining the classes with impact upon the health of the population and the risk upon the safety of the inhabitants, the objectives of the national and public interest area and also the synergic effects of other emissions;
- ***the efficiency of the measures towards the limitation of pollutants in underground waters*** and of the prevention of the deterioration of the quality of the underground waters due to flooding and its effects on the ecological quality of the water streams.

3. CURRENT STATE OF THE REGIONAL ENVIRONMENTAL SYSTEM

The standard harmonisation of the different categories of indicators used in assessing the environment was accomplished based on statistics and forecast information provided by the official institutions (The Romania Water Directorate, The National Agency for Environmental Protection, regional and county agencies for environmental protection, The Pedology and Agrochemical Studies Offices – OSPA -, the water management systems – SGA – etc) and by accessing national and international databases (ESPON, EUROSTAT, ICPDR).

3.1. ***The air quality*** in the investigated area is not different from the whole country and it is considered as average. The main pollutant substances are CO_2, SO_2, NO_x and the solid particles generated by the human activities carried out in the analysed areas and by the heavy road traffic. In addition, there are also natural polluting sources (pollen grains, spores, aerosol and different allergens). The main **sources of CO_2** are the burning wastes from the energetic system, the non-industrial burning units, the burning ashes from the processing industry and the emissions from the road traffic, production processes, waste treatment and depositing. Figure 1 represents the environmental structural indicator "**total annual emissions of CO_2** (tonnes/capita)" for the period between 2002 and 2007, where we can notice an involution between 2002 and 2006 and a slight increase in 2007.

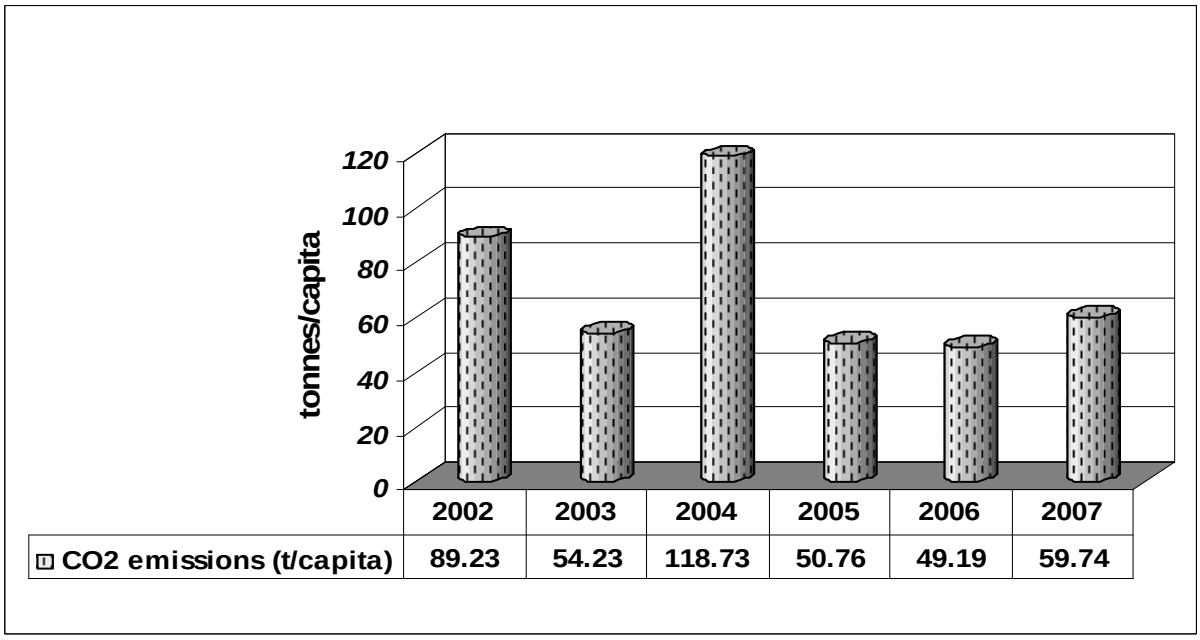

Figure 1. *Total annual CO_2 emissions (2002-2007) in the Romanian catchment area of Tisa river*

In 2004, there was a significant increase in the level of CO_2 emissions in Bihor county (76.96 tonnes/capita), due to the activities in 02 group *("Non-industrial burning units"*) and 03 group *("Burning ashes from the processing industry*"). The evolution of the annual emissions of the **greenhouse effect gases**, expressed in CO_2 Eq, had a decreasing movement in the analysed period (2002-2007). Romania is to reduce the emissions of CO_2 Eq by 8% in the first engagement period (2008-2012), as compared to the reference year 1989. The **SO2 concentration** in the atmosphere comes from the sulphur and carburant used in the combustion processes, at the thermal stations and in the industrial sources. The major sources of SO2 pollution are: *the thermo-electrical stations using coal or oil as fuel (65%), petrol refineries, steel plants, iron foundries, non-ferrous industry, etc. (30%) and transportation (5%).* The frequent overtaking of the maximum accepted concentrations at

the air quality indicators are due to the pollution by ***heavy-metal dust*** that comes from the settling ponds and the waste dumps resulted from the deserted mining areas and also to the pollutant emissions from the fuel combustion of the technological processes, from thermal stations that produce heating and hot household water, as well as from road traffic. It is useful to find appropriate solutions in order *to mitigate the pollution of the atmosphere* by regulations that could lead to *the improvement of the air quality*. These should be determined by measures regarding the improvement of the phonic regime, of the vegetation and soil (planting phono-absorbant vegetation, deviating hard traffic, clearing the road traffic, enlarging the green surfaces, etc.) In undertaking these regulations, there has been an interest in their harmonisation with the European Union requirements, especially **Directive 96/61/EC** regarding *the prevention, the reduction and the integrated control of pollution*, which mainly refers to *the pollution caused by industrial and agricultural activities*.

3.2. ***The water quality***. The main source of water pollution is the wastewater as result of different human activities. The pollutants in this wastewater are, in most cases, very toxic substances (*cyanides, sulphur hydrogen, phosphorous compounds, manganese, magnesium, oil products, inorganic compounds, sometimes radioactive compounds,* etc.) However, the waters in these analysed regions are mainly comprised in the second quality category (45-63%) and very few in the first and third quality categories (Figure 2). **The major sources** of *permanent surface water pollution* are the industrial activities (extraction industry, mining, wood exploitation and processing, chemical industry, manufacture of basic metals and machinery, electricity, etc.), agro-zootechnical activities and also the unauthorised and misplaced waste dumps, especially the mining waste dumps (Table 1). There is a noticeable *critical situation of the aquiferous water table* in several areas of the Romanian catchment area of the Tisa river. Although in the recent years, the intensity of the human impact has decreased (the reduction of the industrial productivity and of the animal raising led to the decreasing of pollutants in the natural receptors) and more measures for the purification of the wastewater have been taken, the quality of the underground waters is still unsatisfying because of their slow self-purification rhythm.

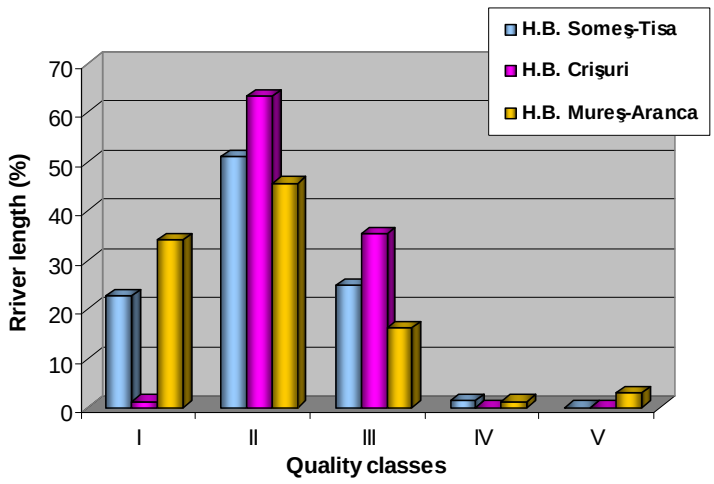

Figure 2. *The share of water streams in quality classes, according to the ecological state (2009)*

The natural regime of the underground water has gone through several qualitative and quantitative changes, because of using water as a source of drinking water and industrial water for the population and because of the pollution factors (natural or anthropogenic). *The forms of multiple depreciation of the quality of underground water* in the Romanian area of the Tisa river were identified in the rural built-up areas, where, because of the lack of any hydro-edilitary equipment, the liquid wastes get underground. **The wastewaters** evacuated from the water treatment stations do not respect the current regulations, being insufficiently purified. There is *a low treatment capacity* at the stations that serve animal raising activities, mining, wood exploitation, etc.

Table 1. *Industrial sources with a potentially high degree of accidental pollution in the Romanian catchment area of the Tisa river*

No.	Name	Location	Watercourse	Risk Index ≥ 5.0
1	U.P. Săsar (iaz)	Baia Mare/Maramureş	Lăpuş-Someş	8.6
2	E.M. Abrud (iaz)	Abrud/Alba	Arieş	8.4
3	E.M. Coranda (iaz)	Certej/Hunedora	Mureş	8.1
4	E.M. Baia Sprie (iaz)	Baia Sprie/Maramureş	Lăpuş-Someş	8.1
5	E.M. Rodna (iaz)	Rodna/Bistriţa Năsăud	Someşul Mare	8.1
6	S.C. Devamin S.A. Rabita (iaz)	Brad/Hunedoara	Crişul Alb	8.0
7	E.M. Roşia Montană (iaz)	Roşia Montană/Alba	Arieş	7.9
8	E.M. Băiuţ (iaz)	Băiuţ/Maramureş	Lăpuş-Someş	7.6
9	S.C. Devamin S.A. Fânaţe (iaz)	Ştei/Bihor	Crişul Negru	7.5
10	S.M. Borşa Colbu (iaz)	Borşa/Maramureş	Vişeu-Tisa	7.5
11	S.C. Mining S.A. (iaz Aurul)	Baia Mare/Maramureş	Someş	7.4
12	E.M. Turţ (iaz)	Turţ/Satu Mare	Tur-Tisa	7.4
13	S.M. Borşa Novăţ (iaz)	Borşa/Maramureş	Vişeu-Tisa	7.3
14	S.C. Bicapa S.A. (iaz)	Târnăveni/Mureş	Târnava Mică	7.0
15	E.M. Baia de Arieş (iaz)	Baia de Arieş/Alba	Arieş	7.0
16	S.M. Cavnic	Cavnic/Maramureş	Cavnic/Lăpuş/Someş	6.9
17	S.C. Cominex (P)	Aghireş/Cluj	Someşul Mic/Someş	6.0
18	S.C. Agroconsum (P)	Bonţida/Cluj	Someşul Mic/Someş	5.6
19	S.C. Cuprom S.A	Băiuţ/Maramureş	Săsar/Lăpuş/Someş	5.1

Source: The National Management Plan – A synthesis of the management plans at catchment areas level/ hydrographical areas (2009)

This leads to the discharge of high quantities of potentially polluting substances and to the increase of *the risk of accidental pollution* in the cross-border Tisa catchment area. Another important aspect is *the efficient use of the water resources*, in the households and in industry, an issue that can be solved by a good management of the supply. According to the position document signed between Romania and the EU referring to "Environment" (finalised in December 2004), the whole territory of Romania is considered as *area sensitive to nutrients* (total nitrogen and total phosphorous), based on the identification criteria in *Appendix II* of **Directive 91/271/EEC** *regarding the treatment of urban wastewater*.

3.3. ***The soil quality*** comes from the badly run interventions and the inadequate agricultural practices, from the introduction in the soil of toxic substances to the accumulation of toxic products resulting from urban and industrial activities. Because of these activities, especially those from mining, there are lands that have been withdrawn entirely from the agricultural circuit. Near settlement ponds, waste dumps, coast galleries, ore preparation plants and quarries, the soil has been structurally modified by an addition of pool sludge and it has been harmed by the "infiltration-diffusion" of different chemical pollutants (*zinc, copper, lead, iron, sulphates, cyanides*), which can be seen in the environmental system of the investigated area as a series of dysfunctions, with long-term negative effects: *the appearance of polluted water environments, the disappearance of the aquatic biodiversity, the aggression and destruction of the natural habitats, the degradation of vegetation, the advanced soil erosion, the drastic decrease of agricultural productivity, the long-term landscape transformation, etc*. **The chemical pollution** has very aggressive effects on the soil with heavy metals (especially Cu, Pb, Zn, Cd) and sulphur dioxide, identifiable especially in Baia Mare, Zlatna and Copşa Mică. The pollution with oil and salt water from the petrol exploitation and transportation is noticeable in Suplacu de Barcău. During the ***environmental reconstruction efforts*** carried out in the Romanian

catchment area of the Tisa river, two main measures were considered: *general measures* (the reanalysis of the structure of utilities, establishment of the measures for preventing and reducing soil degradation, the formation of some improvement perimeters, etc.) and *specific measures* (agricultural ones: the improvement of the physical state of the soils by deep soil aeration, the correction of the soil reaction, the improvement of the reserve of organic matter and of the nutrients, the prevention and the reduction of the heavy metal chemical pollution of soil – sulphur, fluoride, oil waste, pesticides, etc.).

3.4. *The management of urban (domestic) waste*

The activity of waste management is performed according to the national, regional and county strategies and plans and by respecting other commanding documents. The issue of waste in the Tisa catchment area is systemically and causally approached, following the technological stages of the waste cycle: production or generation, collection, transport and disposal (storage) of waste.

a) *Production or generation of waste*

The basic data concerning the generation of urban waste can be obtained by using two methods: they are either provided by the sanitation service operators and are based on estimations or on weighing the waste at the storage site, or assessed according to the generation indicators, with the risk of errors. The waste generation ratio is an indicator with a high generalization value that expresses the average amount of waste produced by an inhabitant daily or annually. The value of the urban waste generation ratio, and implicitly its evolution, is mainly determined by the economic changes (the evolution of the GDP), the changes of consumption habits, the changes of production technologies, the level of education, etc. As for the evolution of the domestic waste generation ratio, an annual increase of 0.8% has been taken into consideration, starting from the generation ratios of 2005, which means 0.9 in the urban areas and 0.4 kgs/inhabitant per day in the rural areas.

Table 2. *The collected domestic waste generation ratio according to the urban/rural areas (kgs/inhabitant/day)*

Year	2005	2006	2007	2008	2009
Urban areas	0.90	0.91	0.91	0.92	0.93
Rural areas	0.40	0.40	0.41	0.41	0.41

The composition of waste has a great importance because the capitalization potential of waste is defined according to it. Moreover, this indicator may represent a decisive factor in the setting up and the size of the waste collecting, transport and disposal systems. The exact composition of the total amounts of generated or collected waste is difficult to establish. Based on estimates related to the type of producer, as well as on individual determination of domestic waste composition, the following features characterize the catchment area of the Tisa River according to the urban or rural areas of origin:

Table 3. *The average composition of domestic waste*

	Organic mass (%)	Wood (%)	Plastic (%)	Metals (%)	Glass (%)	Paper and cardboard (%)	Others (%)
Urban area	61	1	16	5	3	7	7
Rural area	55	1	5	4	2	4	29

The statistical data indicate that the largest amount of urban waste (higher than the regional average) is generated in Arad, Hunedoara and Sibiu counties (more than 550 kgs/inhabitant per year). In addition, the average generation ratio of 445 kgs/inhabitant per year is higher than the national average ratio of 364 kgs/inhabitant/year.

b) ***Waste collection and transport***

The activities of urban waste collection and transport are organized differently in the region according to the size of the settlement, the number of people serviced, the equipment of the companies and their form of property. The settlement sanitation service (urban waste pre-collection, collection, transport and storage) is developed under the control, leadership or coordination of the local public authorities.

The sanitation activity can be performed by:

- direct management of the local public administrative authorities, by means of specialized departments organized within the local council;
- commissioned management, when the local public administrative authorities may ask one or several public service operators to perform these services.

In the more densely populated urban areas, there are private sanitation companies which develop their activity based on concession contracts. Apart from these operators, in some settlements there are companies belonging to the local authorities that collect all types of urban waste. In the rural areas, the collection activity is not performed in all places due to the higher costs caused by the larger distances to be covered and the low level of the population income.

The coverage degree of sanitation services, reflected in the collection degree of domestic waste, has registered a constant increase during the latest years, so that it is estimated at about 75% at regional level. The degree of coverage is almost 100% in the case of urban population. However, there are problems registered at the level of rural communities which have a coverage degree below 50%, either due to isolation or to the low level of population income.

Within the analysed territory, the manner mostly used for the domestic waste collection is mixed unselective collection. The selective collection of domestic waste is not yet generalized and it is mainly performed only within pilot projects. The selective collection started up only in the large urban centres, both by collection at source in pilot areas and by containers located in the public space, in most cases for paper-cardboard and plastic material packing waste. The transport of waste to the storage sites is made by specific means of transportation, such as compacting garbage truck with a capacity of 12 mc, container transporter with a capacity of 5.4 mc, tractor with trailer having a capacity of 6.3 mc, auto-swinging trailer with a capacity of 8.6 mc.

c) ***Disposal of waste***

The storage of waste represents the final channel of waste treatment and disposal and the last stage of the waste management cycle. At present, the largest part of the urban waste generated in the analysed area is disposed of by storage. Storage represents the method most widely used in Romania for the disposal of urban waste.

Waste deposits are classified as following, according to the nature of the waste stored: deposits for dangerous waste (class A), deposits for non-dangerous waste (class B), deposits for inert waste (class C). Within the analysed area, there are more than 100 inadequate deposits for non-dangerous waste (class „B") in urban areas. The Government Decision no. 349/2005 concerning the storage of waste established the dates when they will cease their existence.

In conclusion, the present situation regarding the waste management in the catchment area of Tisa River may be characterized by:

- a coverage degree of sanitation services for less than 75% of the total population of the Tisa catchment area;
- the lack of extensive programmes for the separate collection, at source, of recyclable waste;
- the lack of waste treatment installations (sorting stations, dating stations) aiming at minimizing and recycling the amounts;
- the operation of several inadequate urban deposits and of very many inadequate rural pits.

With regard to this situation, the following objectives are established:

- a coverage degree of 100% both in urban and rural areas for sanitation services;

- the separate collection of recyclable waste at the source and the building of sorting stations able to recycle more than 200,000 tonnes of waste;
- the treatment of more than 350,000 tonnes/year of biodegradable waste in 2015 and of more than 750,000 tonnes in 2020;
- the storage of waste in controlled deposits only.

In order to achieve these objectives, it is necessary to implement an integrated system of domestic solid waste management (made up by the county and regional subsystems, under development), supported by an investment plan including the following components:

- a system of separate collection by fractions: paper and cardboard; plastic; metal and wood; biodegradable waste; residual waste;
- the separate collection of green waste from individual households or other dwellings with gardens and green spaces;
- the building of sorting stations to ensure the raw material for the recycling of amounts established by targets;
- the building of dating capacities for the biodegradable and green waste to achieve the reduction of deposited amounts;
- the closing of all the garbage pits in the rural settlements;
- the closing within the established dates of the last urban domestic waste deposits.

3.5. *Natural patrimony*

The unitary evaluation of the natural patrimony in the catchment area of the Tisa river is inevitably tributary to the indices formulated in the working draft, common to all the partners implicated in the project. The aim was to monitor the natural capital from a quantitative point of view, having in mind that all that goes under the influence of the national and international classifications takes advantage of a higher qualitative status.

The indices viewed are as follows:

- NATURA 2000 sites;
- Protected areas according to the National law;
- National Ecological network;
- Sites inscribed on the World Heritage List;
- Sites with international significance (RAMSAR, Nature and Biosphere reserves).

Not all the indices used in the working draft could be operated. Thus, for instance, the National Ecological network has no correspondence in the Romanian legislation. The others have been rendered according to the previous understanding between the partners of the project.

The requests regarding the indices above demanded an emphasis of these indices under the form of lists or of polygon-type themes, represented cartographically. For some of the categories, there was a representation under the form of graphs that was intended, graphs that should express the ration between the surface (expressed in hectares) of the categories of protected areas and the surface of the monitored territory unit (especially the case of NATURA 2000 sites). There was also the intention for a graphic representation of a global index that includes the total number of categories of the protected areas. The sum of the surface of all the categories of the protected areas, compared to the surface of the Romanian catchment area of the Tisa river, formed an index called Level of ecological stability in the region.

Some of the difficulties faced in the collection and organisation of all data are presented, shortly and retrospectively, in the present paper. Although the qualitative aspects were not taken into account, some dysfunctions specific to the Romanian management system of the protected areas are also presented.

Firstly, it is necessary to mention the different approach to the data organisation referring to the categories of protected areas, on the web sites of the county and regional agency of environmental protection. There is no unitary system as far as the interface is concerned or the standardisation of the categories of the protected areas. Moreover, the information available is not updated: the newly

declared areas or the extension of the old ones is not found in the inventory of the regional or county natural patrimony. The problem of updating is the same also in the case of the database provided by the National Agency for Environmental Protection. It is about the shape files with polygon-like themes for the main categories of protected areas.

Secondly, there were difficulties in getting the right surface for a NATURA 2000 site. The list contains information about the administrative territory units that overlap and is expressed in percentage referring to each unit. There is no list comprising the whole and expressing in specific measurements the surface that rests to each site. This surface can be obtained from the polygon-type theme attached to NATURA 2000 and it is possible not to be up to date.

Then, it was difficult to render the index that comprises all the categories of the protected areas and compare them to the whole surface of the Romanian catchment area of the Tisa. Some of the categories are comprised into others and thus, the counting can compromise the reality of the situation.

Finally, the limits of the protected areas often go beyond the limit of the studied area. For those categories that are expressed only as total surface and do not have a cartographic representation, it was difficult to identify the surface of the analysed area.

As for the dysfunctions specific to the Romanian management system of the protected areas, only several considered suggestive are mentioned in the following:

- the lack of a correct management of the protected areas with a special anthropogenic impact and the lack of funds directed to this task;
- conflicts with the land owners and the forest owners (natural persons, mayor houses, co-owners etc) inside the protected areas;
- the existence of nature reserves with no clear location or limits;
- the necessity for an economic development and for the county/inter-county infrastructure leads to the emergence of large projects with negative impact upon biodiversity and the integrity of the protected areas;
- because of the human impact (house and hotel building sites, disorganised tourism, lack of environmental education, cleared forests, etc.), the expansion areas of many endemic species, rare or endangered, has become increasingly smaller as compared to previous years, some of the species being on the verge of extinction, although they are protected, nationally or internationally.

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