Implementation of Online Monitoring Stations to Secure the Iaşi (Romania) Drinking Water Supply

Drinking water production from river water is a serious challenge. The quality of river water can fluctuate rapidly and it is sensitive to accidental pollution. To deal with such a variable source, active management of water intake and production processes is required. This is especially important when the water is taken directly from the river without the luxury of a storage reservoir or bank infiltration to reduce variability and improve water quality. Therefore, for effective management, access to reliable (near) real-time information on water quality and changes therein is essential.

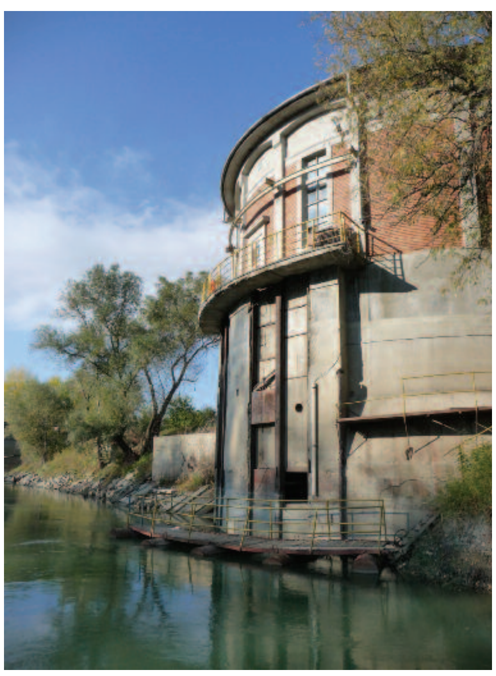

Figure 1: Water intake station on the Prut River.

Author Details:
Corina Carpentier (MsC.)
Aquatic Ecologist / Water Quality Expert
Dr. Joep van den Broeke
Water Quality and Sensoring Consultant
Benten Water Solutions
De Nieuwesluis 2
8064 EB Zwartsluis
the Netherlands
Tel: +31 85 877 03 86
Email: info@benten-water.com
Web: www.benten-water.com

The Need for Monitoring in Iaşi

This paper describes an example of a pilot project for Apavital Water Company in Iaşi, Romania, executed as part of a project funded by the Dutch Ministry of Economic Affairs. Besides Benten Water Solutions, the Dutch project team consisted of Dunea (water supply company), Interline Systems, Het Waterlaboratorium, and Biemond Business Support. The project assisted Apavital with the implementation of an intake management system. Apavital uses a combination of groundwater and river water from the Prut and Moldova rivers, the Prut being the primary source (Figure 1). The water in these rivers is heavily affected by anthropogenic activity and its quality can vary rapidly. Current monitoring is based on grab sampling every 4 hours and focuses on a limited number of parameters. No organic parameters are analysed regularly. This approach is unsuitable to detect contamination from raw sewage, industrial pollution and pesticides, although this is known to occur. Apavital's goal for the intake management is the identification of high-impact contamination in the river water within a time frame which allows an effective response to reduce or avoid an adverse impact on drinking water quality. Apavital can respond to water quality issues by changing the mixture of the water sources, adjusting the ratio between groundwater, river water and water from Lake Chiriţa, a small storage reservoir. Adaptation of the treatment processes, which include coagulation, dosing of powdered activated carbon, activated carbon filtration and chlorination, is also possible. But as these were not designed to deal with high concentrations of dissolved chemicals, the efficacy of such a response is only limited. To support the decision-making process, two early warning monitoring stations (EWMS) for the Prut and Moldova rivers were designed and implemented.

Analysis of the monitoring requirements

To design an EWMS, a stepwise approach needs to be followed, which includes the inventory of monitoring priorities, and a survey of operational requirements and limitations. A schematic overview is shown in Figure 2.

In the Apavital example, the first step (A1) in the design process consisted of a survey of the industrial, domestic and agricultural discharges upstream of the abstraction points. Over 300 concentrated pollution sources were identified which discharge directly or indirectly into the Prut river alone. Major sources included (large) urban agglomerations, a high percentage of which have inadequately functioning WWTPs; power plants, chemical and metal industries; untreated leakage of solid waste landfills, both municipal and industrial; and diffuse and point sources from agriculture. Based on the results of this inventory, a list of 'Priority Compounds' was compiled.

Following the survey of contamination sources, a sampling campaign was performed to analyse specific discharge points as well as map the general river water quality (A2). A lack of adequate, recent, water quality information made it impossible to evaluate the impact of the identified pollution sources and to verify whether the shortlist of priority substances was appropriate and complete, since parameters such as pharmaceuticals, pesticides and metals were not included in the regular monitoring programme. Monitoring of such parameters was considered essential, as the presence of significant levels of these contaminants were expected. During the sampling campaign grab samples were collected and screened for a broad range of analytes.

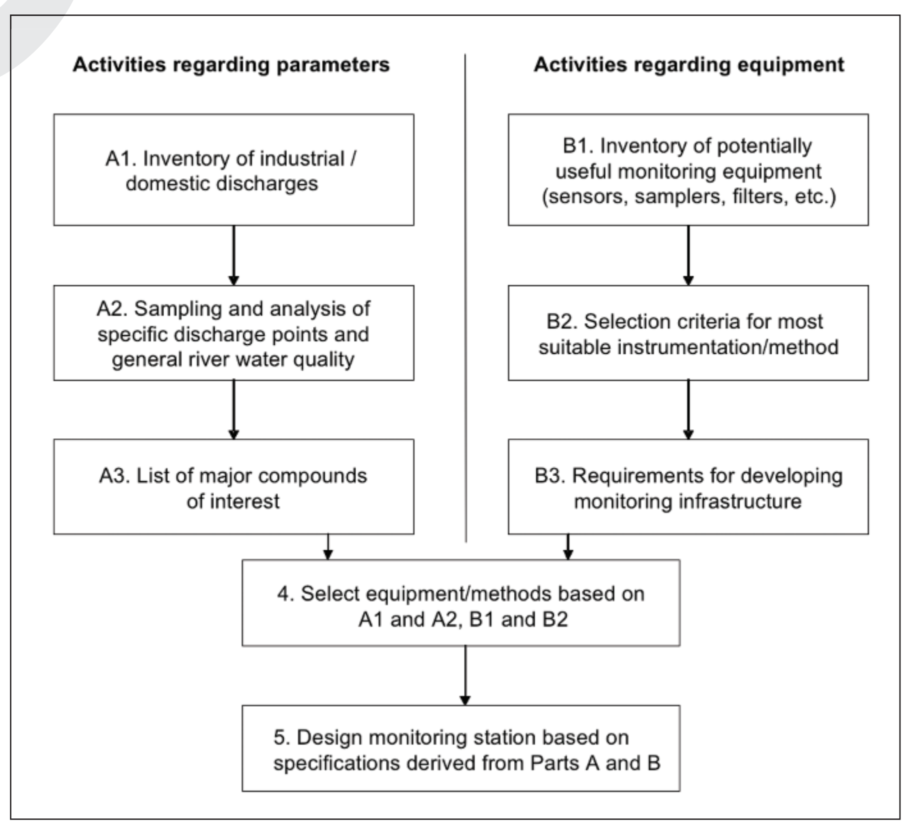

Figure 2: Stages in the design of an EWMS

Passive samplers, specifically targeted at capturing low concentrations of pesticides, were also used.

Steps A1 and A2 resulted in a list of major compounds of interest which formed the basis for the choice of detection methods in the EWMS. Parameters of major interest included:

- incidental/accidental organic pollution from pharmaceutical/chemical processing industries
- suspended solids
- metals
- ammonium
- dissolved organic compounds
- oxygen demanding materials
- pH

This list was supplemented by general parameters of interest which were used for intake management and process control, and which included turbidity, conductivity, dissolved oxygen and temperature.

Development of requirements and selection criteria

The design and implementation of an EWMS requires careful planning. The station should meet the monitoring needs but should also be designed in such a way that it can be operated under the prevailing conditions and with regard to the technical capabilities of the operators. Furthermore, the availability of infrastructure and the costs required to enhance this need to be taken into account. An inventory of equipment, operational requirements and selection criteria (B1 – B3, Figure 2) can be performed in parallel with the analysis of the monitoring requirements (A1 - A3, Figure 2).

Thus, a list of monitoring systems for classical physico-chemical parameters as well as equipment for monitoring TOC, DOC, nitrate and general toxic effects was compiled. The monitoring of a parameter for sum organics and toxicity was considered essential due to the many sources of pollution along the rivers. Furthermore, an inventory was made of additional equipment required in order to operate the monitoring stations. This auxiliary equipment was deemed just as essential for the successful implementation of the EWMS as the sensors themselves. This included: a pump to provide sample flow through the EWMS, a pre-filtration unit to remove extreme amounts of solids, air conditioning as well as an autosampler to collect water for further analysis in case of a water quality alarm.

Further priority criteria for the selection of equipment included economy of use (acquisition and life cycle costs), maintenance requirement and response time. The availability of easy and quick access to technical support from the manufacturer and local sourcing of spare parts was deemed crucial as this was Apavital's first experience with this type of advanced sensor technology. Furthermore, climatological aspects needed to be taken into account: during the cold winters, the rivers can freeze over and abstraction of water has to be stopped. In such a case, the EWMS is also cut off from water supply and must be able to handle prolonged no-flow conditions.

The possibility of remote access and control of the stations through a cellular network was also seen as essential for the technical support and because of the remote location of the Moldova EWMS.

Figure 3: Detail of the Prut monitoring station.

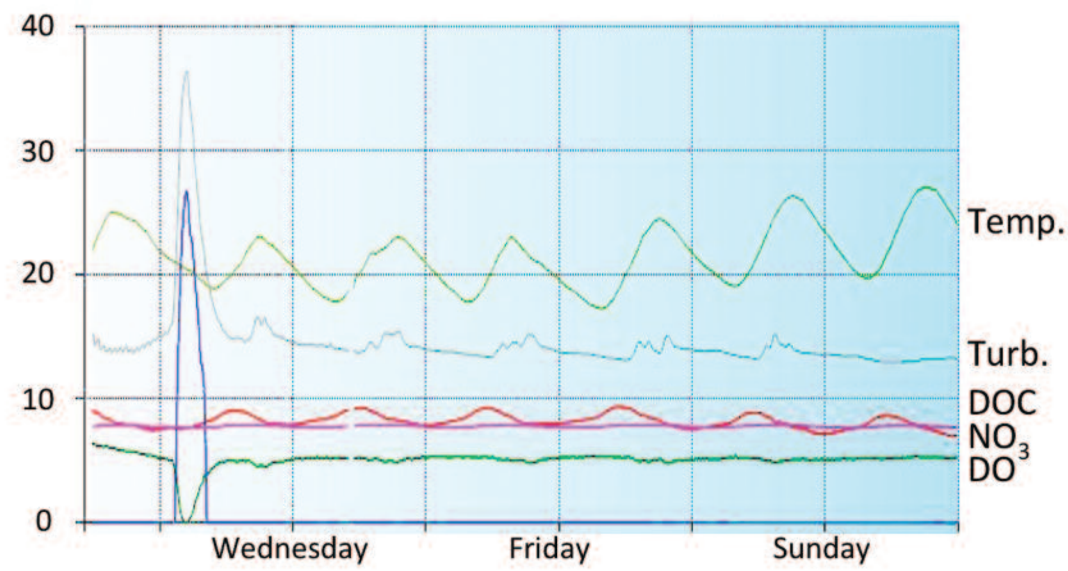

Figure 4: One week of data from June 2012, showing natural diurnal water quality variations as well as a water quality event with elevated turbidity and DOC and a drop in DO to 0 mg/L which lasted for several hours.

Monitoring station design and implementation

The selection of the most suitable equipment (monitoring systems and other equipment) for the Prut and Moldova stations was based on the inventories compiled in A and B. A suite of sensors for measurement of pH, dissolved oxygen, electric conductivity, turbidity and temperature was chosen. Additionally, an online UV/Vis spectrometer probe for measuring TOC, DOC and nitrate was selected. For the Prut EWMS, a biomonitor using luminescent bacteria to detect toxic effects in the river water was also installed. As such a system needs weekly maintenance, it was considered unsuitable for the remote Moldova location.

After equipment selection, the monitoring station was designed in detail. Apavital prepared the necessary on-site infrastructure and Interline Systems built and implemented the stations. Both stations were installed in October 2011 (Figure 3). After several months of performance evaluation, optimisation and calibrations, both stations are now producing reliable data. A baseline for normal water quality is being collected, which will form the basis of the alarm thresholds for abnormal events. Real-time events (Figure 4) which are being used as input for the development of operational and management strategies have also been detected.

All data is accessible remotely through a special data communications unit, which enables web-based access to the results. This facilitates direct support of Apavital by the Dutch project team, without the need to travel to Romania on a regular basis. Furthermore, remote access allows automatic central data collection at the Apavital main offices. The database application is implemented as part of the project, enabling centralised data storage and backup, as well as data processing and automatic generation of periodic reports.

Outlook

The use of variable water quality demands real-time insight into its fluctuations. However, online monitoring requires advanced equipment and the development of online monitoring strategies should be done carefully. Expensive, state-of-the-art monitoring stations can easily become a white elephant when they do not fit the users' requirements and technological capabilities. To develop tailor-made solutions, a stepwise approach is required that analyses the needs, possibilities and restrictions of the end-user. This type of approach has proven to be successful and can be used for any type of water monitoring application, as illustrated by the Apavital case described. In this example, online monitoring stations replaced manual sampling programmes. This has had major consequences for the availability of water quality data and now allows (pro)active water quality management. It has also had major consequences for the management staff involved: online monitoring requires online management. Such a change in approach cannot be carried out overnight; it takes time to adjust all the related procedures, and the staff members need time to become used to the new way of working. Apavital has embraced this challenge and is on the right track to a successful implementation of their monitoring stations.