ADVANCED SURFACE WATER QUALITY MONITORING IN THE PROTECTED AREAS OF EASTERN SERBIA

Dejan Vasović
University of Nis, Faculty of Occupational Safety
djnvasovic@gmail.com

Miomir Stanković
University of Nis, Faculty of Occupational Safety
miomir.stankovic@gmail.com
Milan Gocić, University of Nis, Faculty of Civil Engineering,
mgocic@yahoo.com

ABSTRACT: Water is a complex issue embedding different disciplines from biology, chemistry, physics, law, economics, and politics. However, water quality is affected by many other factors. It's very important to have a holistic approach to do a better assessment and management of a catchment. Previous research and evaluation of anthropogenous effects of discharged wastewater conducted in eastern Serbia, clearly indicates a necessity of advanced surface water quality system development. As the starting point of this research, the protected areas within Studena river basin were chosen. Besides theirs importance as protected areas, abovementioned sites are of tremendous significance for regional water supply system. The biggest water supply sources from which city of Niš is supplied with drinking water are located in this area. Those sources consist of three smaller capped springs, with the flow capacity up to 400 l/s. The paper provides an overview of the necessary activities:

- identification of tracking changes indicators of the quality of surface waters in the protected areas,
- establishment of standardized water quality monitoring in the areas, in compliance with the EU directives in this domain,
- realization of interoperability with information systems used by decision makers, as well by institutions involved in the process of water quality control and preservation.

Keywords: surface water quality, monitoring, protected areas

1. INTRODUCTION

The EU Water Framework Directive implementation process (WFD, 2000/60/EC) in Serbia started at the early beginning of 2004. With regard to this fact, basics of sustainable water management must be considered as the analysis of the international legislation and praxis related to it. In accordance with Water Framework Directive, monitoring, assessment process and integral management of surface waters quality should be based on ecoregional approach, meaning both antropological and hydro morphological assessment. Current state of surface waters quality management praxis in the Republic Serbia need to be improved, with regard to future activities. The basis for monitoring redesign and establishment of intercalibration network is provided (in legislative sense). Basic aim of mentioned water monitoring system redesign is to enable efficient, reliable and comparable evaluation of quality status of surface water bodies. Also, it is important to recognize that ecoregional approach allows both better management of transboundary basins and decentralization of institutions in charged.

During the past several years there have been changes in the conception of the environmental monitoring system. The growing public interest in environmental protection and sustainable development calls for a diffusion of information from the surrounding towards all social groups. This leads to a conclusion that strengthening the ties between scientists, managers, and organizations can contribute to a more adequate ecosystem protection management (Branković, Gocić, Stanković,Trajković, & Stanković,2006). European and American legislators are taking into consideration the indicators of environmental quality, which enable communication with the public in real time, i.e. at the moment of accident; likewise, these indicators enable accident identification. It is also necessary to include media services in environmental management systems. Development of resource management consistently identifies adaptive monitoring of ecosystems as an underdeveloped tool required for protection of the environment, i.e. biodiversity.

Eastern Serbia covers the area of 7 133 square kilometers, with total number of 284 000 inhabitants. Within the region there are two protected areas: The Djerdap National Park (largest in Serbia and one of the largest in the Europe) and Stara Planina Nature Park. It is still not completely explored and hides numerous environmental treasures, lake Canyon of Jerma river which is widely known by its natural beauties – waterfalls, caves and rare flora and fauna. Within Stara Planina Natural Park there are located a few river basins, relatively small in sense of surface that drains, but with significant importance both for biodiversity protection and for human needs. Examples are basins of Temska, Visočica, Jerma, Kutinska, Jelasnička, and Studena river.

2. PREVIOUS RESEARCH ACTIVITIES

Both Serbian Institute for Nature Conservation and Republic Hidrometeorological Service of Serbia monitors the conditions of ecosystem in the protected areas of Eeastern Serbia. In April 2004, the Serbian Institute for Nature Conservation – Niš Office began realization of the project "Improvement of the conditions of management and control of water and environmental resources in the City of Niš – Serbia", financed by the Italian Government via the Italian Ministry of Foreign Affairs. The main

partner in the project realization was the City of Niš while other partners were five Niš municipalities (Mediana, Palilula, Crveni Krst, Pantelej, and Niška Banja) public communal enterprise Medijana (departments of sanitation and landscaping), public water supply enterprise Naissus, and public forest management enterprise Srbijašume. The project included hydro-biological research of surface water quality in the protected areas of Jelašnička and Sićevačka Gorges (placed within Eastern Serbia, i.e. within Ecoregion No 7 (Eastern Balcan)). In accordance with the Water Framework Directive (European Comission,2003), that research included both physicochemical (thermal and oxygenation conditions, salinity, acidification status) and biological elements (flora and fauna). Another previous research and evaluation of anthropogenous effects of wastewater indicated a necessity to develop monitoring system for surface water quality in the protected areas of Jelašnička and Sićevačka Gorges, i.e. in the Studena river basin (Gocić,Stanković & Stanković,2006; Trajkovic,Brankovic &Simic,2006; Branković, Gocić, Stanković,Trajković, & Stanković,2006)

2.1. THE STUDENA RIVER BASIN

The Studena river basin is located to the southeast of Niš. The area of the basin covers the surface of about 5,700 hectares, whereas the river itself is 11,553 metres in length. The basin is situated at 433 metres above sea level on average. Over 80% of the basin is wooded land, while the rest of it is covered with arable land or residential areas. Studena river basin is located within the Ecoregion No 7 (Eastern Balcan)). One of the biggest water supply source from which Niš is supplied with drinking water is located on this river. The source consists of three smaller capped springs, located south of the village of Donja Studena, with the capacity between 240 and 400 l s^{-1}. It satisfies one quarter of the total water demand of the City of Niš. The water, with its excellent chemical content, is sent to the city reservoirs after processing, which only includes chlorination. Two parts of the basin are government-protected: the Kunovica Gorge (ca1,560 ha) as a part of the Sićevačka Gorge Nature Park, and the Jelašnička Gorge (116 ha) as a special natural reservation. The banks of the Studena are home to the following villages: Gornja Studena, Donja Studena, Čukljenik, and Jelašnica, with a total population of 2,700. The average age of the residents is ca 43 and an average household owns 0,9 ha of arable land. The working part of the population is mostly employed in industry, so the land is cultivated solely for private purposes and there is no widespread use of pesticides and artificial fertilizers. There is no industrial activity around the basin. The river is exposed to excess waste water, since there is no sewerage in the villages and all waste water is discharged directly into the river. The locality upstream of Gornja Studena village represents a part of the water course that retained almost all of natural characteristics. The locality downstream of Gornja Studena village represent clear evidence of human influence primarily caused by nutrients from agriculture and from wastewater directly discharged from households.

2.2. PROJECT OBJECTIVES

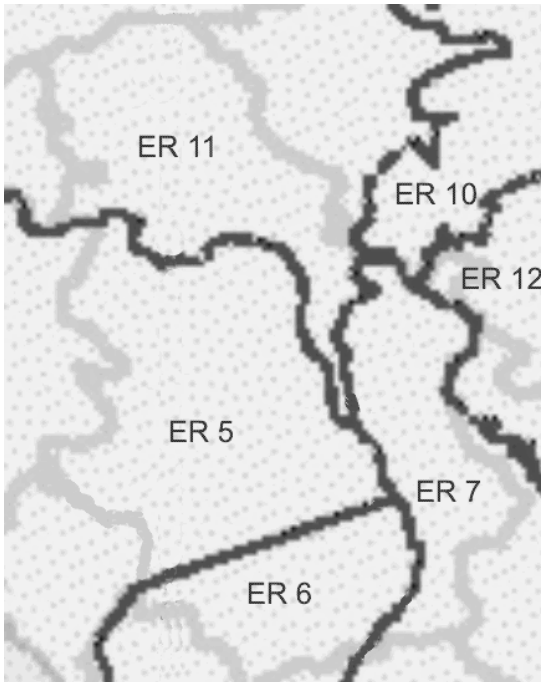

Fig 1: Europe ecoregions for river and lakes – areas in Serbia [4]

Starting from the report by the Serbian Institute for Nature Conservation – Niš Office about environmental quality in the protected areas of Jelašnička and Sićevačka Gorges, and the EU Water Framework Directive (European Comission,2003; European parliament & the council of the european comission,2000), the necessary objectives have been defined. They are based on adequate past and present knowledge and potential future conditions of the ecosystem.

Primary objectives:

- identification of parameters for tracking changes in the quality of running waters in the protected areas of Jelašnička and Sićevačka Gorges,
- establishment of a program of long-term standardized measuring and observation of water quality in the areas of Jelašnička and Sićevačka Gorges, in compliance with the EU directives for this domain (European Comission,2003),
- realization of interoperability with information systems used by decision makers (planners, executives, and managers at the Serbian Institute for Nature Conservation and JKP Naissus), local and regional authorities (Niška Banja Municipality and the City of Niš), as well as by institutions involved in the process of water quality control.

Specific objectives:

- Synchronization of running water quality monitoring in the protected areas of Jelašnička and Sićevačka Gorges with the EU Water Framework Directive;
- Optimization of the water quality monitoring system by automation of the testing process and selection of indicators and locations for testing;
- Consequent monitoring of quantitative (physicochemical, hydro-biological and microbiological) and qualitative (water flow and water speed) features of fluvial ecosystems in the protected areas of Jelašnička and Sićevačka Gorges;
- Establishment and support to local partner organizations (Institute for Nature Conservation – Niš Office, JKP Naissus) in nature protection, to special needs of the population, and to preservation and control of water supply sources;
- Constant monitoring of the water flow ecological values in terms of preservation of ecological status and natural resources;
- Active participation of the general public in the process of informing and consulting on the condition, causes and evaluations of water quality;
- Introduction of e-learning pertaining to running waters.

For the realization of these objectives, the following activities should be considered:

- Analysis of surface water quality;
- Selection of quality parameters and sampling locations;
- Concept of the system for surface water quality monitoring;
- Installation of automated measuring stations;
- Hydro-biological research of surface water quality in the protected areas;
- Monitoring system test phase;
- Reporting to target groups about water quality.

Fig 2: Ecoregion 7; PA – protected area of Stara Planina

2.3. SYSTEM FOR SURFACE WATER QUALITY MONITORING

Actual operational jobs in surface water quality monitoring program are mainly covered by Republic Hydrometeorolological Service that exploits over 200 measuring stations. The majority of those stations (2/3) are of old design, semi-automated. Many analyses are done by daily sampling procedures, requesting additional staff. Simplified scheme of existing surface water quality monitoring system is shown on Figure 3.

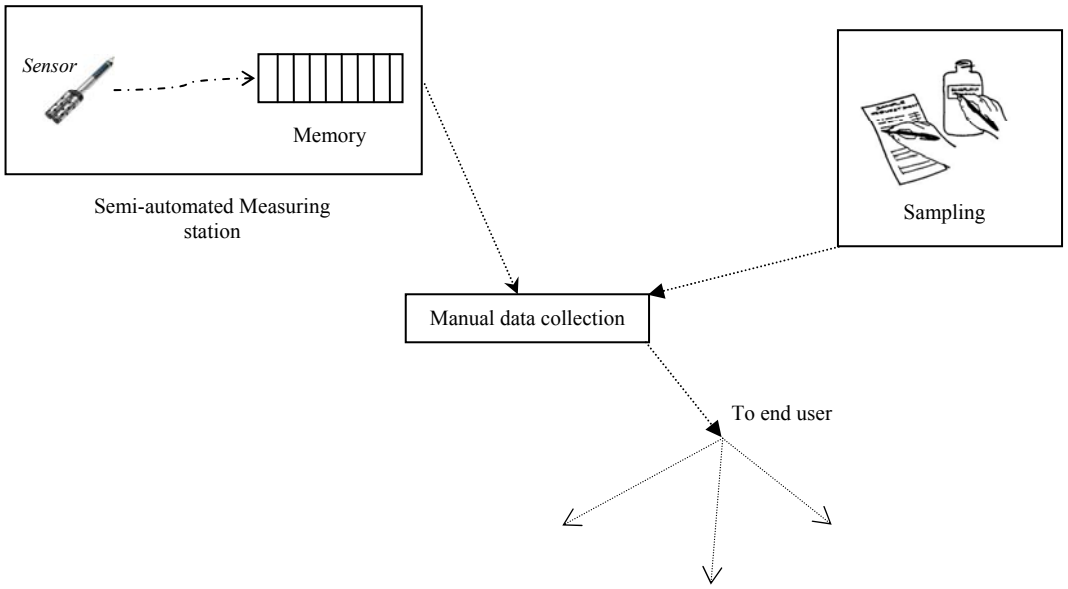

Fig. 3: Surface water quality monitoring system – basic concept

Existing monitoring system could be optimized by partial or complete automation of the testing processes and selection of indicators and locations for testing. Data transfer and reporting procedure are also subjected to possible upgrade to the advanced system for surface water quality monitoring.

3. ADVANCED SYSTEM FOR SURFACE WATER QUALITY MONITORING

Advanced system for surface water quality monitoring, i.e. monitoring running water quality enables collection, transfer, and modeling of data, and informing target groups on running water quality in the protected areas of Jelašnička and Sićevačka Gorges.

The monitoring system will comprise the following elements:

- Automated measuring stations for measuring water quality parameters,
- Transfer units,
- Appropriate software for communication with the measuring station, for work with the database, for data processing and formation of a model for water quality evaluation, for interoperability with other systems, for creation of reports and visualization of data.

Special attention is given to the development of a module for communication with the measuring station and for interoperability.

Data collection would be performed by a measuring station which consists of:

- transmitter-type sensors;
- electronic module for generating trigger impulses of the type 'request for sampling measuring units at a random moment', in order to track sudden quick changes in the measuring parameters;
- electronic module for data storage with battery;
- communication modem;
- solar charge unit.

Connection of remote measuring stations into a unified system is realized by connecting measuring stations into a virtual private network service.

The software will enable the signals, which are read directly from the sensors, and in a format depending on the measuring station type and on the manufacturer, to be formatted in a form suitable for transfer and unique within the whole measuring stations network system. The role of the server software is to receive measuring parameters from measuring stations and automatically create a unifying report in the format required by the Serbian Institute for Nature Conservation for its database.

The interoperability module will enable exchange of information with other information systems. This is especially significant in the process of tracking quality parameters of surface waters, considering the fact those institutions which monitor water quality parameters possess their own information systems, and that it is necessary to have access to data from other institutions in order to efficiently make quality decisions within one institution. The interoperability module will be designed in a manner which will completely separate data display from data storage. The system can be dynamically connected to information sources, but it can also dynamically alter the user interface in accordance with user privileges.

In case of unforeseen circumstances, the system will enable asynchronous readouts from individual measuring stations, or summoning of a desired station. Thus, it is possible to obtain measuring from separate measuring stations which might be of interest in a given situation, in irregular order and with a desired reading frequency. A two-way asynchronous communication with individual measuring stations also enables administrators to reconfigure remote measuring stations without any need for physical access to those stations, which may be located in inaccessible areas already covered by the mobile telephony signal.

Realization of data transfer from a measuring station to end user is represented in figure 4.

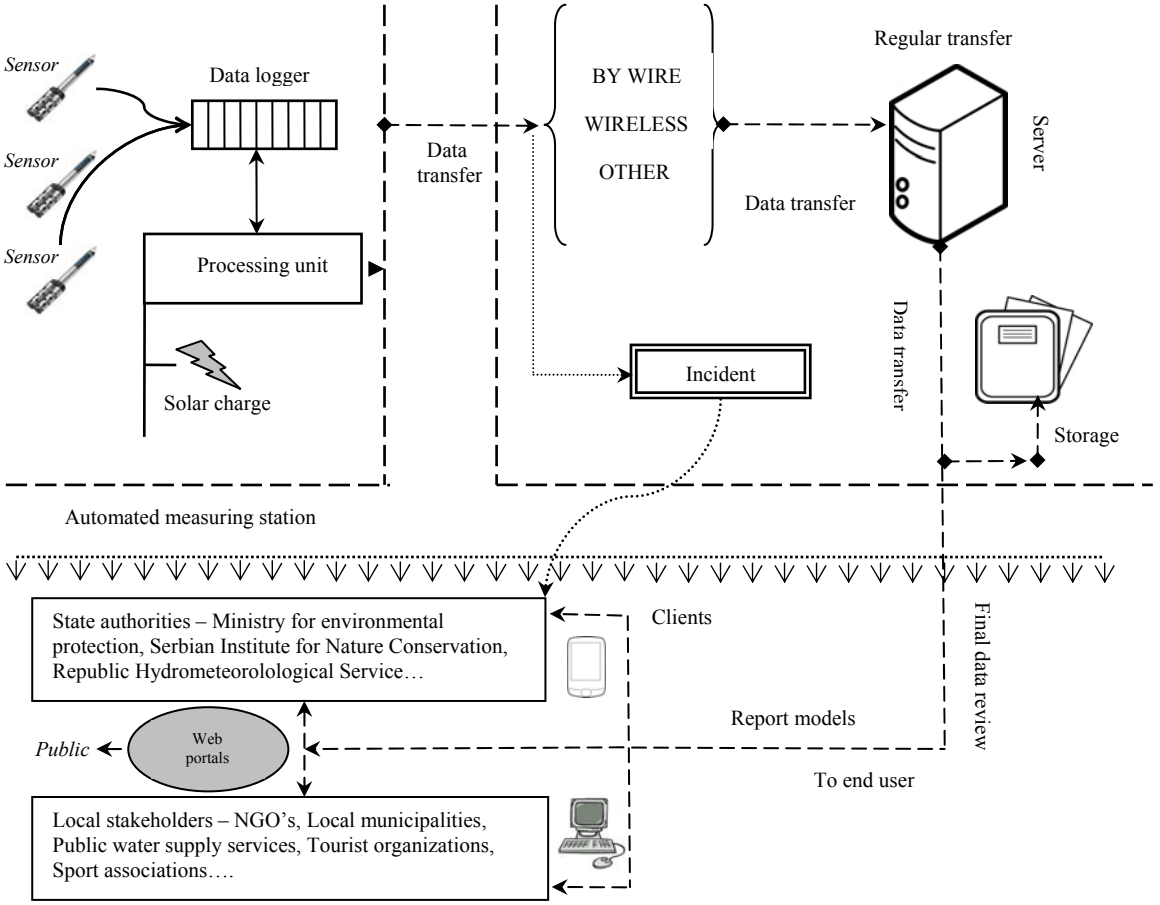

Fig. 4: Advanced system for surface water quality monitoring

4. RECOMMENDED ACTIVITIES

Most water catchment areas in our country are being threatened so fast with pollution due to massive environmental degradation as a result of uncontrolled human activities and unplanned urbanization. This has resulted in increasing cases of water related issues; hence there is need for proper water quality management in order to alleviate this catastrophe. A successful program of ecosystem monitoring enables analysis of both the condition of the ecosystem and the interdependence between this system and social and economic systems. The program of ecosystem monitoring based on the interests of a community(Yarnell& Gayton ,2003)is a process with the help of which NGOs and groups of communities or individuals participate in the monitoring of selected types, areas, or processes of an ecosystem. All this is aimed towards upgrading management of ecosystems and natural resources and towards enabling the abovementioned analyses. These analyses represent a basis for developing a system for decision-making support in the management of surface water quality in protected areas.
The following activities are being planned:

- integrating the water quality monitoring system into the information system of the Serbian Institute for Nature Conservation,
- developing a module for team work support,
- development of a module to support knowledge-based decision making.

5. CLOSING REMARKS

The paper provides an overview of the activities that should be done in order to improve current surface water quality monitoring system. Starting from previous researches and guidelines for Water Framework Directive implementation, activities have been defined, based on adequate past and present knowledge and potential future states of the ecosystem. Also, the paper evaluates the possible conception of the advanced surface water quality monitoring system. Special attention is given to the development of a module for communication with the measuring station and for interoperability.
Nevertheless, it is particularly important to state that the realization of abovementioned activities would enable the future development of adaptive management of running water quality in the protected areas of Eastern Serbia, which combines local community opinions and defines room for dialogue on the implementation of water preservation strategy.

References

Branković S., Gocić. M., Stanković P., Trajković S., & Stanković M. (2006). Running water quality monitoring in the

Gocić M., Stanković P., & Stanković M. (2006). GPRS as a tool for water flow and water pollution monitoring. *Proceedings from SYM-OP-IS 2006, Banja Koviljača, Serbia.*

Illies, J. (1978). Limnofauna Europeae. 2, überarbeitete und ergänzte Auflage. *G. Fischer Verlag, Stuttgart, New York, pp.552.*

protected areas of Jelašnička and Sićevačka gorges. *Project of Serbian Institute for Nature Conservation* – Niš department.

The European Commission,(2003).Common Implementation Strategy for the Water Framework Directive. *Directorate General Environment of the European Commission Guidance Document No. 7,Brussels.*

The European Parliament & The Council of the European Union(2000). Directive 2000/60/EC of the European Parliament and of the Council of the 23. Official Journal of the European Communities. L 327.

Trajkovic S., Brankovic S., & Simic V. (2006). Analysis Of Pressures And Impacts On The Watershed Of Studena River According To The Water Framework Directive. *Proceedings from BALWOIS Conference, Ohrid, Macedonia.*

Yarnell P., & Gayton D. V. (2003). Community-based Ecosytem Monitoring in British Columbia, A Survey and Recommendations for Extension. *FORREX – Forest Research Extension Partnership. Kamloops*.