Sustainable Water Resources Development as Part of the Integrated Water Resource Management for Mureș River

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Abstract. The special importance of water and the many problems that its current use causes has led to increasingly intense and widespread concerns of international bodies. Freshwater is an exhausting and vulnerable resource essential to sustain life, development and the environment. Water development and management must be based on the principle of participation, involving consumers, planners and decision-makers at all levels. Integrated water resource management is a process that promotes coordinated development and management of water, land and related resources to achieve maximum growth in economic outcomes and social status in a fair way without compromising the sustainability of vital ecosystems.

1. Introduction

Integrated water resource management is a process that promotes coordinated development and management of water, land and related resources to achieve maximum growth in economic outcomes and social status in a fair way without compromising the sustainability of vital ecosystems. Integrating can be seen from different points of view by the reference system: the natural system is essential for the availability and quality of water resources; the human system determines the use of resources, waste production and water pollution and thus influences development priorities.

Integration must be done within and between these systems, taking into account the variability in time and space. Contemporary managerial policy is based on the neutral role of the manager who manages the natural system to satisfy the human system.

Integration into the natural system - The exploitation and sustainable development of the natural system must take into account the components and the correlation strategies between them. Thus, the management of inland water resources must be correlated with that of coastal areas, because there is certain continuity between these water types. Water management at the basin level starts from the existence of the ecosystems of the natural system that determine the relationships between quantity and quality, the interests of upstream and downstream consumers. Water management should treat surface water and groundwater resources integrated, and there is continuous correspondence between the two systems: a drop of water falling into a river basin may alternatively appear as surface water and groundwater in its way towards downstream. Underground water resources make up the water supply for much of the world's population. Chemical treatments applied to agricultural crops and pollution from diffuse sources is increasingly aggressive threats to groundwater quality, and pollution is usually irreversible at the human time scale under current technology. Integrating quantity and quality into water resource management is an important element of strategy. Users are demanding
certain quantities of water of a certain quality according to the intended use. This element is related to the integration of upstream and downstream interests on water, upstream pollution degrades downstream water quality, the modification of upstream land uses produce changes in groundwater recharge and in downstream seasonal flow formation. Water management must take into account the interests of all users and apply strategies to prevent conflicts between consumers.

Integration into the human system - The human system, made up of all activities and the population that uses water, depends on the availability and quality of these resources. At the same time, the human system determines the vulnerability of water as a resource through the use and return of wastewaters in the natural environment. Water policy has to be integrated with national economic policy and national sectorial policies whose impacts on the environment in general and water in particular need to be highlighted through specialist studies. The water resource planning and development programs produce important macroeconomic effects. Thus, water transfer between river basins can develop energy activities with major economic impacts, protect flood-related areas, create jobs in hydro-technical constructions, etc. at the same time, important financial resources are being consumed that can affect investments in other economic and social sectors. The development of integrated cross-sectorial policies is difficult to achieve in practice, but there are some basic principles that can contribute to better implementation of integration: launching large-scale water investment programs must be based on a realistic balance of payments the macroeconomic impact of investment; river basin planning and use programs should take into account the consequences of proposed land use projects as well as external costs and benefits to the natural water system; policies involving increased water demand, including the removal of residual products, need to be developed only in the knowledge of global growth and related costs; regulations on the distribution of water between different uses must be based on relative usage values expressed in economic and social terms; applying the principle of subsidiarity by assuming tasks starting from the lowest operational level.

Integrated water resource management also requires the involvement of all stakeholders - public and private - at all levels and at the time ported. Decisions and actions in the field of integrated water resource management must be taken by all those who may be affected at the most appropriate level (the principle of subsidiarity). The use of water resources or whatever it is should be organized so as not to be depleted or to reach a critical threshold that affects ecosystems and the possibility of future generations to use them.

1.1. The aim and the scope of the article
Water is one of the fundamental elements of life and, at the same time, a factor that determines social and economic development and is often a limiting factor. Society and the economy will be able to develop only to the extent that water management will develop and this conditioning marks the role and importance of activity in the context of sustainable development. Integrated water resource management is based on the Basin River Basin Management Plan, in accordance with the provisions of the EU Framework Directive 2000/60. Based on knowledge of the status of water bodies, this Plan sets out the six-year target objectives and proposes measures at river basin level to achieve good water status for sustainable use [1,2].

2. The principles of integrated water resources management
Among the global problems faced by mankind at the beginning of the third millennium are the lack of water and the degradation of water quality. Also, the achievement of the sustainable development objectives depends to a great extent on the integrated management of water resources. Water is an essential factor for the existence of life and the development of human society. For integrated water resource management, the international community has recommended governments to apply the following principles: [3]
- basin principle - water resources are formed and managed in river basins. Freshwater is a limited resource and vulnerable, essential for life, the environment and social development. Rational management of water resources requires a global approach combining social issues and economic development with the protection of natural ecosystems. Sustainable water management will integrate water users from a river basin;

- unitary management principle quantity-quality - the both parts of water management are closely linked, it results that a unitary approach is needed leading to optimal technical and economic solutions for both aspects;

- the principle of solidarity - planning and development of water resources involve the collaboration of all actors involved in the water sector: the state, local communities, users, water households and NGOs;

- the "polluter pays" principle - all expenses related to a pollution of various water users and the environment is borne by the polluter;

- the economic principle - the beneficiary pays, water has an economic value in all its forms of use and must be recognized as an economic good. Past failures to recognize the economic value of water have led to pollution and unreasonable exploitation of water resources. Water management, as an economic asset, is an important way to achieve efficient and equitable exploitation and to conserve and protect water resources;

- the principle of access to water - by virtue of this principle, it is vital to recognize that the fundamental right of the human being is to have access to clean and sufficient water at an appropriate price.

The principles underlying the concept of integrated management of water resources combining water use problems with the protection of natural ecosystems by integrating a basin-wide water use.

3. Study area

The Mureş River Basin (Figure 1) is located in the central and western part of Romania and springs from the Oriental Carpathians (Giurgeului Depression), the Hâşmasul Mare Mountains. The Mureş River Basin is bordered at North by the Crişuri and Someş River Basin, to the South with the Banat River Basin, the Jiu and Olt River Basins, the Siret River Basin at the West and the Hungarian border to the East. Up to the border with Hungary, it runs its 761 km long, the longest of the country's inner rivers. The coded hydrographic network is summing 797 water courses and 10861 km, ie 13.7% of the total length of the country's codified network with a density of 0.39 km / km² compared to 0.33 km / km² - the country’s average [4].

The area of the upper course is delimited by Giurgeului Depression and Toplița - Deda Gorge, the middle course is represented by the central area of the Transylvania Plateau, and the lower course is delimited by the Apuseni Mountains, the Meridionali Carpathians, the Banat Mountains and the Western Plain (between Lipova and the border with Hungary). Total surface water resources in the Mureş catchment area total approx. 5876,3 mil.m³ / year, of which the usable resources are approx. 1054,07 million m³ / year. They represent approx. 88,9% of the total resources and are mainly formed by the rivers Mureş, Târnave, Arieş, Strei, Cerna and their tributaries [5].

The water resources cantonated in the Mureş river basin can be considered as having sufficient resources water, but unevenly distributed over time and space.
The situation of the usable water resources in the Mureș catchment area, according to the degree of development and calculated for the hydrological conditions of 2013, is as follows:

- within the Mureș hydrographic basin, of the total multiannual volume of surface and underground water resources of about 6.3 billion cubic meters, about 92% of the surface water resources (5.8 billion cubic meters);

- the groundwater resources cantoned within the Mureș basin amount to about 464 million cubic meters;

- of the total of 610.954 million cubic meters - volume of water taken at basin level, 94.35% is the surface source, the difference being groundwater.

The volumes of water actually captured in the years 2001-2017 are relatively close, the differences occur especially from the energy industry. The potential and technical water resources usable for 2017 are shown in Table 1.

The amount of water prelevation for 2017 were 663216.768 thousand of m³, 86759.338 768 thousand of m³ for population, 500495.144 768 thousand of m³ for industry and 75962.286 768 thousand of m³ for agriculture activities.
Table 1. The water source of hydrographic Mureș basin

|                             | Total (m³ x 10³) |
|-----------------------------|------------------|
| **Intrenal rivers**         |                  |
| 1. Theoretic resource       | 5876340.696      |
| 2. Real resource according to the hydrographic basin arrangement | 1091522.600 |
| 3. The water demand, according to the catchment capacity in use | 1054953.308 |
| **Groundwater**             |                  |
| 1. Theoretic resource       | 463545.76        |
| 2. Groundwater              | 297479.08        |
| 3. Deep water               | 48276.258        |
| **Total resources**         |                  |
| 1. Theoretic resource       | 6339886.456      |
| 2. Water demand for user, according to the existing catchment capacities | 1103229.566 |

Figure 2. The water volume dynamic for water catchment in the Mures catchment

According to the water quality summary of Mures Hydrographic Basin in the year of 2017, the water quality characterization was performed on water bodies, taking into account the limits assigned to the quality indicators for each type of water.

For the natural water bodies (natural rivers and lakes) the ecological status (5 classes of quality) and the chemical status (2 quality classes) were determined.

For the heavily modified water bodies and artificial water bodies (rivers and reservoirs) the ecological potential (3 classes of quality) and the chemical status (2 quality classes) were determined. Concerning the artificial water bodies, the only body of artificially monitored water has been classified.
as potentially ecologically moderate or good in good chemical status. In terms of lakes in 2017, 1 natural lake was monitored, fitting to good environmental status and good chemical status.

In the Mureș hydrographic area, 25 bodies of groundwater have been identified, of which 2 bodies are cross-border. In 2017, 22 bodies of groundwater were monitored qualitatively at the level of: 92 hydrogeological drillings and 26 springs.

In addition to these drillings and springs, 13 control drillings have been monitored in the area of pollution sources. The assessment of the quality of underground water bodies was made according to Environmental Ministry Order no. 621/2014 regarding the approval of threshold values for groundwater bodies in Romania.

The surface wastewater characterization for the year 2017 consist in water prelevation from 278 discharges, of which 220 through treatment plants, the prelevation frequency ranging between 12 prelevation / year and two prelevation / year, depending on the influence of each use on the receptors.

Urban waste water is defined as domestic sewage or a mixture of domestic sewage with industrial waste water and / or rainwater leakage.

Water pollution caused by human agglomerations is mainly due to the following factors:

- Reduced population rates connected to sewage collection and treatment systems;

- The lack of public water supply, sewage and treatment services that play an important role in improving the quality of life;

- Due to the reduced connection rate of the population to sewage collection and treatment systems, the pollution of the rivers occurs through the discharge of domestic waste water through gullies, directly into the river and pollution of the groundwater through the infiltration of the wastewater into the soil;

- Inappropriate operation of existing treatment plants;

- Inappropriate waste management;

- Surface water quality is influenced by wastewater discharges when they are not pre-treated or inadequately cleaned before being discharged into the receiver.

Increasing the amount of organic substances in water, synonymous with water pollution, favors long-term persistence of germs, including pathogens. Decreasing the amount of oxygen dissolved in the water leads to the reduction of self-purification capacity of natural waters, favoring the persistence of pollution. The increase in CBO5 characterizes the degree of contamination of water with organic substances, and it is therefore supposed that the increased values are accompanied by an obvious increase of organic substances.

For instance, due to the special weather conditions of 2005, especially in spring-summer, there was a significant increase in the average concentrations of total suspensions in the Mureș River, the increase being influenced by the floods this year.

However, wastewater treatment plants are the main means for the treatment of polluted waters, but if they do not function properly, they lead to pollution of surface waters with organic substances, nuts and toxic substances [5].
Figure 3. The county distribution for the evacuated ammonia quantity.

Figure 4. The county distribution for the organic substances evacuated CBOs.

4. Conclusions and strategies for the sustainable use of water resources

Overall, national strategies and programs on the environment are in line with the Renewed EU Sustainable Development Strategy and aim at achieving the specific objectives as follow. Improving the quality and access to water and waste water infrastructure by providing water and sanitation services in most urban areas. Establishing effective regional structures for water / wastewater management.

Given the state of the existing water management infrastructure under the Accession Treaty to the European Community, Romania has achieved transition periods for complying with the acquits on Municipal waste water collection, discharge and treatment. It is intended to promote integrated water and wastewater systems in a regional approach to provide water and water to the population and other consumers at the required quality and at acceptable rates.

The Basin Management Plan is a tool for implementing the Water Framework Directive, aiming to propose measures to achieve good water status and prevent its deterioration. The Operational Program for Environment financed by Cohesion Funds ensures through the European funds and state budget funds, the development of the water and wastewater infrastructure through important investment projects in all the counties part of Water Basin Administration Mureş.

The Directive 91/271/EEC on Urban Waste Water Treatment has been fully transposed into Romanian legislation by Government Decision no. 188/2002 for the approval of the norms regarding the conditions for discharge of waste water into the aquatic environment, modified and completed with the Government Decision no. 352/2005.

The central objective of the directive is to protect the environment from the negative effects of discharges of urban waste water and waste water from certain industrial sectors (mainly the processing and manufacturing of food products). Concerning the floods, action will be taken to streamline interventions after floods and other natural disasters (earthquakes, landslides) by creating special operations units, training and equipping them with equipment such as improving warning systems and public disclosure of risks. To the extent that the financing needs for water and wastewater management are covered, according to the objectives assumed by the Accession Treaty to the European Union, the localities with more than 2,000 inhabitants will have the supply of quality drinking water and access to sewage, as well as endowment with waste water treatment plants in 100% since 2018. The process of improving water services, sewerage and wastewater treatment in smaller rural areas will continue. In 2021, the management and planning plans for basins and river basins will be reviewed.
The flood risk management plan will be finalized and published by December 2015, and in 2018 a preliminary assessment will be made, introducing the necessary adjustments. Gambling maps and flood risk maps will be reviewed by December 2019 and updated every 6 years thereafter. Based on the analysis of the results obtained by 2013, the intervention areas, the priorities for action and the financing needs for the next period will be reassessed. Like any strategic document, the Basin Management Plan needs to be updated every 6 years. After updating, it should contain a summary of all changes or updates since the release of the previous version, an assessment of the progress made towards achieving environmental objectives including the presentation of the results for the previous plan map plan and an explanation for any environmental objectives have not been met.

The Basin Management Plan is closely correlated with socio-economic development and is the starting point for management measures in all branches of the economy, water management measures at the basin and local level and highlights the major factors influencing water management in a hydrographic basin. Also, the management plan establishes the necessary decisions in the water economy and the development of objectives for a sustainable, unitary, balanced and complex water resource management.

References
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