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INDICATORS FOR SUSTAINABLE USE OF WATER RESOURCES – THEORETICAL APPROACH

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Abstract. The state of the water resources in Republic of Macedonia is directly related to the services provided by ecosystems to the society and it has to be examined in the context of their sustainable exploitation. The water resources of Republic of Macedonia have major importance in the economic development of the country. Access to clean water and the constant water supply is a crucial factor for the functioning and development of many economic sectors – energy production, industry, agriculture, forestry, etc. Water resources need to be managed sustainably in order to guarantee maintenance of the economic prosperity of those sectors. International experience shows that management of the water resources only for satisfaction of the human needs, without consideration of the needs of the ecosystems, could create risks for the environment, as well as for the society.

The aim of this article is to examine the European practice in relation to environmental indicators for sustainable development and concretely in relation to water resources, and to define their applicability in republic of Macedonia.

Main point, functions and aims of the indicators

"Indicator" – a parameter, or a value derived from parameters, which points to / provides information about / describes the environmental state, with a significance extending beyond the one, directly associated with a parameter value.

Indicators have been used for a long time as an instrument to receive information about human health and economic wellness. Compared to the indicators, providing information about the economic and social development, environmental indicators are relatively new phenomena.

Elaboration of a system of indicators for sustainable development was initially included in the agenda of the World Summit – "Environment and Development" in Rio de Janeiro in 1992. In the concluding document of the conference – AGENDA 21, Article 40 – countries call upon to "create systems of indicators for sustainable development on a national level as a basis for more adequate political decision-making". Since then, this topic has been a subject of researches and workings out, conducted in different institutions, organizations, governments and scientific teams all over the world. The International Institute for Sustainable Development identifies 836 initiatives for the elaboration and use of the indicators for sustainable development at different levels.

The two major functions of the indicators are:

- They reduce the number of the measurements and the parameters which are normally needed to give a

precise assessment of the environmental state. Therefore, the size of the group of indicators and the details in the group should be limited. A group containing a big number of indicators will cause a chaos in the common idea of the environmental state.

- They simplify the informational relation through which the results from the observation reach the users.

Environmental indicators help achieve three major goals:

- provide information about the environmental state;
- they serve as a basis to identify eventual negative anthropogenic effects on environment;
- provide information for elaboration of adequate measures for sustainable development of the environment.

Conceptual frameworks

Generally, the different levels of environmental state assessment, and specifically of the water resources, require different conceptual frameworks. This means that they depend on how detailed the analysis is, what the aim of the analysis is, etc.

Mostly the conceptual frameworks for environmental state assessment, incl. water resources are:

- Project-based conceptual framework (Input-Output-Outcome-Impact framework);
- A framework for the analysis at national, regional and international level, developed by the Organization for Economic Cooperation and Development (OECD);
- A framework, based on separate issues about environmental sustainable development.

A project-based conceptual framework

Input-Output-Outcome-Impact framework:

- Environmental monitoring, incl. water resources monitoring, can be realized at a project level and the indicators are related to the different project stages.
- Input indicators: to monitor the specific resources, provided to accomplish the project.
- Output indicators: to monitor the goods and the services produced by the project implementation.
- Outcome indicators: to observe the immediate or short-term project results.
- Impact indicators: to monitor the long-term project results (Fig. 1).

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Observation at national, regional and international level
In some cases Input and Output are not practical-
• maintenance and preservation of the environment
and the natural resources.
The conceptual framework Pressure – State – Re-

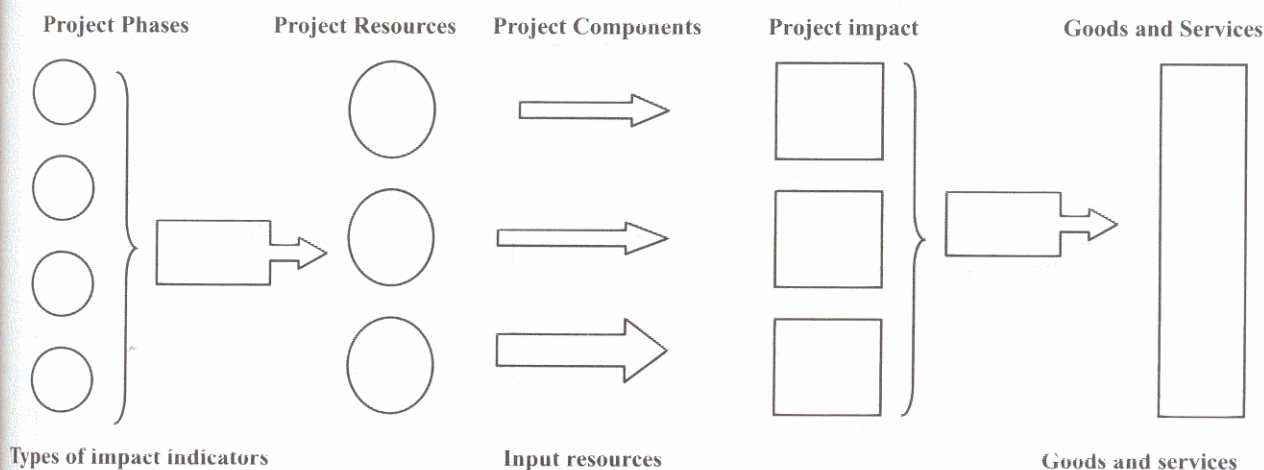


Fig. 1. Project-based Framework
Source: L. Segnestam, 2002.

ly significant or it is difficult to be determined. Then more appropriate is the model Pressure – State – Response. Instead of focusing on the different phases of a certain project, this model distinguishes three different viewpoints, related to the environment.

Environmental pressure describes the negative impact on environment, including on natural resources. The pressure includes the indirect influences on environment from all anthropogenic actions, as well as the direct pressure (including use of the resources, discharge of wastewater and waste). Indicators for environmental pressure are directly related to production and consumption; often represent the intensity of the emissions or use of resources, together with the related modifications for a certain period. They can be used to demonstrate the progress in decoupling economic activities from related environmental pressures or to accomplish the national, regional and international goals and agreements (i.e. aims for emissions reduction).

Environmental state is related to environmental quality and the quality and quantity of the natural resources. They show the environmental state and its development through a certain period. Practically, the measurement of the environmental state is difficult and very expensive. There environmental pressure is often measured as a substitute.

Societal response is the extent to which the society recognizes the environmental problems and its actions towards their solution. The response includes individual and collective actions and reactions, related to:

- mitigation, adaptation or protection from the negative anthropogenic impact on environment;
- prevention or change of the damage on environment, which are yet caused;

sponse (PSR) (as shown in Fig. 2.) is based on the conception of the relation cause-effect (OECD, 1994).

The model (PSR) describes the interrelation between the society, its economic activities and the environment. It is based on the conception that societies, through their actions, cause pressure on environment and thus affect environmental state, changing the qualitative parameters, as well as the quantity of the natural resources (state). Information about these changes reaches the institutions responsible for the environmental state, which *respond* to these changes through environmental policies, common economic policy and sectoral policies, and through changes in the lucid attitude and behavior towards environment (societal response).

The model (PSR) underlines the “cause – effect” relations and assists decision-makers and societies to realize the interrelation between environment and economic development. This relation is considered linear, which corresponds to the much more complex interrelation within the ecosystems and between society and environment.

The model (PSR) has the advantage to be one of the easiest frameworks to understand and use when researching the relation society – nature but simultaneously it is neutral in the sense that it shows only the kind of a relationship and not if it has negative or positive effect on development. However, this fact should not conceal the more complex relations in the ecosystems, environment – economy and environment – society.

Last but no least, the PSR model can be easily regulated depending on the purpose of use so that more details and more specific information are extracted.

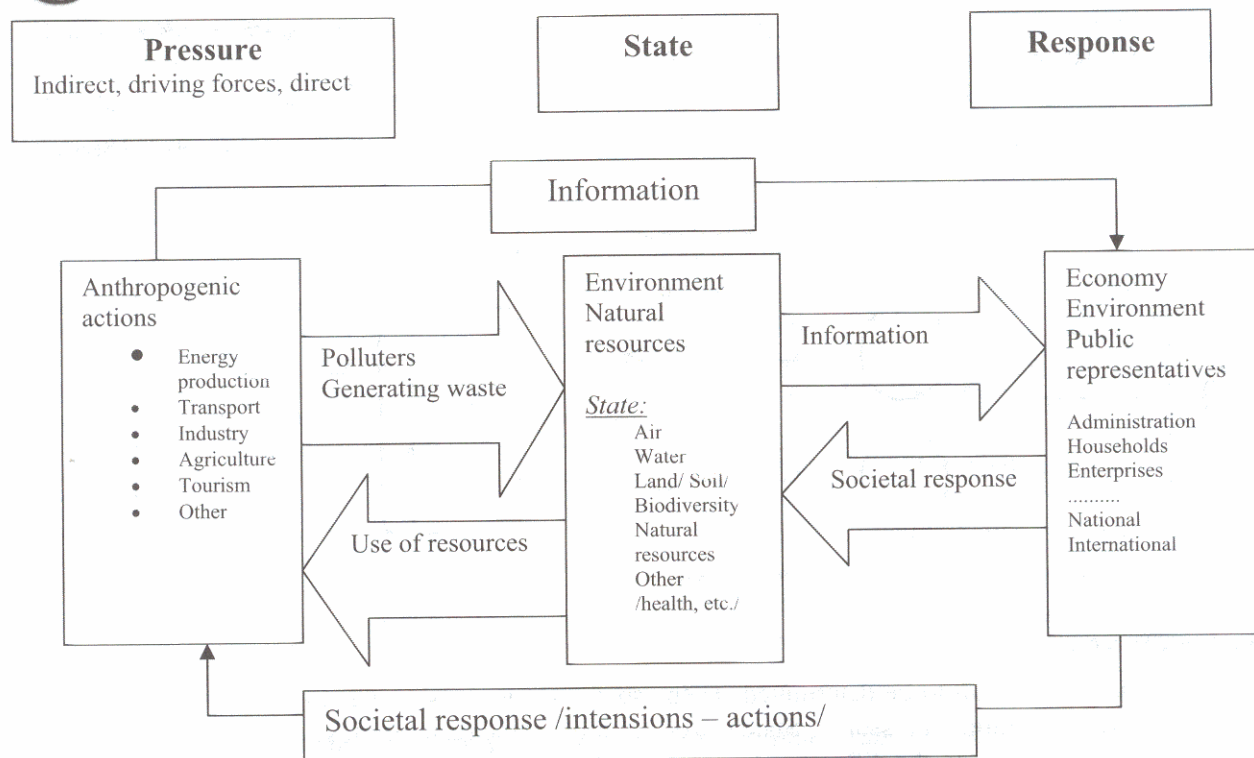


Fig. 2. Conceptual Framework of the model Pressure – State – Response

The next stage of the elaboration of the conceptual framework is the including of indicators for *Driving Forces*, which differ from the indicators for *Pressure* in their scope.

The supporters of the framework DSR claim that indicators for pressure are most suitable for identification only of the environmental problems. Indicators for driving forces in comparison to indicators for pressure also provide information for the social, economic and institutional aspects. In addition, indicators for "driving forces" can be used as explanations for the positive and the negative impacts on sustainable development (Virtual Research and Development Centre, 2001).

Along with the increasing use of the indicators as an instrument for decision-making, it is necessary to make a better difference between the environmental state and the changes in the state. Several organizations propose that "indicators for impact" should be included in the PSR framework and thus the changes in environmental state will be caught as well (Winograd et al., 1998).

The advantage of the frameworks PSIR is that indicators for state are concentrated only in measurable physical characteristics of the environment. The category "indicators for impact" is included in order to gather information about the effects of the possible pressure.

This is how the idea of the conceptual framework PSR was developed and all five categories of indicators were included: Driving force – Pressures – State – Impact – Responses (*DPSIR*) (Fig. 3.).

Conceptual framework – fields, topics and subtopics of environmental sustainable development

Another conceptual framework, which ignores the different viewpoints about environmental problems, is based on elaboration of main fields, topics and subtopics about sustainable development, elaborated by the UNCSO (United Nations Commission on Sustainable Development) (Table 1)

A main aim of the creation of this framework for monitoring of the development progress, based on main topics and related subtopics, is to assist politicians in decision-making on a national level. (UNCSO 2000).

However, all described conceptual frameworks should have indicators, specially defined for the following categories regardless of the phase of the project, categories of indicators (driving forces, pressure, impact, response), or topics of environmental sustainable development.

Criteria for indicators selection

There is no universal set of criteria which are equally applicable in all cases. Nevertheless, a small set of well selected indicators is the most effective approach. There is a variety of selection criteria, which are applicable when reducing the number of indicators. Selection criteria guarantee that the parameters are useful and effective to inform politicians. There are many criteria in the literature dedicated to indicators selection but those listed in Table 2 are representative for a major part of the indicators and usually include:



Table 1

Main fields, topics and subtopics about sustainable development, UNCSD

Main fields	Topics	Subtopics
Social	Equity	Poverty
		Gender equality
	Health	Alimentation status
		Death
		Sewage system
		Drinkable water
		Access to health services
	Education	Educational level
		Literacy
	Housing	Living conditions
	Security	Crime
Environment	Atmosphere	Dynamics of the population
		Climate change
		Thinning of the ozone layer
	Land	Air quality
		Agriculture
		Forestation
		Desertification
		Urbanization
	Ocean, seas, coastal zones	Coastal zones
		Fishery
Economic	Fresh water	Quantity of the water resources
		Quality of the water resources
		Biodiversity
	Ecosystems	Spices
		Economic sectors
		Trade
		Finance
	Consumption and production	Consumption of materials
		Energy consumption
		Waste accumulation and management
		Transport
Institutional	Institutional framework	Implementation of strategies for sustainable development
		International cooperation
	Institutional capacity	Access to information
		Communicational infrastructure
		Science and technology
		Preparedness and reaction to calamities

Source: UNDISD, 2000.

Types of indicators

The EEA has elaborated the following types of indicators:

Type A: *descriptive parameters* about environment and human health. For instance: emissions and concentrations of pollutants.

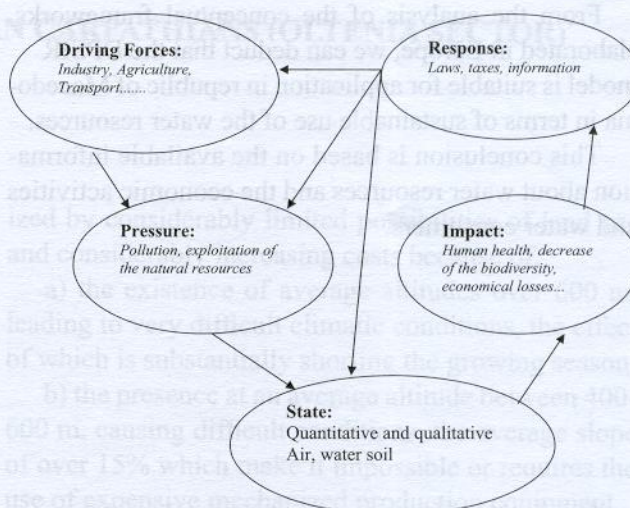


Fig. 3. Conceptual Framework – DPSIR

Table 2

Criteria for environmental indicators selection

Indicator	Description
<i>Relation to policy and utility for the users</i>	To guarantee representative information about environmental state and pressure or the societal response; To be simple, easy for interpretation and able to represent the tendency in modification in a certain period; To allow comparison on national and international level; To be applicable on a regional level and have national significance; To have a threshold or marginal value and comparison by the users of the indicator;
<i>Theoretical validity</i>	Theoretically well defined in technical and scientific point of view; To be based on international standards and national consensus about its definition; Suitable for relation with the economic models, prognosis and informational systems;
<i>Measurability</i>	The indicator should be based on data which is: Easily accessible or accessible at a reasonable price; Correspondingly documented and with a certain quality; To be regularly renewed in accordance with reliable procedure.

Source: OECD, 2003.

Type B: *parameters for accomplishment*, related to the reference value or objective policy. They illustrate how far away from the aiming level the parameter is standing.

Type C: *effectiveness parameters* which illustrate the production and consumption effectiveness. For instance, energy consumption by production unit.

Type D: *summarizing parameters about the common wellness*, which combine economic, social and environmental dimensions in order to illustrate whether the common wellness is increasing.



From the analysis of the conceptual frameworks, elaborated in Europe, we can deduct that the DPSIR model is suitable for application in republic of Macedonia in terms of sustainable use of the water resources.

This conclusion is based on the available information about water resources and the economic activities and water consumers.

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