BALANCE OF NECESSARY ENVIRONMENTAL STATE AND SOCIAL-ECONOMIC EFFICIENCY AS CONDITION OF RIVER BASIN SECURITY

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Abstract: New approach to definition of river basin security was proposed. It is based on optimal balance of basin necessary environmental state and basin social-economic efficiency. Elaborated proper software is applicable for different river basins under international hydro-environmental cooperation.
Keywords: river basin security, environmental state, social-economic efficiency, ecosystem management, international cooperation.

BALANCE DES UNBEDINGTEN ÖKOLOGISCHEN ZUSTANDS UND SOZIAL-WIRTSCHAFTLICHEN EFFEKTIVITÄT ALS BEDINUNG DER SICHERHEIT DES STROMGEBIETS

Zusammenfassung: Neue Behandlung zur Ermittlung des Stromgebiets ist vorgeschlagen. Sie basiert auf den optimalen Balance des unbedingten ökologischen Zustands des Stromgebiets und seiner sozial-wirtschaftlichen Effektivität. Der entwickelte Programmprodukt wird angewandt für den verschiedenen Stromgebieten unter die internationale hydroökologische Partnerschaft.
Schlüsselworte: Sicherheit des Stromgebiets, ökologischen Zustand, sozial-wirtschaftlichen Effektivität, Steuerung des Ökosystems, internationale Partnerschaft.

1. Introduction

Problem of river basin security during natural resource use can be solved by combination of two interrelated issues: basin necessary environmental state and basin social-economic efficiency. Such integrated approach is developed in our monographs (Samoylenko, 1998, 1999, 2000, 2002, 2003) and was partly realized in Ukraine during elaboration of project under UNDP/GEF Dnipro Transboundary Basin Environmental Program in 2001 – 2003.

That's why the experience gained under such international project composed the subject of this paper aimed to identify the priorities of securely river basin management, based on identification of basin pollution root causes and proper actions on sustainable improvements.

At that, water pollution abatement as related simultaneously to ecosystem protection and effective resources use in river basins, originally reflecting concept of Water Framework Directive and other concepts, such as for example Australian "healthy working river" approach, must be based on special advanced procedure and criteria.

2. Approach and procedure

Approach for balancing of necessary environmental state and social-economic efficiency of river basin is based on the theses of stochastic environmental hydrology (or hydro-environmentology) as a new scientific sphere (Samoylenko, 1998 etc.). Such approach includes some principal terminology and procedures.

2.1. Principal terminology

River basin is defined as controllable macro-ecosystem which consists from modules (rivers, water reservoirs, catchments etc.) and spatial substructures (sub-basins distinguished by special zoning). Therefore, basin macro-ecosystem can be divided into two classes of structurally-functional organization – class of ecosystem natural resources and

class of its spatial substructures with both classes realization by way of social-economic functions.

Social-economic functions regard as macro-ecosystem characteristics of necessary requirements' accomplishment of water users taking into account the ecological/environmental criteria. Social-economic functions fall into two types: environmental-positive and environmental-negative.

Environmental-positive social-economic functions, for example, involve functions of nature resource reproduction (for water supply, irrigation, fishery etc.), resource protection (water protection, sanitary etc.), environment reproduction (recreation, spawning etc.), environment protection (drainage function, coast protection, reservation of biodiversity etc.).

Environmental-negative social-economic functions, for example, are divided into functions of resource reduction (chemical water pollution, radioactive contamination, swamping etc.), environment reduction (landscape degradation, underflooding etc.), risk functions (health risk, risk for human economic activity and inhabitation etc.).

Environmental state of river basin macro-ecosystem is identified in two ways.

For the first, such state, as characteristic of *ecosystem stability*, is determined as conformity degree of basin ecosystem properties to ecological/environmental standards (water quality, health standards etc.).

For the second, river basin environmental state, as characteristic of *ecosystem reliability*, is interpreted as conformity degree of basin ecosystem potential to realize the required social-economic functions under real situation in resource use and ecosystem management.

Therefore, basin macro-ecosystem sustainable development is identified as the balance of its proper directly stability and reliability. At that, ecosystem state deterioration is credited with divergence of real state from such optimal state, which guarantee the basin ecosystem rehabilitation and environmental enhancement.

2.2. Procedures

Foregoing principles was realized first of all in the *scheme for diagnostics of root causes of river basin environmental state deterioration*. This diagnostic cause-effect scheme additionally takes into account some principles of GIWA and consists of such steps (Figure 1):

- selection of typical basin environmental state deterioration problems (such as eutrophication, toxic pollution, biodiversity reduce, land resource losses, silting of water reservoirs etc.) in fixed basin substructures by sign-sets of basin environmental state;
- determination of main direct causes for environmental state problems (such as sewage disposal, water runoff from agricultural territories, detention with polluted underground waters etc.);
- revelation of economic sectors, which are interrelated with typical environmental problems and its direct causes (industry, agriculture, municipal economy, power engineering, forestry and fish industry, transport, recreation etc.);
- analysis of predominant impact of typical environmental problems, its direct causes and interrelated economic sectors on environmental state deterioration by limitation of environmental-positive social-economic functions and intensification of environmental-negative functions for fixed types of basin ecosystem natural resources (water, land, biological, recreational etc.);
- determination and veracity testing of principal components in root causes of basin environmental state deterioration;
- systematization and similarity grouping of obtained principal components into direct root causes;
- discovery of all root causes of river basin environmental state deterioration with sequenced collection of its components.

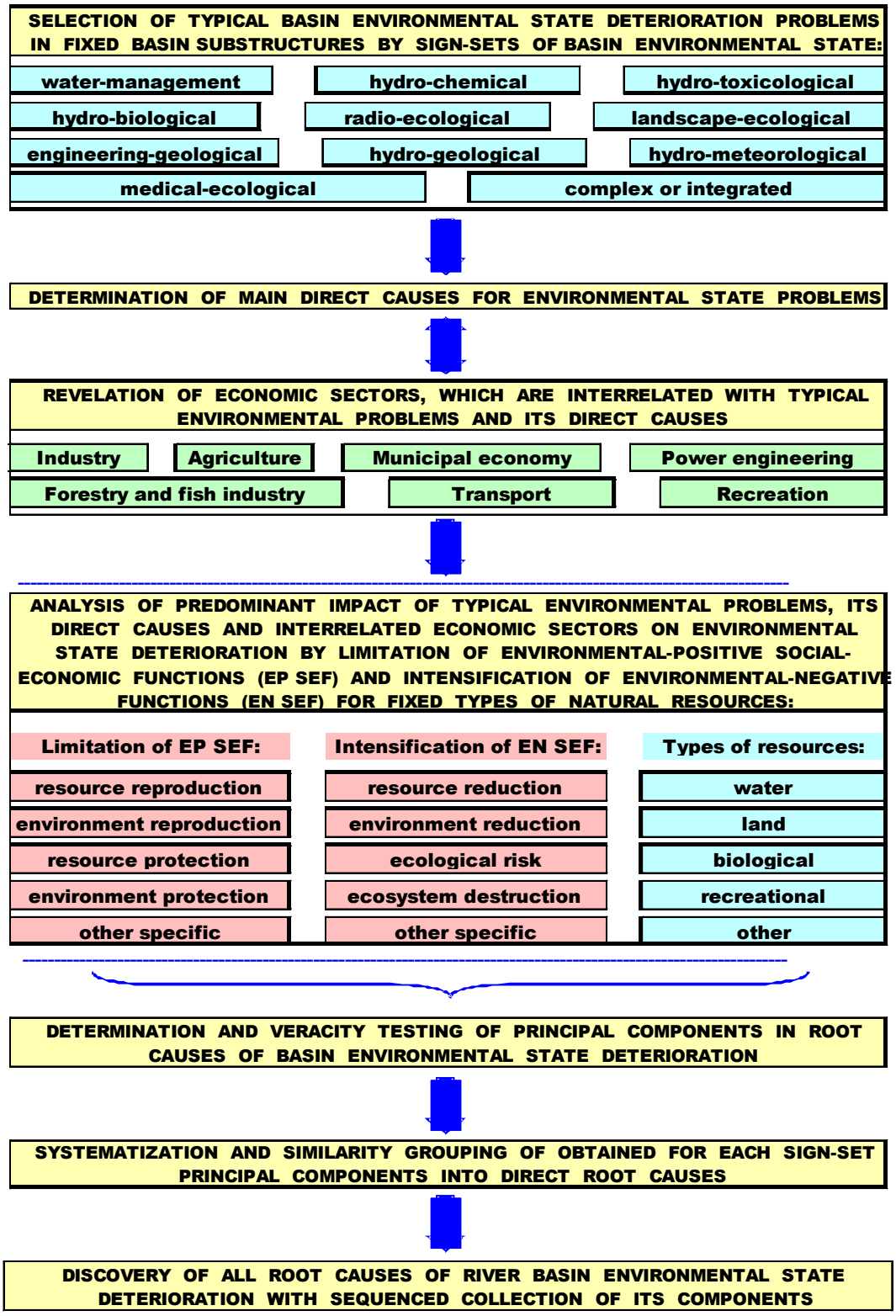

Figure 1. Diagnostic cause-effect scheme

3. Principal results

3.1. First implementation

First implementation of foregoing approach permitted to obtain under UNDP/GEF project seven root causes of river basin environmental state deterioration for Dnipro

Transboundary Basin (territory of Belarus Republic, Russian Federation and Ukraine). Such root causes with their principal components are the following:

1) Excessive and environmental-hazardous human impact on basin macro-ecosystem, including:

- placement of economic establishments without taking into consideration the quantity and quality of natural resources;
- existence of transition period economic, which is structurally strained by water-retaining and resource-retaining technologies;
- excessive industrialization and urbanization as well as intensification and chemicalixation of agriculture;
- availability of exploitable atomic and heat power plants;
- creation of large water reservoirs and at that lack of environmental-compensatory and environmental-rehabilitation spade-works;
- availability of excessive regulated Dnipro tributaries, including small rivers;
- availability and surplus of environmentally unwarrantable land-reclamation systems and their types (designs) etc.;

2) Chernobyl Accident Consequences, including:

- initial radioactive fall-out, resource losses and availability of "hot spots" under radio-ecological criterion;
- processes of secondary radioactive pollution and radioisotope sedimentation in water reservoirs;
- insufficient substantiation, financing and efficiency of post-Chernobyl counter-measures;
- imperfection of radio-ecological control of natural resource use etc.;

3) Ineffective water & resource use and management of basin macro-ecosystem environmental state and resource use, including:

- misallocation and losses of basin natural resources, above all water resources, and obsolete & environmentally hazardous technologies of resource utilization and water preparation;
- lack of effective planning and management of man's impact on typical ecosystem elements corresponding with ecological/environmental risk assessment;
- utilization of drinking quality water in wet industrial processes and low level of water conservation;
- insufficient renovation of water and other basin resources and ineffective indemnity of ecological/environmental damages caused by water use;
- insufficient efficiency and investment support of basin remedial measures and technologies;
- insufficient efficiency of environmental audit concerning economic projects etc.;
- initial stage of international cooperation in the domain of Dnipro Transboundary Basin monitoring and environmental enhancement, including legislation;
- infraction of environmental regulations, including regime of water-protective zones etc.;

4) Lack of basin macro-ecosystem sustainable development, taking into consideration ecosystem degradation and threat for biodiversity, including:

- transformation of landscape and ecosystems self-regulation characteristics towards their degradation with general tendency for biotope loss;
- reduction of territories with natural landscapes (including forests etc.), excessive land ploughing up, wasting and other negative features of land tenure structure;
- wetland losses and adverse for water ecosystems movement of hydrological, chemical and temperature conditions of water bodies;
- existence of endangered biological species;

- lack of quantity and squares of reserves and other protected natural areas etc.;

5) Lack of optimal environmental-economic balanced resources output of basin macro-ecosystem, including:

- quantitative and qualitative deficits of basin natural resources;
- irrevocable water consumption and consumptive utilization of other basin natural resources;
- lack of safe and sufficient sources of drinking water;
- synergism of chemical, radioactive and other types of water and landscape pollution etc.;

6) Environmental-economic unfavorable global and regional natural and man-caused processes, including:

- global climatic changes (precipitation, temperature);
- global and regional transboundary atmospheric transport of pollutants, including toxic and radioactive;
- catastrophic floods, underflooding, swamping, pickling of land resources etc.;
- changes of water environment quality conductive to secondary ecosystem pollution etc.;

7) Non-domination of paradigm for environmental priorities in social evolution, including:

- insufficient level of environmental education and popularization;
- poor lobbying of environmental measures, especially on legislative level;
- insufficient cooperation of government establishments and NGO in environmental planning and actions etc.

3.2. Second implementation

Second implementation of foregoing approach, taking into account root causes of previous item, permitted to elaborate on example of Dnipro Transboundary Basin *the algorithmic scheme for environmental-economic optimization of basin macro-ecosystem management modes*. This scheme provides for the following interrelated steps:

- simulation of basin macro-ecosystem social-economic functions' efficiency based on ecosystem stability criteria (ecological/environmental standards etc.) and ecosystem reliability criteria (conformity degree of capability to realize the required social-economic functions) as related to ecological/environmental risk reduction;
- synthesis of simulated optimal social-economic functions of basin ecosystem with its real, design or predicted environmental state, aimed to provisional definition of optimal ecosystem management mode;
- synthesis of provisional optimal management mode with data on basin ecosystem resource potential (quantity and quality of water, land, biological resources etc.) aimed to formulate the general possibility of resource use under optimal management;
- definition of operational and remedial measures in macro-ecosystem, which can support simulated optimal management mode;
- negotiations with basin ecosystem resource users for sale of nature resources with usage charge according to optimal management mode and selected measures;
- definition of final optimal management mode, incarnated in national/international Dnipro Basin Operating Rules, which will be the principal document on river basin environmental security under optimal basin resource use.

Proper software was elaborated for the foregoing algorithmic scheme, applicable not only for Dnipro, but for different international river basins.

4. Conclusions

As a result of case study, new approach to definition of river basin security was proposed, based on optimal balance of basin necessary environmental state and basin social-economic efficiency.

Such approach was implemented under UNDP/GEF project on example of Dnipro Transboundary Basin, for the first, in scheme for diagnostics of root causes of basin environmental state deterioration and results of analysis by such scheme.

Secondly, the algorithmic scheme for environmental-economic optimization of basin macro-ecosystem management modes was created with sufficiently general software for different international river basins.

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