APPLYING OF THE ENVIRONMENTAL ASSESSMENT MODEL IN THE WATER POLICY PLANNING

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Abstract

The paper presents a multidisciplinary expert system which can be applied in the field of ex-ante assessment both of regional development programmes and river basin management planning. The research has been introducing the so called "complex knowledge space" model what is the further improvement of the environmental management model which was presented during the Conference on Environmental Engineering Education and Training organised by Wessex Institute of Technology in 1996.

The system analysis in the model contents beyond the indication of the state as well as the utilization of the environmental resources also the investigation of the relevant rules and the evaluation of the mutual effects with other development programmes in a certain region, eg. on a river basin.

The presentation is closing with examples of applications.

Keywords: *regional development; river basin management; complex knowledge space model of environmental assessment; water policy integration into sector policies; relevance analysis of rules and other development programmes*

1 Introduction

The river basin management planning essentially refers to the development of the complex utilization of environmental resources. Its information system, databases and indicators can be utilized in regional planning as well as the planning and ex ante evaluation of regional development programs. The common methodology is the Strategic Environmental Assessment (SEA). In addition to presenting the application of SEA, our paper reviews the environmental assessment model and the relevant Hungarian information to be loaded into the complex knowledge space of this environmental assessment model.

The complex knowledge space model is further improvement of the environmental management model which was presented during the Conference on Environmental Engineering Education and Training organized by the Wessex Institute of Technology in 1996.

We believe that the environmental assessment expert system, which is a strategic environmental assessment tool, is suitable, and offers mutual support, for both regional development and river basin management planning purposes.

2 Water management policies; EU Water Framework Directive

The European Community has implemented a series of water protection laws since the mid 1970s. However, the condition of waters did not improve as expected, indeed, in certain cases become even worse. In order to implement the new water policy of the European Union, which was developed by the middle of 1990s, the Water Directive was elaborated as a result of a nearly 5 year long debate. The EU Water Framework Directive 2000/60/EC (establishing a framework for Community action in the field of water policy) took effect as of the 22nd of December 2000.

The implementation tool of the Water Framework Directive is the river basin management planning. The river basin management planning is not merely a water quality improvement program, but the largest existing environmental program of the EU and even the world. It is being aimed at achieving that all the environmental and economic activities within the borders of natural river basin support a sustainable environmental status and resource management. This is indicated by the good - even ecologically good - water quality. It is therefore clear that the river basin management planning to be performed due to the common determination of the EU

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shall be connected with regional developments. Development programs, however, call for indicators, because it is impossible to control the achievement of goals without relevant indicators.

2.1 The content of river basin management plans

- General description of the characteristics of the river basin districts. " Summary of significant pressures and impact of human activity on the status of surface water and ground water.
- Identification and mapping of protected areas and waters used for the abstraction of drinking water.
- Mapping of monitoring networks established for the observation of water status.
- Mapping in geographical information system.
- List of environmental objectives.
- Detailed description of information related to the unfeasibility of original objectives.
- Summary of the economic analysis of water use.
- Summary of the programs or programs of measures.
- Information to be provided about pollutants and indicators that have thresholds associated with.
- List of programs and plans (availability of integration).
- Summary of the public information and consultation measures taken.
- List of competent authorities.
- Any documents prescribed by other laws to be included into river basin management plans.

Based on the above, the human impacts and water management issues affecting the given river-basin shall be assessed and program of measures shall be developed to attain ecological objectives (such as good status or good potential). The river basin management plans including the programs of measures shall be published and submitted for a wide-scale public consultation.

2.2 Integration of water policy into the sector policies

Between 2000 and 2010 key attention was paid to the integration of water protection and water management policy into other sector-policies, meaning that the EU water protection policy was extended by way of integration with other water management policies and sector policies, such as:

- Integration of inland waterway transportation policy and water protection policy (outcome: Joint Statement on sustainable waterway development).
- Integration of Common Agricultural Policy and water protection policy (outcome: Rural Development Plans).
- Integration of energy/renewable energy and water protection policy.
- Sustainable hydraulic power generation.

2.3 Policy documents

In order to implement the new policies, rules and other law papers were established:

- 2007: Flood-risk management directive.
- 2008: Marine Strategy Framework Directive.
- 2009: Drought and water shortage strategy and work program.
- 2010: Climate policy and strategy.

The existing water protection directives have also gone through some development:

- 2006: Directive on ground waters.
- IPCC Directive had been amended four times until 2008.

The Environmental Impact Assessment (EIA) Directive, Strategic Environmental Assessment (SEA, 2004) and the building of NATURA 2000 network are of increasing importance.

The role of integration in the enforcement of water protection aspects is also reflected in large-scale development programs:

- Baltic Sea Region Strategy of the EU. Objectives: to protect the water body of the sea and protect waters all over the sea basin (in accordance with the provisions of the Water Framework Directive and Marine Strategy Framework Directive). A new water protection policy element is the protection of marine waters.
- The Danube Macro-Region Strategy of the EU. Objectives: to protect water quality in Danube river basin and protect the water along sea-shores in line with the provisions of the Water Framework Directive.

3 Introduction of the environmental complex knowledge space and the SEA as an application thereof

There were many efforts in the last two decades to analyze the relations between the environment utilization and the change of resource kit and environmental status. This is reflected in the development of environmental problem space model (Bulla, 1989), the model of environment management and analysis (Bulla, 1996, 2004), the OECD model (PSR, PSIR), the UN model (UN National Statistical Division, 1997) and the EU model (DPSIR) (EEA, 1997).

With view to these models we attempt to outline an expert system which includes all the potential and considerable components of analyses. The framework of the system resembles the ”problem space”, where intersections of environment utilizations (loads) and changes of environment status (i.e. the changes of natural resource kits) are the stages or platforms (as called in Information and Computing Technology) of complex and multidisciplinary impact analyses, which inherently comprise ecological, economic, technological, social, etc. aspects. A bit more specifically, this means that the analysis of impacts and triggered impacts and interactions need heterogeneous sets of technical-economic-legal data and information, and, in addition to the inter- and multidisciplinary management of disciplinary-structured knowledge bases, the interoperability shall also be ensured - these efforts all call for IT applications and application developments.

In addition to creating meta databases we also need to analyze the relations of these databases. It is recommended to create virtual platforms to overview the conclusions and visualize the results. This is increasingly less, or even not, possible without the use of 3D or, recently, virtual 4D IT applications. So the complex space of environmental analysis shall include relevant information to all environment statuses, environment loads and rules, plans and programs of environment utilization. This can be achieved by structuring the information into ”knowledge bases” (Figure 1, 2).

All policies, sectorial or regional development programs shall be implemented in this space, or its feasibility shall be studied in the system of rules that prescribe the environment status, the degree of resource utilization and/or load bearing limits. The analysis of interactions with other plans and programs and positive and negative synergies shall also be performed in this space. For this reason the ”cassettes” of layers created by rows and columns of the spatial matrix of the complex problem space shall be filled with knowledge bases. The initial contents of knowledge bases are shown in the recommended lists of this chapter - these contents shall, naturally, be regularly maintained, selected and updated.

The recommended elements and the establishment of the knowledge base can be summarized as follows:

- selection and creation of (some) indicators depending on the objective to be presented and availability of basic data;
- overview, determination of the relevance of control(s), review of conclusions;

review of different (development) programs, determination of relevance, review of consequence(s) and positive/negative synergies.

In the following part of the chapter we give an overview of the factors of environmental resource management, i.e. the knowledge base of the complex space.

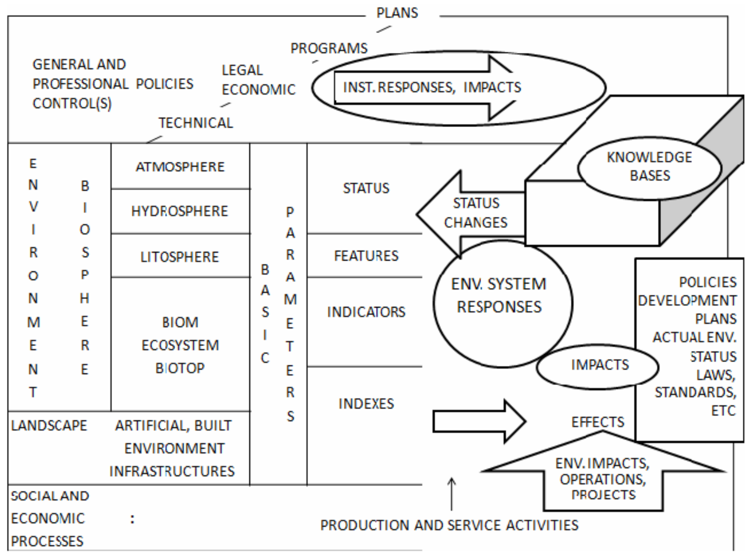

Figure 1: The complex environmental problem space (Source: Bulla, 2010)

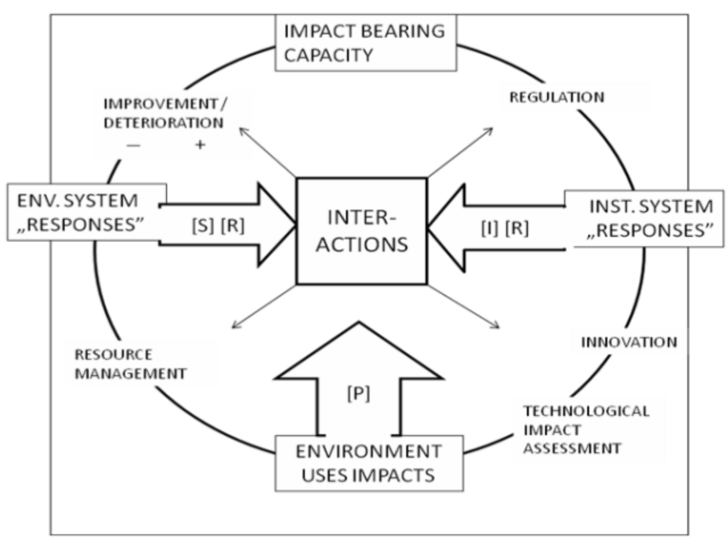

Figure 2: Environmental analysis - a multidisciplinary analysis of factors in the complex knowledge space [KxTT] (Source: Bulla, 2010)

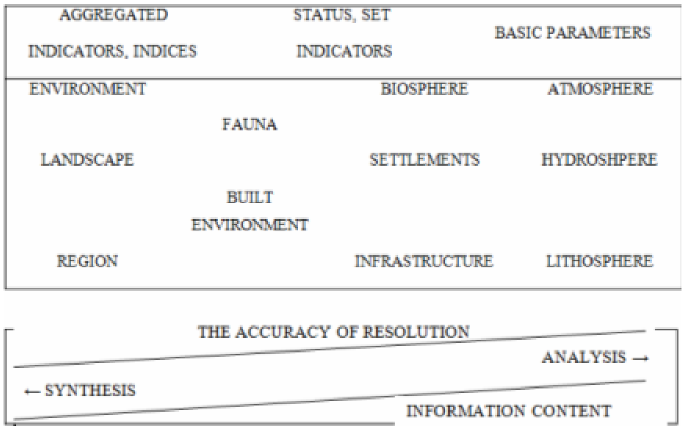

Figure 3: Complexity of indices (Source: Bulla, 2010)

3.1 Components of the environmental status and resource kit (∼Status)

The resource kits, which represent the highest level of integration, and the complex indices related to their use, i.e. the datasets building up the status indicators and listing the essential parameters of the ”elements” forming the systems can be organized into a scheme where the development of indicators and the increase of their accuracy can easily be tracked, ranging from ”impressions” through measured data to the complex indicators supported by model calculations (Figure 3).

3.2 The effects of environment utilization and impacts

The study of partial operations by means of essential status indicators is unsuitable for a decision making analysis and forecast of the changes in large-scale environmental resource utilization (e.g. development programs, economic structural change, etc.) This technology represents the level of environmental impact assessments (EIA). The analysis of complex processes, however, calls for indicators that include a set of aggregate information. Based on the review of available attempts (Verbruggen 1997., OECD 1999, 2004) we propose the use of the following six multi-component aggregate indices:

1. the change of land use;
2. use of waters (and waste-waters);
3. the change of energy use;
4. generation of (excess) transports;
5. the quantity and composition of waste;
6. the degree of biodiversity (change).

The proposed indices are (may be) suitable for the characterization of both the utilization as well as the change in stock and status (Figure 4). This is a key benefit in the execution of compact analyses characterized by high information density.

3.3 Components of the development of environmental resource utilization - controls, plans, programs (∼Response)

The aim of the analysis/evaluation is to review the interactions of environmental systems consisting of, or formed by, different activities, interventions and individual or all of the environmental elements on the affected area. This method and the technology developed by assembling the measuring, observing, data collection (transmitting), information producing and processing, analyzing-evaluating phases to be developed for the application thereof enable the generation of forecasts, the elaboration of known alternatives as well as regulation and development interventions needed for the implementation thereof.

USES	IMPACTS (EMISSIONS)	SETS, STATUS (IMMISSION)
Use of land	to ground	Use of land
Use of water	to water	Soil quality
Use of energy	to atmosphere	Water resource, quality
Transports	to biosphere	Inhabited environment
Waste	to built environment	Biodiversity
Biodiversity		

Figure 4: Indicators of environment utilization and impact (Source: Bulla, 2010)

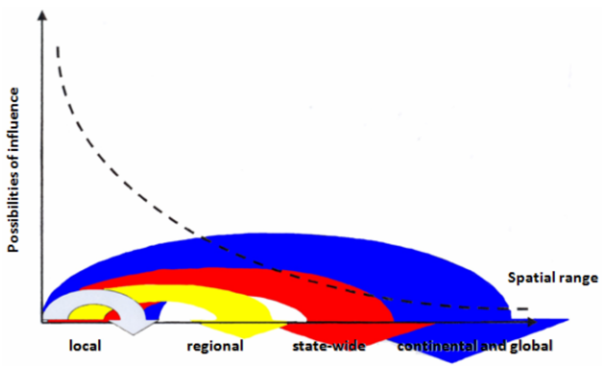

Figure 5: extent of environmental effect & possibilities of influence (Source: Bulla-Flachner, 2003)

The criteria of State Evaluation of Environment (SEE) shall include the definition of the term environmental element or systems as well as the term and extension of the area affected. The analysis of the status of fauna of a given area (including the human) shall cover the study of land and aquatic ecosystems as well as the atmosphere, while in the case of landscape or inhabited areas, the scope of analysis shall cover the artificial (built) elements of the environment as well as the change of resource kits, too.

The resolution of analysis and, in turn, the accuracy and feasibility of casual exploration of (inter)actions will depend on the size of the area selected. In line with the international experience, the attention shall be focused on local and regional level, where development policies, actions and effects can actually be analyzed. Although global reports can be made on changes, the actual decision-making, implementation, effect analysis and/or forecasting processes should be based on local or regional (!) level (Figure 5).

These considerations are applied by the Hungarian procedures established and institutionalized for revealing the economic relations between the environment - society - economy, such as: analysis of assessment (A.A, Act LIII of 1995), strategic environmental assessment (SEA, Gov. Decree 5/2005), environmental impact assessment (EIA, Gov. Decree 314/2005) (Figure 6).

EXTENT	MACRO		MEZO	MICRO
DRIVING FORCES OR IMPACTS	SECTORAL AND REGIONAL POLICIES	PLANS PROGRAMS	PROJECTS	PARTIAL TASKS
ANALYTICAL PROCEDURE	AoA	SEA		EIA

Figure 6: The relation between development policies and assessment analyses (Source: Bulla, 2009)

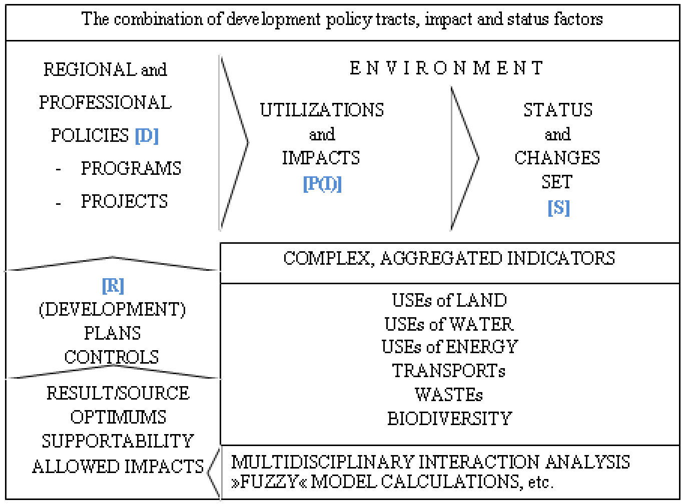

Figure 7: The combination of development policy tracts, impact and status factors (Source: Bulla, 2010)

3.4 The combination of development policies and factors of environment utilization

The proposed aggregated indices are (may be) suitable for the analysis of both the environment utilizations and impacts as well as the characterization of change in stock and status. Figure 7 was prepared to introduce this analysis model.

4 Indicators of sustainable development with regards to water

Developments in a given area (e.g. industrial, agricultural, infrastructural, energy, traffic, waste management projects) exert extra load (such as more kilometers driven, transportation of more waste-water), which, in turn, changes the earlier material flows (e.g. resource use, emissions) typical to the given area. This affects the environment, making changes, in turn, to the status of individual environmental elements (earth, water, atmosphere, fauna, inhabited area, landscape). We are able to characterize or indicate the change of impacts (so called "consequence-type impacts") caused by the extra load from project (so called "casual impacts"): we can define to what extent will these change (increase/decrease) (on the given geographic location). The "consequence-type impacts" can be categorized into several groups like the use of water, land, energy, waste-water generation, waste generation, change of biodiversity. Impacts can be characterized by several parameters. With regards to environmental impact assessments and strategic environmental assessments, the Hungarian laws prescribe the assessment of several parameters for characterization of impacts and status. The question is how much and how detailed information these parameters can provide about the sustainability of a development.

Chapter 40 of the Agenda 21 calls for development of sustainable development indicators. A number of countries and international organizations (both governmental and non-governmental) are developing indicators in response to this request.

Currently, there has been no internationally accepted system developed for the indicators of sustainable development. In recent years many different types of indicator-systems were developed globally (e.g. systems used by UN or EU institutions such as the Statistical Office of the Economic Cooperation and Development OECD, own systems of individual countries). Whether numeric or projected on maps, these complex systems consist of many parameters.

In the following we give a brief and limited overview of the indicators of sustainable development created over time, with special regards to water-related indicators.

4.1 Indicator set of OECD, 1993

The OECD distinguished three broad types of indicators:

- Indicators of environmental pressures.

- Indicators of environmental conditions.
- Indicators of social responses.

Table 1: A selection of OECD candidate indicators regarding to freshwater (Source: OECD, 1993)

	Indicators of environmental pressures		**Indicators of environmental conditions**		**Indicators of social responses**	
Eutrophication	Emission of P and N in water and soil	L	BOD/DO, concentration of N and P in inland waters	S/M	% of population connected to biological and/or chemical sewage treatment plants	
	N from fertilize use and from livestock	S			% of population connected to sewage treatment plant	
	P from fertilize use and from livestock	S			User charges for waste water treatment	
					Market share of phosphate-free detergents	
Acidification			Exceedance of critical loads of pH in water and soil	M/L		
Toxic contamination	Emission of heavy metals	M/L	Concentration of heavy metals and organic compounds in environmental media and living species	L		
	Emission of organic compounds	L	Concentration of heavy metals in rivers	S/M		
	Consumption of pesticides	S/M				
Urban environmental quality			Ambient water condition in urban areas	M/L	Water treatment and noise abatement expenditures	S/M
Water resources	Intensity of use of water resources	S	Frequency, duration and extent of water shortages	M/L	Water prices and user charges for sewage treatment	M

Legend: S = short term (current available), M = medium term (data available, but a supplementary effort still needed), L = long term (basic data not available, conceptual efforts needed)

4.2 Indicator set of United Nations, 1996

Building on many national and international initiatives aimed at developing and using indicators, the Commission on Sustainable Development in 1995 adopted a work program on indicators for sustainable development. The work program includes an initial set of 132 indicators.

Indicators have 4 categories:

1. Social (39 indicators: 11 driving forces, 21 state and 7 response indicators).
2. Economic (23 indicators: 9 driving forces, 11 state and 3 response indicators).
3. Environmental (55 indicators: 22 driving forces, 18 state and 15 response indicators).
4. Institutional (15 indicators: 0 driving forces, 3 state and 12 response indicators).

There are 7 indicators for protection of the quality and supply of freshwater resources:

Driving force indicators:

- annual withdrawals of ground and surface water as of a percent of available water (%);
- domestic consumption of water per capita (litres per capita per day).

State indicators:

- groundwater reserves (indicator under development);

- concentration of faceal coliform in freshwater (%) (The proportion of freshwater resources containing concentrations of faceal coliformss which exceed the levels recommended in the WHO Drinking Water Duidelines.);
- biochemical oxygen demand (BOD) in water bodies ($[\mathbf{mg/l}]$).

Response indicators:

- waste-water treatment coverage (%) (proportion of the wastewater generated by the community receiving acceptable levels of treatment prior to discharge);
- density of hydrological networks (area in $\mathbf{km^2}$ per station). (Density of hydrological network is defined as the average area served by one hydrological station. It is derived by dividing the area of the territory by the number of hydrological stations operated within this territory).

4.3 Indicator set of the European Environmental Agency (EEA), 2000

The two main criteria for the selection of indicators were: policy relevance for most EEA member countries and adequate data from a sufficiently large number of member countries. Indicators in the theme of water quantity were the follows:

- Exploitation index (pressure)
- Water use by sector (driving force)
- Irrigated area (driving force)
- Public water supply (driving force)

Indicators in the theme of eutrophication were the follows:

- Nitrogen and phosphorus concentrations in rivers (state)
- Nitrogen run-off (pressure)
- Nitrogen balance (pressure)
- Phosphorus load (pressure)
- Discharge of phosphorus from urban wastewater treatment plants (pressure)
- Wastewater treated (response)
- Nitrate concentrations in groundwater (state)
- Nitrate concentrations in lakes (state)
- Phosphate concentrations in coastal water (state)
- Nitrate concentrations in coastal water (state)

Selected indicators (regarding to water quality) in the theme of agriculture were the follows:

- Livestock numbers
- Fertiliser consumption per hectare
- Irrigated land
- Pesticide consumption per hectare

4.4 Indicator set of CEROI, 2003

The Cities Environment Reports on the Internet (CEROI) Program has worked within the framework of Local Agenda 21 to facilitate access to environmental information for sound decision-making and general awareness-raising in cities. There are 90 CEROI core and city-specific indicators.

The City Environmental Indicators Encyclopaedia consists of 11 indicators about water:

- Sources of drinking water (driving forces indicator)
- Water consumption (driving forces indicator)
- Annual withdrawals of ground and surface water (pressure indicator)
- Wastewater treatment (pressure indicator)
- Quality of drinking water (state indicator)
- Water quality on surface streams (state indicator)
- Access to drinking water (response indicator)
- Investments to water supply system (response indicator)
- Price of water (response indicator)
- Reduction of waste water flows (response indicator)
- Reduction of water consumption (response indicator)

4.5 Indicator set recommended for ex-ante evaluation of Structural Fund projects

The EU Structural Funds regulations explicitly require that the formulation of regional policy should take account both the existing environmental context and the probable environmental impacts of any public intervention so that regional economic development is not pursued at the expense of the regional environment. To check the program against key environmental criteria the EU recommend the use a limited set of indicators to represent the key criteria. They were selected after discussion with DG XVI, DG XI and Eurostat. The corresponding ratios of resource use per unit of output should also be monitored (in brackets) so that the progress towards a more eco-efficient or sustainable development path can be tracked.

In the theme of water quantity the recommended indicators (and ratios) are:

- Water consumption: billion litres (Industrial/commercial abstraction per GDP).
- Abstractions as percentage of availability: % (Abstraction per GDP).

In the theme of water quality the recommended indicators are:

- Heavy metals discharges: tonnes (Effluent HMD per employment)
- Nitrates used per $\mathbf{km^2}$ of agricultural lands: tonnes (Tonnes per agricultural employment)

4.6 Present indicator set of the EU and Hungary

The present EU indicator set of sustainable development was created by Eurostat in 2007 (and was published in "'Measuring progress towards a more sustainable Europe, 2007). The Sustainable Development Indicators (SDIs) are used to monitor the EU Sustainable Development Strategy (EU SDS) in a report published by Eurostat every two years. They are presented in ten themes.

The indicators of the European indicator set form a hierarchical framework comprising three levels, which serve as a basis for analysing the situation of sustainable development and for following up changes. Level 1 consists of a set of high-level indicators (headline indicators) allowing an initial analysis of the theme development. Level 2 corresponds to the sub-themes of the framework and, together with level 1 indicators, monitors progress in achieving the headline policy objectives. Level 3 (analysis indicators) facilitates a deeper insight into special issues in the theme. Of more than 100 indicators, eleven have been identified as headline indicators.

The present Hungarian indicator set of sustainable development can be found in the publication titled ”Sustainable development indicators in Hungary” issued by KSH (Central Bureau of Statistics) in 2011. The publication contains 9 indicators at level 1, 30 at level 2 and 111 at level 3, totaling 150. The former publication: ”Sustainable development indicators in Hungary” issued also by KSH in 2008 contained 10 indicators at level 1, 32 at level 2 and 71 at level 3, totaling 113. The basis of the Hungarian data compilation was the Eurostat publication ”Measuring progress towards a more sustainable Europe, 2007”, while some chapters were elaborated on the basis of ”Environmental pressure indicators of Hungary, 2005”, published by the Hungarian Central Statistical Office.

In the publication of year 2008 indicators connecting to water can be found in Chapter ”Natural resources”: groundwater abstraction (level 2), Municipal wastewater treatment (level 3) and Biochemical oxygen demand in rivers (level 3).). The Eurostat indicator set has the same three indicators for water. The new publication in 2011 gives an additional indicator connecting to water in Chapter ”Sustainable production and consumption”: water consumption.

Groundwater abstraction:

This indicator shows the annual sum of groundwater abstraction as a percentage of resources available over a long-term (at least 20 years). In case of groundwater abstraction, the annual abstraction of karst, stratum and subsoil waters was assessed because according to international classifications bank filtered water is classified to surface waters.

Municipal wastewater treatment:

The indicator on municipal wastewater treatment shows the efficiency of stages in wastewater treatment based on average weighting factors developed by Eurostat: untreated wastewater: 1,00; only primary (mechanical) treatment: 0,86; secondary (biological) treatment: 0,49; tertiary treatment 0,00. An index on municipal wastewater treatment is 100% if there is no wastewater treatment; 0% if all municipal wastewaters are purified by tertiary treatment.

Biochemical oxygen demand in rivers ($\mathbf{BOD_5}$, $[\mathrm{mg/l}]$***):***

This indicator is to show water quality in river waters based on an annual probability value of 90% of the measured biochemical oxygen demands ($\mathbf{BOD_5}$), for larger surface water bodies at some measurement points.

4.7 A recommended indicator set for waters

4.7.1 Proposed indicators of the water use

Indicators are not measured but generated from existing or calculated data and parameters. It is practical to select indicators for which the necessary parameter set is available, easily accessible and measured or calculated regularly. In order to evaluate the change of water use we need to know the water demand of the development (new technology to be introduced, etc.) and the water resource available in the area.

From sustainability point of view, all of the proposed indicators should be interpreted so that we examine the change of indicators in comparison with the original (pre-development) status. The sustainability of the rate of change is a further task for experts.

W1) ”Surface water resource index” (%):

Calculation:

$$\frac{\textbf{water withdrawn} \quad [\mathrm{m^3/s}]}{\textbf{natural water resource available for utilization} \quad [\mathrm{m^3/s}]} \times \mathbf{100.}$$

The indicator shows to what extent the development utilizes surface waters. It is applied when the development project needs the withdrawal of surface water for industrial technology, agricultural or communal purposes. The impact of water shed can be expressed by dividing the required annual water withdrawal (in $\mathrm{m^3/s}$) with the natural water shed to be used for withdrawal (expressed in %). From sustainability point of view, first the water resource index of the development project should be assessed, then the change of index should be compared to the original status (existing impacts). The initial surface water resource index is known or can be calculated from the local water management balance of the water shed. In the case of cooling water withdrawal (when almost all the water is return flown into a point not too far from the point of withdrawal), it should be individually assessed whether the withdrawal from the available water quantity is sustainable or not.

W2) ”Underground water resource index” (%):

Calculation:

$$\frac{\textbf{water withdrawn} \quad [\mathrm{m^3/year}]}{\textbf{renewable water resource of the given water shed} \quad [\mathrm{m^3/year}]} \times \mathbf{100.}$$

The underground water resource index compares the annually renewable water resource of the water shed affected by the project with the water demand of the development project. The index can be used when the development project requires underground water resources. From sustainability point of view, first the water resource index of the development project should be assessed, then the change of index should be compared to the original status (existing impacts). The initial underground water resource index can be calculated on the basis of the existing water withdrawals from underground water shed (as fixed in the legal approval of water rights).

W3) Underground water withdrawal per capita $[\mathbf{m^3/capita/year}]$ ***:***

Existing and applied indicator, but at national level only. Since the water kept in our underground water sheds renews in geological time-scale only, we have to consider this as a non-renewable resource. The number of inhabitants should be determined in awareness of the scope of the actual project: we need to decide whether to calculate with the population of the settlement, the micro-region, the region or the country. This indicator makes sense only when used for presenting the change due to the development. If the original value of underground water withdrawal per capita (before the commencement of the development) is not available or cannot be calculated, then we have to calculate it at higher NUTS level. However, in this case the evaluation of sustainability of changes is harder to determine for the given development.

W4) Use of drinking water per capita $[\mathbf{m^3/capita/year}]$***:***

Existing and applied indicator in Hungary, but at national level only. Can be calculated and interpreted as detailed in the description of the underground water withdrawal per capita indicator. This indicator shows the change of drinking water use in the given area due to the development.

4.7.2 Proposed indicators of the change of waste-water load

All of the proposed indicators can be used for the evaluation of sustainability when we study how the value of these indicators changes in comparison with the initial (pre-development) status. The sustainability of the rate of change is a further task for experts.

SZ1) The change of water-quality with regards to TOC (%):

Calculation:

$$\frac{\text{concentration after discharge } (c_{\text{new}})}{\text{original concentration } (c_{\text{o}})} \times 100.$$

This indicator shows the effect of (purified) waste-water discharged into living waters on the original organic matter concentration of the living water (expressed by TOC - total organic carbon). Based on the available data, the indicator can also be expressed in $\mathbf{BOD_5}$ (Biological Oxygen Demand) and COD (Chemical Oxygen Demand), because these latter are more wide-spread.

SZ2) The change of water-quality with regards to $\sum N$ ***(%):***

Calculation:

$$\frac{\text{concentration after discharge } (c_{\text{new}})}{\text{original concentration } (c_{\text{o}})} \times 100.$$

This indicator shows the effect of (purified) waste-water discharged into living waters on the original total nitrogen content of the living water.

SZ3) The change of water-quality with regards to $\sum P$ ***(%):***

Calculation:

$$\frac{\text{concentration after discharge } (c_{\text{new}})}{\text{original concentration } (c_{\text{o}})} \times 100.$$

This indicator shows the effect of (purified) waste-water discharged into living waters on the original total phosphorus content of the living water.

SZ4) The change of water-quality with regards to a given parameter (%):

Calculation:

$$\frac{\text{concentration after discharge } (c_{\text{new}})}{\text{original concentration } (c_{\text{o}})} \times 100.$$

This indicator shows the effect of (purified) waste-water discharged into living waters on the original hazardous material concentration of the living water (which represents a significant risk in relation to the development).

SZ5) The rate of sludge of after-treated waste-water to be used in agriculture (%):

Calculation:

$$\frac{\text{the quantity of sludge of after} - \text{treated waste} - \text{water to be used for agricultural purposes } [t/\text{year}]}{\text{total quantity of sludge of waste} - \text{water after pre} - \text{treatment } [t/\text{year}]} \times 100.$$

This indicator shows the rate of agricultural utilization out of the possible ways of utilization of the sludge of waste-water (use in agriculture, combustion, disposal, etc.) For the proper calculation of this indicator the mass of sludge measured before pre-treatment (dewatering, digestion, drying) should be specified.

European / Hungarian relevant indicators

SZ6) The rate of drained houses out of the households of the area under review (%):

This indicator can be interpreted in relation to sewer network development and drainage projects. It shows how many percent of the households of the country will be connected to the sewer network as a result of developments. With regards to sustainability, the drainage percentage after development should be compared to the original (pre-development) value.

SZ7) Population with no access to waste-water treatment (%):

This indicator shows the rate of population having no access to waste-water treatment plants in the given area. This indicator can be interpreted in relation to sewer network development and drainage projects. With regards to sustainability, the percentage of population with no access before the development should be compared to the reduced percentage rate as a result of the development.

SZ8) Municipal waste-water treatment index:

The municipal waste-water treatment index characterizes the effectiveness of municipal waste-water treatment stages. It is based on the average weighting factors developed by Eurostat:

- untreated waste-water: 1,00;
- waste-water treated with primary (mechanical) treatment only: 0,86;
- waste-water treated with secondary (biological) treatment: 0,49;
- waste-water treated with tertiary treatment: 0,00.

The municipal waste-water treatment index is

- 100%, if there is no waste-water treatment at all;
- 0% if all the municipal waste-water is treated with tertiary treatment.

5 Assessment of relevance of regulations

During developments we have to pay attention to specific technological realizations, economic and social consequences, environmental effects, actual regulations of a given (geographical) area and other earlier/current/future developments, since our ideas should be realized in a realistic environment instead of a ”pure” space. This means that our development (our policies, ideas, actual projects) should be integrated into the system of existing rules, other policies, projects, plans, strategies and material consequences (impacts on water, land, atmosphere, fauna and built environment).

5.1 Examples of laws relevant to river basin developments

Introduction of methodology: a search engine is to review the entire set of laws to find those that are relevant to the actual development, e.g. protection of drinking water resources, nutrient and nitrate-sensitive areas, settlements located in areas with sensitive underground water, natural watering places, source waters specified for the provision of living conditions for fishes.

5.1.1 Protection of drinking water resources

In accordance with the Water Framework Directive, the environment of (current or future) water withdrawal points that supply 10 $\mathbf{m^3}$ of water per day or serve 50 persons should be protected. With regards to public aquifers, the national practice meets this criterion.

5.1.2 Nutrient and nitrate-sensitive areas

These laws and decrees determine the nutrient and nitrate-sensitive areas provide for the designation of vulnerable surface waters and catchment areas thereof, as well as the protection of waters from agricultural nitrate contamination. This latter is to serve the adaptation of the EU Nitrate Directive.

5.1.3 Settlements located in areas with sensitive underground water

With regards to areas with sensitive underground water, we can distinguish between settlements located in area with highly sensitive, sensitive, less sensitive and extremely sensitive underground water quality protection. This information is essential for the feasibility of developments.

5.1.4 Areas protected due to natural assets

In accordance with river basin management practices, the achievement and maintenance of good water potential can only be effective if natural protection goals are also met. Important areas with regards to river basin management plans:

- protected natural areas of national importance;
- natural areas protected by individual laws (national parks, zones of protection, natural conservation areas);
- natural areas protected by the force of law ("ex lege"), such as moors, natron lakes, natural memorials (sources, sinkholes, caves);
- protected elements designated in line with EU regulations: Natura 2000 areas;
- areas designated in the framework of Ramsar Convention.

The Hungarian watercourse water-sheds flow through approximatley 6400 km of protected areas, while in the case of standing water water-sheds the size of affected area is 2656 $\mathbf{km^2}$.

5.2 Assessment of relevance of other relevant programs

The knowledge and consideration of other relevant programs affecting the given region is inevitable during the planning, implementation and evaluation of a development project. Introduction of methodology: a search engine is to review all sectorial and regional developments programs to find those that are relevant to the actual development and to determine any interactions and positive / negative synergies that may arise.

5.2.1 River basin management plan(s)

The River Basin Management Plan is the implementation tool of the Water Framework Directive (WFD). The term "river basin" in WFD is a land from where all surface watercourses flow (possibly through a series of lakes) to the sea. As the entire area of Hungary belongs to the river basin of Danube, we had to prepare a river basin management plan for the whole area of the country (as part of the Danube RBMP) and for 4 partial water catchment areas: the part of Danube river basin that connects directly to Danube river, the part of Dráva river basin that falls within the borders of Hungary, the part of Tisza river basin that falls within the borders of Hungary and the water catchment area of lake Balaton. Due to the result of an effective social interaction and practical reasons, the partial water catchment areas have been divided into 42 planning subunits (Figure 8).

The plan gives a detailed overview of the current status of Hungarian surface and underground water resources, the schedule of objectives and the planned programs of measures based on the present status and economic analyses, which, hopefully, will be adequate to bring all our surface and ground water bodies into a good status by 2027. The most important tasks related to the protection of surface and ground waters are the preparation, planning and implementation of these measures, which affect several sectors.

5.2.2 Drinking water quality improvement program

The national Program of improvement of drinking water quality (in line with the Drinking Water Directive of EU) started in 2001, full implementation is not finished yet. The program, which affects 908 settlements (2,5 million inhabitants, a quarter of the entire population) is to provide a solution for water-quality problems affecting public drinking water supply.

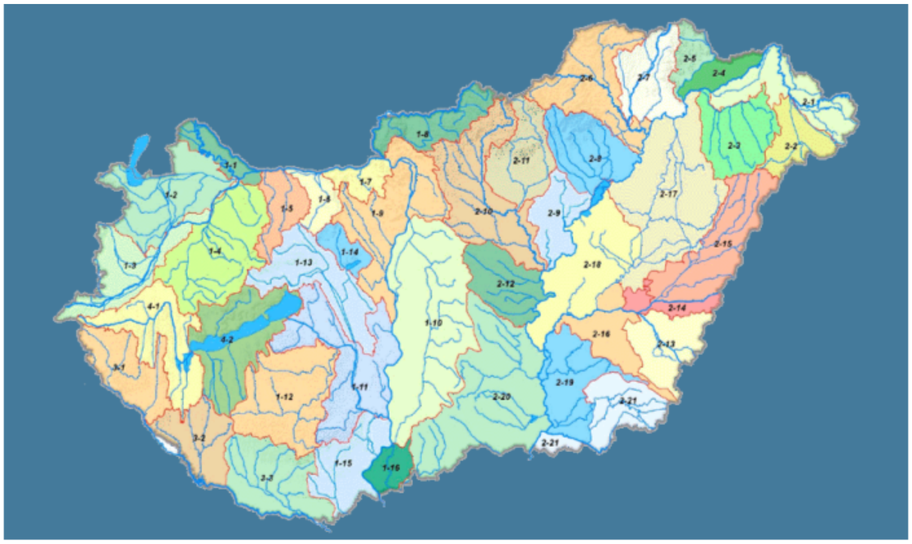

Figure 8: River basin management planning subunits (Source: VKKI, 2010)

5.2.3 National Implementation Program for Sewer and Waste-water Treatment

The relevant law is a Government Decree on National Implementation Program for Sewer and Waste-water Treatment (in accordance with the Urban Wastewater Directive of EU). The annexes of the Government Decree introduce the affected drainage agglomerations: which settlements belong to these, are these located in a sensitive area, what is the range of impact expressed in population equivalent. In the case of development of sewer and waste water treatment facilities we have to know and adapt to the status of settlements (as defined in the National Implementation Program for Sewer and Waste-water Treatment) affected by the development. The program started in 1996. Timetable:

Until 2008: sensitive areas.
Until 2010: $>$ 15.000 p.e.
Until 2015: $>$ 2000 p.e.
$>$ 2000 p.e. (EU requirement): 684 agglomerations, 1472 settlements
$<$ 2000 p.e. (national requirement): 840 settlements.
The estimated cost is 3500 + 500 million EUR.

5.2.4 Tasks related to nitrate and bath water quality directives

The Government Decree on the adaptation of EU Nitrate Directive stipulates the general rules about the protection of waters against nitrate pollution. in nitrate-sensitive areas any agricultural activities can only be performed in line with the action program and subject to the obligatory requirements of good agricultural practices as defined in the action program. The rules of good agricultural practices are published in the action program by the minister responsible for agricultural affairs. The action program consists of 4-year long periods and is announced in a separate law. The program started in 2001 and Hungary currently implements action program No. II started in 2008. Full implementation is expected in 2015. The estimated cost is 250 million EUR.

When considering agricultural developments, it is essential to clarify whether the development affects a nitrate-sensitive area and if so, we have to learn the actual action program relevant to the given area.

5.2.5 Aquifer protection program

With the aim being at determining hydrogeological protection areas (Section 4.2.1.), evaluating the current status and developing a monitoring network, the Aquifer Protection Program was launched in 1997 and full implementation is on-going. Within the framework of this program diagnostic assessments have been completed for 343 current and future aquifers, while additional 24 aquifers are currently being analyzed. The diagnosis of 36 aquifers is ongoing. Out of the scope of the program the hydrogeological protection areas of additional 251 aquifers have been determined, while 64 are being determined now. The estimated cost of the program is 110 million EUR.

5.2.6 National Environmental Remediation Program

The National Environmental Remediation Program (NERP) was launched with the aim being at the remediation of lasting environmental damages and polluted areas. The program started in 2001 and full implementation is expected in 2040. The estimated cost is 4000 million EUR. The objective of the program is to prevent surface and underground waters from threats and pollution and to reveal all previous environmental damages, irrespective of responsibility, and take actions to mitigate or eliminate further pollution.

5.2.7 ”Vásárhelyi plan”

The main goal of the Development of Vásárhelyi Plan (DVP) is to enhance the safety against the over-flow as well as improve capacity of sustainable land use in Tisza valley. In addition to flood control development, the program contains infrastructural developments (municipal drainage, sewer development, construction of bicycle roads) and the introduction of farming practices that adapt to the natural conditions, including landscape management, as well.

One of the key principles of the DVP is to create a spillway system consisting of structures and reservoirs (which enable the controlled discharge and recirculation of flood water to the river-bed or possibly draught areas) so that this system can also be utilized for the attainment of goals related to the development of Tisza valley as well as the enrichment of natural habitats.

5.2.8 Tasks related to international water authority cooperation

Tasks related to international water cooperation are very important, with special regards to Danube River Protection Convention and our bilateral boundary water relations. The aim of Danube Region Strategy is to protect water quality in Danube river basin and to protect the water of sea-shores (in line with the provisions of the Water Framework Directive).

6 Conclusion

The planning and/or (ex ante) assessment of sustainable environmental resource management as well as the modeling (or at least estimation) of adequacy and results of regulation policies is a typical example of a problem with extreme information demand. It can be resolved by algorithms applicable for revealing relations of highly complex systems, which generally means the application of artificial intelligent and (in a broader sense) the ICTs for implementation (Bulla 2004): a multidisciplinary navigation between heterogeneous databases on virtual process management (4D) meta surfaces. The main goal of environmental analysis is, therefore, the combination of environmental sciences and ICT applications, or more specifically: assessment and multi-faceted analysis of the effect of industrial, agricultural, service activities, local and regional development programs, investment projects to the natural and social environment. Such a problem is not linear and not deterministic; it is a typical example of highly complex systems, which call for the generation of algorithms between sets of fading borders, and the solution of operations by means of intelligent calculation tools. From information technology point of view, this needs the development of an application which enables the management, transmission, storage of heterogeneous datasets with absolutely different structure (and contents) as well as is able to flexibly serve different user needs. It should also enable the generation of virtual platforms suitable for interoperability (i.e. generation and connection of knowledge bases) and, in turn, can reveal interactions and visualize the results. The development of environmental analysis consists of the solution of these tasks and the application of the results.

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