Development of decision support systems for integrated water management in Belarus
Central Europe Initiative-KEP project (Ref. 1206.006A-09)

Integrated Water Resources Management planning
Working document

Introduction

One of the main objectives of the project is to diffuse the knowledge and the application of IWRM principles and techniques to the Belarus environmental needs, according to the EU standards, to the main Belarusian authorities and stakeholders and to contribute to the overall acquisition of the EU standards by Belarus in the field of environmental resources management. This could help in the establishment of upgraded legislative perspectives in order to favour the approach of Belarus to EU.

The question on optimisation and protection of water resources in the Republic of Belarus is of primary importance. In fact, there are about 10,000 lakes and artificial water bodies with slow water circulation within the territory of Belarus. Water is relatively abundant in Belarus, and the available water resources are sufficient to meet both present and future needs. At the same time, anthropogenic activity has negative influence on water quality factors and biological characteristics, which can in many cases cause a very complicated geo-ecological situation within the territory of lakes and reservoirs of Belarus.

The quality of surface and underground waters is greatly affected by such factors as: wastewater discharges from industry, towns and cities, and cattle-breeding complexes; pollutants transferred with precipitation as well as by radio-nuclides. A number of highly sensitive factors interacting with water quality and management must be considered and controlled, such as:

- Waste water;
- Pollutants emissions;
- Radioactive pollution of territories;
- Industrial and household wastes;
- Agricultural activities;
- Mining and construction activities;
- Wetlands reclamation;
- Regulation of river flow.

Belarus strives to improve the effectiveness of use of the natural water and its protection, conducing surface and groundwater monitoring. Water bodies monitoring is carried out within the National Environmental Monitoring System by the Hydrometeorology Department of the Ministry of Natural Resources and Environmental Protection (MNREP). This involves monitoring of the background state of natural waters, the environmental state of water bodies as well as recording surface flow. In the regional and local context the MNREP sub-national authorities exercise hydro-chemical monitoring of the watercourses pollution and pollution sources. Monitoring of the sanitary-hygienic state of waters that have a physical contact with population and a direct impact on human health is implemented within the framework of medical monitoring under the Ministry of Health.

One of the main objectives of the project is to promote the knowledge and the application of Integrated Water Resources Management (IWRM) principles and techniques to the Belarus environmental needs, according to the EU standards.

The IWRM concept basis on the fact that many different uses of water resources are interdependent. High irrigation demands and polluted drainage flows from agriculture mean less freshwater for drinking or industrial use; contaminated municipal and industrial wastewater pollutes rivers and threatens ecosystems etc. Integrated management means that all the different uses of water resources are considered together. Water allocations and management decisions consider the effects of each use on the others. They are able to take account of overall social and economic goals, including the achievement of sustainable development. This also means ensuring coherent policy making related to all sectors. The basic IWRM concept has been

extended to incorporate participatory decision-making. Different user groups (farmers, communities, environmentalists, ect) can influence strategies for water resource development and management. That brings additional benefits, as informed users apply local self-regulation in relation to issues such as water conservation and catchment protection far more effectively than central regulation and surveillance can achieve.

Water is vital for human survival, health and dignity and a fundamental resource for human development. IWRM can help to safeguard an "environmental reserve" of water with the value of ecosystems to human development.

There are a number of benefits possibly to be achieved from IWRM

- Ecosystems can benefit from applying an integrated approach to water management by giving environmental needs a voice in the water allocation debate. At present these needs are often not represented at the negotiating table.

- IWRM can assist Belarus by raising awareness among other users of the needs of ecosystems and the benefits these generate for them. Often these are undervalued and not incorporated into planning and decision-making.

- The ecosystem approach provides a new framework for IWRM that focuses more attention on a system approach to water management: -protecting upper catchments (e.g. reforestation, good land husbandry, soil erosion control), pollution control (e.g. point source reduction, non-point source incentives, groundwater protection) and environmental flows.

- As the single largest user of water and the major non-point source polluter of surface and groundwater resources, agriculture has a poor image. Taken alongside the low value added in agricultural production, this frequently means that, especially under conditions of water scarcity, water is diverted from agriculture to other water uses. However, indiscriminate reduction in water allocation for agriculture may have far-reaching economic and social consequences. With IWRM, planners are encouraged to look beyond the sector economics and take account of the implications of water management decisions on employment, the environment and social equity.

- IWRM can bring into the equation the reuse potential of agricultural return flows for other sectors and the scope for agricultural reuse of municipal and industrial wastewaters.

- IWRM calls for integrated planning so that water, land and other resources are utilized in a sustainable manner. For the agricultural sector IWRM seeks to increase water productivity within the constraints imposed by the economic, social and ecological context of a particular region or country.

- Properly applied IWRM would lead to the water security. The implementation of IWRM based policies should mean increased security of domestic water supplies, as well as reduced costs of treatment as pollution is tackled more effectively.

- The focus on integrated management and efficient use should be a stimulus to the sector to push for recycling, reuse and waste reduction. High pollution charges backed by rigid enforcement have led to impressive improvements in industrial water-use efficiencies in the industrialised countries, with benefits for domestic water supplies and the environment.

- Introduction of IWRM will improve the opportunity for introduction of sustainable sanitation

solutions that aim to minimise waste-generating inputs, and reduction of waste outputs, and to solve sanitation problems as close as possible to where they occur.

- At a practical local level, improved integration of water resource management could lead to greatly reduced costs of providing domestic water services, if for instance more irrigation schemes were designed with a domestic water component explicitly involved from the start.

- IWRM is, above all, a philosophy. As such it offers a guiding conceptual framework with a goal of sustainable management and development of water resources. What it does demand is that people try to change their working practices to look at the bigger picture that surrounds their actions and to realise that these do not occur independently of the actions of others. It also seeks to introduce an element of decentralised democracy into how water is managed, with its emphasis on stakeholder participation and decision making at the lowest appropriate level.

IWRM planning requires a strong commitment to a future with sustainable management of water resources. It implies political will and leadership from the top leaders and from stakeholders.

Commitment from stakeholders is necessary as they are the ones who strongly influence water management through joint efforts and/or changing their behaviour. Thus planning requires to recognize and mobilize relevant stakeholders, despite their multiple and often conflicting goals.

IWRM is a cross-sectorial policy approach that requires coordination among the different water uses and institutional sectors to respond to the growing demands for water in the context of finite supplies. This process aims at ensuring the coordinated development of water, land and related resources to optimise economic and social welfare without compromising the sustainability of environmental systems. It is a complex and multi-dimensional process that must be customised to the specific geographical, environmental, social, cultural, political and economic conditions of each region and catchments.

1. IWRM legislation

Water management is one of the main milestones for the European Union sustainable development politics. Starting to apply the European politics according the IWRM would give Belarus the possibility to strength contact with the neighbour countries and all Europe. An important question in the policy system of Belarus is the existence of normative frameworks split in numerous laws that result into significant overlapping of jurisdictions among institutional bodies, and consequently leading to conflicts of competence.

The specialized inspectorates perform simultaneously a number of other functions, namely policy development, issuance of permits, and monitoring and control. International practice attests that these functions are served better by independent units within or outside the Ministry.

In Belarus, there are several dozens of documents, which to a certain extent regulate the activities in this sphere. Many articles of the law contain references to other regulatory documents, which complicates the practical use of legislation and sometimes results in different interpretation of the same document.

The normative framework concerning water use and protection in Belarus includes:

- The Environmental Protection Law, which came force in June 1992;
- Constitution of the Republic of Belarus (1996);
- Water Code (1998);
- Drinking-Water Supply Law (1999);

- Tax on Natural Resource Utilization Law (1991);
- Surface Water Protection Regulations being in force since 1991 etc.

At this moment, a number of legislative instruments are under revision, as the departmental normative for issuing permits for water use, establishment of water-protected areas, environmental monitoring, water cadastre, etc.

In the period 1999-2003, Belarus made particular efforts to introduce the norms and principles of international environmental legal acts and commitments. New versions or completely new national environmental laws were adopted, including a framework for integrated environmental licensing, environmental assessment (ecological expertise), norms for pollutant emissions (effluents) and environmental certification.

The Ministry of Natural Resources and Environmental Protection develops draft environmental legislation taking into account that Belarus strives to make this legislation compatible with the European Union's body of environmental law. However, much remains to be done to harmonize the national legal acts with the EU body of environmental law. Adequate legislative framework is then needed, for both solving institutional conflicts and managing the water resources in optimal way.

The concept of the integrated management plans has been introduced by the European Community since years. Regarding to the water sector, integrated management plans are of high importance since water is connected to all the types of human activity such as agriculture, industry, civil water use, all of them are connected since. The integrated management plans are compulsory for the EU members, but not for Belarus.

The European Water Framework Directive (WFD, 2000/60/EC) sets out, for the first time, a detailed and integrated framework for the improved protection and management of all European water resources and aquatic environments from each catchment to the sea. The development and application of normative on the water management in Belarus should apply the statements and the principles of the EU Water Framework Directive.

Appropriate legislation that enables river basin management, in the sense as it is laid down in the EU Water Framework Directive, would require among other things changes in the Water Code concerning the state organisation of water management and the property rights of water resources. The legislation should identify functions of the different state entities in water management and clearly assign responsibilities and define competences of each entity. The legislation should also clearly point out who the owner is of water bodies and therefore the rightful user of the water resources. Another issue which should be regulated is the ownership of land adjoining water bodies. This is necessary as water bodies should be freely accessible for management and protection.

The framework for Community action in the field of water policy has been established by the DIRECTIVE 2000/60/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 23 October 2000. One of the purposes of this Directive is to establish a framework for the protection of inland surface waters.

The River basin management plans introduced by the Directive shall cover the following elements:

EU Normative for IWRM	*Belarus Normative for IWRM state-of-the-art*
1. A general description of the characteristics of the river basin district - mapping of the location and boundaries of water bodies; - mapping of the eco-regions and surface water body types within the river basin; - identification of reference conditions for the surface water body types. Each Member State shall ensure that for each river basin district or for the portion of an international river basin district falling within its territory: an analysis of its characteristics, a review of the impact of human activity on the status of surface waters and on groundwater, and an economic analysis of water use is undertaken.	1. Geographically water management is organised within the administrative units of the republic. Thus river basins are not used as management units for water and river basin standardised mapping for each major river basin is not prepared. However the legislation in principle does not prevent the introduction of the basin principle, although specific organizational and institutional changes would be required for this. No standardised mapping exists. Belarus has cross-border cooperation with all the neighbouring countries in water management questions. In this respect there is also some water basin consideration and here the impacts of the WFD can also most directly be seen.
2. A summary of significant pressures and impact of human activity on the status of surface water and groundwater, including: - estimation of point source pollution, - estimation of diffuse source pollution, including a summary of land use, - estimation of pressures on the quantitative status of water including abstractions, - analysis of other impacts of human activity on the status of water.	2. There is no system for the diffuse sources or combined approach for these in Belarus. The country has a sufficient fixed system to control enterprises (the point sources of pollution). At the same time there is no control on the pollution source in Belarus.
3. Identification and mapping of protected areas. (Register of protected areas 1. Member States shall ensure the establishment of a register or registers of all areas lying within each river basin district which have been designated as requiring special protection under specific Community legislation for the protection of their surface water and groundwater or for the conservation of habitats and species directly	3. No standardized mapping exists (no official maps).

depending on water. They shall ensure that the register is completed at the latest four years after the date of entry into force of this Directive. 2. The register or registers shall include all bodies of water and all protected areas. 3. For each river basin district, the register or registers of protected areas shall be kept under review and up to date)	
4. A map of the monitoring networks and a presentation in map form of the results of the monitoring programmes for the status of: - surface water (ecological and chemical); - groundwater (chemical and quantitative); - protected areas. (1. Member States shall ensure the establishment of programmes for the monitoring of water status in order to establish a coherent and comprehensive overview of water status within each river basin district: — for surface waters such programmes shall cover: (a) the volume and level or rate of flow to the extent relevant for ecological and chemical status and ecological potential, and (b) the ecological and chemical status and ecological potential; — for groundwater such programmes shall cover monitoring of the chemical and quantitative status, — for protected areas the above programmes shall be supplemented by those specifications contained in Community legislation under which the individual protected areas have been established. 2. These programmes shall be operational at the latest six years after the date of entry into force of this Directive unless otherwise specified in the legislation concerned. 3. Technical specifications and standardised methods for analysis and monitoring of water status shall be laid down).	4. There are some automatic monitoring stations in the transboundary waters. Samples are taken 4 to 12 times a year. Some 50 parameters are used to assess water quality, including chemical composition, suspended and organic matters, biogenic parameters, main pollutants, heavy metals and pesticides. There is no automatic monitoring station to ensure continuous water quality monitoring in Belarus. To adopt a modern approach to surface water monitoring, Belarus would have to set up at least 15 background monitoring stations.

5. A list of the environmental objectives for surface waters, groundwater and protected areas (In making operational the programmes of measures specified in the river basin management plans: (a) Member States shall implement the necessary measures to prevent deterioration of the status of all bodies of surface water, (b) Member States shall protect, enhance and restore all bodies of surface water, (c) Member States shall protect and enhance all artificial and heavily modified bodies of water, with the aim of achieving good ecological potential and good surface water chemical status at the latest 15 years from the date of entry into force of this Directive, (d) Member States shall implement the necessary measures with the aim of progressively reducing pollution from priority substances and ceasing or phasing out emissions, discharges and losses of priority hazardous substances)	5. Some of National programs have the same ideas with the WFD. For example in the state programs in the National Activity Plan on the economical utilization of natural resources and the protection of environment for the period 2001-2005 and the state programme on water supply and water-removal "pure water". However, these purposes can hardly be compared with the WFD, since the environmental objectives are to be reached within the certain periods.
6. A summary of the economic analysis of water use (collection of the relevant data in order to: (a) make the relevant calculations necessary for taking into account the principle of recovery of the costs of water services, taking account of long term forecasts of supply and demand for water in the river basin district and, where necessary: estimates of the volume, prices and costs associated with water services, and estimates of relevant investment including forecasts of such investments; (b) make judgements about the most cost-effective combination of measures in respect of water uses to be included in the programme of measures based on estimates of the potential costs of such measures.)	6. Currently, the charge of water-use is described in a number of legislative acts and normative documents, including water code, the law of republic Belarus "about the protection of environment" and "about the tax for the use of the natural resources (ecological tax)". However, as far as payments for the use of available water resources are concerned, they go directly into the local budgets and the principle of “water pays water” does not work, at least, it is not clear. This is an important concern if considering the introduction of the basin principle control system in a real sense. Some of the surface waters use is under control, but there is no overall control and economic analysis. The average per-capita consumption of water in Belarus exceeds twice the analogous index of Europe, which implies an over expenditure of water resources.
7. A summary of the programme or programmes (each programme of measures shall include the basic measures and, where necessary, supplementary measures): - a summary of the measures required to implement	7. Some programmes exist for selected rivers.

Community legislation for the protection of water; - a report on the practical steps and measures taken to apply the principle of recovery of the costs of water use; - a summary of the measures; - a summary of the controls on abstraction and impoundment of water, including reference to the registers and identifications of the cases where exemptions have been made; - a summary of the controls adopted for point source discharges and other activities with an impact on the status of water; - an identification of the cases where direct discharges to groundwater have been authorised; - a summary of the measures on priority substances; - a summary of the measures taken to prevent or reduce the impact of accidental pollution incidents; - a summary of the measures for bodies of water which are unlikely to achieve the Environmental objectives; - details of the supplementary measures identified as necessary in order to meet the environmental objectives established; - details of the measures taken to avoid increase in pollution of marine waters.	
8. A register of any more detailed programmes and management plans for the river basin district dealing with particular sub-basins, sectors, issues or water types, together with a summary of their contents.	8. Such a management plans have been developed within the frame of some projects, but don't exist on the wider level.
9. A summary of the public information and consultation measures taken, their results and the changes to the plan made as a consequence.	9. One of the guide principles of IWRM and of the water governance, as foreseen by the WFD, is the participatory approach. This means that the identification and the knowledge of the social networks in this system is essential. The involvement of water users and keystone

	stakeholders in the decision-making processes is an advantageous. Participation of stakeholders is not applied in Belarus to any greater extent. The amendment to the Law on Environmental Protection adopted in 2002 provide broader rights to environmental NGOs, there are no detailed procedures ensuring public participation in ecological expertise and decision-making regarding environmental permits, standard-setting or the development of laws, regulations, strategies and policies affecting the environment. (United Nations 2005). Belarus has signed the Aarhus convention which regulates public access to environmental information and public participation in the decision-making process. However, the right to public information and participation is defined very broadly in the legislation and detailed provisions on practical implementation are insufficient. Public should be involved into the decision-making process for authorizing the projects. The total absence of public information and participation is noted.
10. A list of competent authorities.	10. In Belarus The Ministry of Environment is the only authority responsible for various permissions issues.
11. The contact points and procedures for obtaining the background documentation and information, and in particular details of the control measures and of the actual monitoring data gathered	11. Some information is available on-line: web site of the Ministry of Natural Resources and Environmental Protection (ecological review: http://minpriroda.by/ru/bulleten); State Institution "Republican Centre of Radiation Control and Environmental Monitoring, Minsk; State Institution "Republican Hydrometeorological Centre, Minsk. It is legislatively declared that background documentation and information can be obtained free of charge, but in reality, the structures listed up, offer to pay a certain sum in order to receive an information.

2. Decision Support System / Spatial Decision Support system for IWRM

The main problem in the Integrated water resources management is the lack of institutional structures that match the broad scope and aspirations of integrated management. The main requirement to make integrated water resources management a reality is to build and empower the necessary institutional structures within the overall system of governance.

Decision makers need a system that justifies the decisions. A Decision Support System (DSS) is designed to make the choice process more open, rational, free of contradictions, eliminate or at least indicate dominated alternatives, make trade-off obvious and thus negotiable, etc.

This most critical role however, must be to offer a sufficiently rich set of alternatives to choose from. Like any other formal, simplifying and thus model based method, DSS suffer from uncertainty and error in data, procedures, and interpretation. On the other hand, numerical representation suggests a certain level of precision.

What is important in a DSS is to make the participants in the decision process at any level start to think in a structured way about the problem. A good DSS provides a common language, by making basic elements of the decision making process more explicit: criteria, objectives, constraints. Once they are defined and agreed upon, the mechanisms of trade-off and compromise should become more obvious, even if any "optimal" solution may be as elusive as ever. It is important to realize that the mechanism to arrive at a decision may be more important than the actual outcome.

A complex, integrated research is needed in order to estimate the environmental state of water resources in Belarus, to give recommendations on optimisation, sustainable use and protection of water resources. The research on the water bodies conditions should adopt the integration of decision–support tools and methods to manage information from various sources and to enhance decision-making through modelling and mapping. The use of decision support systems combining spatial databases, territorial indicators, numerical models, GIS and remote sensing techniques are a viable approach.

The application of DSS to develop plans for Integrated Water Resources Management should be organised in a clear framework of conceptual and knowledge reference system to policy makers and stakeholders in a social network context. A great potential exists for DSS and related tools in the field of IWRM.

DSS is both a process and a tool for solving problems that are too complex for humans alone, but usually too qualitative for only computers. Multiple objectives can complicate the task of decision-making, especially when the objectives conflict. As a process, a DSS is a systematic method of leading decisionmakers and other stakeholders through the task of considering all objectives and then evaluating options to identify a solution that best solves an explicit problem while satisfying as many objectives as possible to as high a degree as possible.

A DSS can be viewed as "an integrated, interactive computer system, consisting of analytical tools and information management capabilities, designed to aid decision makers in solving relatively large, unstructured problems". DSS operate within the spatial-temporal context and permit planners and policy makers to:

- integrate large quantities of existing space-time data,
- use these data as inputs to sophisticated forecasting models for predicting the results of alternative policy choices,
- display the model results in easily understood ways to public officials and private citizens as

well as to the scientific community.

Basic to the use of the DSS is the ability to examine various "what if" situations within the operational context of the spatial or temporal problem. Building a spatial or spatial-temporal DSS generally involves four major activities:

- data acquisition and evaluation,
- database design and construction,
- construction and testing of analytic space-time forecast models,
- primary data and end product visualization.

The main elements of a decision include the design of promising, feasible alternatives and the subsequent selection of a solution (alternative) from a set of alternatives thus generated or identified. This decision process is based on:

1. a set of ***Alternatives***, which can be discrete and pre-existing, or generated on demand;

2. a set of ***Criteria*** describing each of the alternatives; criteria can be qualitative or quantitative, cardinal, ordinal or nominal;

3. ***Constraints*** describing acceptable lower or upper bounds on any one of the criteria; only a solution that meets all constraints is deemed a feasible alternative and subsequently considered;

4. ***Objectives*** or objective function(s), expressed in terms of the criteria that should be minimized or maximized by the selection;

5. A ***Preference Structure*** that defines the relative importance of different criteria in contributing to the objective function, and the different importance of different objectives in an overall evaluation.

Geographic Information System (GIS) technologies have been extensively used for decision-making alongside DSS models. In recent times, Spatial Decision Support Systems (SDSS) technologies have been widely built and marketed by all the big names in the field of GIS which is a powerful tool, wherein complicated operations can be performed with greater ease and better quality information gleaned.

By integrating GIS and decision support systems, decision makers may become active participants in a planning analysis, rather than selectors among a few, pre-planned alternatives.

The integration of GIS and DSS model designs may bring about the following advantages:

- a GIS serves as a basic platform from which a DSS may be developed;
- the system integration provides an effective functional coupling of spatial data, spatial simulation and optimization models;
- it supports various analysis techniques for solving spatial conflicts of different objectives, and for spatial decision making.

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