ENHANCING THE EFFICIENCY OF THE INFORMATION SYSTEM MONITORING THE HYDROGEOLOGICAL REGIME OF THE COSTESTI-STANCA RESERVOIR

Viorica MOCREAC[1], Anatol Gavriliuc [1]

e-mail: v.mocreac@uasm.md

Abstract

At present, process monitoring using automated information systems, based on the use of computer technologies and computers, is increasingly being used. Due to the information system we have the possibility to perform and combine all the necessary processes for automation and monitoring.

In the Republic of Moldova the spread of information system possibilities is studied in connection with the need to regulate the streams on rivers and to monitor the status of hydrotechnical facilities. The development of the information system is of great importance as we'll have the possibility to receive the necessary data in time in order to prevent damages caused by floods, abundant rainfall or drought.

The purpose of this paper is to enhance the efficiency of the information system monitoring the hydrological regime and dam body status of the Costesti-Stanca reservoir:

- ✓ warning and monitoring systems' efficiency of the hydrogeological regime of Costesti-Stanca reservoir;
- ✓ operation of the contemporary warning and monitoring systems of the reservoir hydrogeological regime;
- ✓ upgrading the system of hydrogeological parameters monitoring.

Key words: information system, stream regulation, flood, hydrotechnical facility

The information system represents the totality of methods, procedures and means used in the information process, representing all the operations regarding data collection, transmission and processing, and information systematization, analysis and valorization.

Achieving complete and quality information, as well as full valorization of information can only be possible within a system conceived as an integrated set, which includes: procedures, methods and means used both to generate and store data as well as to transform them into information, provided with programs, operations performed by people or by technical means, data structured according to efficiency criteria and methods of their rational use.

In most cases, the information system is used to monitor the object. As a consequence of this process, it is sometimes possible to obtain a diagnosis of the current state and eventually to make prognosis.

The environmental monitoring system is an integrated system that continuously monitors the state of the environment and provides data regarding all its structural components. The obtained data are processed using specific methods and the obtained final information is used to assess the environmental impact.

The main purpose of an environmental monitoring system, regardless of the scale it covers or the number of components it encompasses, is to provide an objective image, as close as possible to the reality of the environment, for the purpose of taking correct measures of pollution and recovery control.

MATERIAL AND METHOD

In order to perform the monitoring of the main parameters regarding the safe behaviour of earth or clay-core rock fill dams, it is necessary to measure and monitor over time the following parameters:

- the pressure up to and beyond the clay screen – it is measured using the piezometric drillings;
- water streams filtered through the dam body - through the drainage system the streams are collected and the filtered volume is measured;
- deformation of concrete;
- vertical and horizontal settlements and displacements - the geodetic points are measured and their record is kept in time.

Modern data acquisition systems use a personal computer that has the following typical

[1] State Agrarian University of Moldova, 2049 Chisinau , Moldova

structure:
- sensors that have transducers, which convert the physical phenomenon into an electrical signal that can be measured;
- signal adaptation circuits for isolating, converting and amplifying the signal coming from the transducer;
- a data acquisition subsystem;
- a computing system;
- a soft for data acquisition.

Data acquisition system represents an interface between the analog world, represented by sensors and signal conditioning blocks, and the digital world, represented by analog digital converters and processing and control blocks made using a microprocessor.

The risk situation monitoring and warning system of a dam is made up of four components:

The component of construction behaviour monitoring that accomplishes the following functions:
- acquisition of physical dimensions with relevance to risk and their transformation into engineering units;
- display and storage of engineering units in the form of databases;
- processing and interpreting engineering data at the dispatcher level in order to facilitate decision-making process in emergency situations.

The alarming-warning component ensures the following functions:
- informing the dispatcher;
- registering and storing system events.

The communication network. The communication network consists of nodes and point-to-point links between nodes; each node includes one or more equipment. The exchange of information between functional blocks is carried out via a communication network.

The communication network consists of the following components:
- ✓ local communication network;
- ✓ communication network between the dam and the dispatcher;
- ✓ communication network between the dispatcher and the external information systems.

The information system for data processing and evaluation of risk parameters - this unit is located at the dispatcher’s headquarters and accomplishes the following functions:
- ✓ accessing data, related to the parameters defining dam behaviour, from the database managed using information appliances and units (levels, streams) collected in the dam section managed by the electronic appliance;
- ✓ taking the risk data from the information system;
- ✓ processing the accessed data and displaying the measured units;
- ✓ calculating the risk parameters and displaying the resulting units by processing them;
- ✓ alerting the decision-makers in emergency situations;
- ✓ providing data on attention, alert and danger thresholds for actuating the alarm system;
- ✓ data storage and production of synthetic reports.

Factors leading to equipment failure:
- o humidity and
- o electrical discharge.

Continuous study of the documentation and analyzes of the new technologies in the field of monitoring must serve as a starting point for the development of a unitary strategy in choosing the type of measuring and control devices specific to each hydrotechnical work depending on their reliability.

Behaviour monitoring of the hydrotechnical facilities over time is carried out at two levels:
- ✓ current monitoring and
- ✓ special monitoring.

Assessment of dam behaviour mostly relies on the interpretation of data provided by the monitoring system.

As for the communication system between the terminal stations with the dispatchers involved in the exploitation of facilities and higher hierarchical levels, it is necessary to ensure the circulation of data and information vehiculated in the system at the level of terminal stations and local, zonal and reservoir dispatchers.

The investments envisaged to increase the safety degree of hydrotechnical facilities were divided into:
1. Automatic stations with sensors for increasing dam safety;
2. Automatic stations with snow depth measurement sensors and hydrometric stations for the measurement of affluent streams, water inlets and derivations;
3. Software and hardware for controlling and coordinating the exploitation of hydrotechnical facilities;
4. Equipment and spare parts.

Automatic stations with sensors to increase dam safety - anti-vandal equipment and monitoring systems are provided. These stations allow automated monitoring and have the objective of collecting and transmitting hydro-pluviometric data, quantitative water management data, as well as monitoring dam behaviour over time. For this purpose the following parameters were considered:
- water level in the reservoir;
- rainfall and air temperature in the receiving basin and reservoir dam area;
- water streams delivered for use in the water inlets;
- positions of the floodgates where appropriate (closed, open and intermediate) to control water flow in large reservoirs;
- monitoring system of the hydrotechnical facility behaviour over time.

The construction works in these stations differ from one reservoir to another, depending on its location, dam type, related hydrotechnical works - with their equipment, type of high water

dischargers, etc., consist mainly of the following parts:
- the stand-pipe protecting the level sensor;
- the support on which the rain and air temperature sensor assembly is mounted;
- sensors detecting floodgate/ floodgate valve movement;
- electrical, data transmission and water inlet installations.

The surveillance system of dam behaviour basically depends essentially on the type of dam and phenomena to be surveyed in order to prevent dam failure risk.

The automated monitoring stations with sensors are designed to provide essential information for better and faster intervention in order to reduce the effects of floods.

The most important indicators related to the status of hydro-technical water retention facilities and to the development of dangerous processes in hydrotechnical facilities that should be monitored all the time include:
- vertical compaction and horizontal movement of constructions and their foundations;
- pressure in constructions and in their foundations;
- contact pressure at the bottom of the dam, vertical and inclined surfaces of constructions;
- the size of cracks in hydrotechnical facilities;
- pore water pressure;
- filtered water streams that drain or rise to the surface;
- the depression curve in the dam body;
- water levels in the piezometric system;
- the characteristics of erosion of the downstream side of a dam;
- the characteristics of alluvial deposits before hydrotechnical facilities.

RESULTS AND DISCUSSIONS

Natural observations regarding the behaviour and functioning of hydrotechnical facilities within Costesti - Stanca Hydrotechnical Node on the Prut River had the purpose to perform the planned control depending on the surface of depression, the stability effect of the anti-filtration facilities, and the opening of the thermo-compaction joints, the water pipes of the stationary water inlet and the horizontal and vertical compaction of the hydrotechnical facilities.

This multilateral control is absolutely necessary for timely detection of the negative moments in the functioning process and to take all the necessary measures to eliminate the consequences.

The performed observations and measurements are classified into the following groups:

- *daily observations and measurements:*

✓ recording water level and temperatures in the reservoir and in the compensation lake;

✓ measurement of hydrometeorological data and visual observation of the status of hydrotechnical facilities (water inlet, dispatch facility, main dam's crest, main dam body, access roads and other hydrotechnical facilities).

Figure 1. Water level measuring rod used in the reservoir Costesti – Stanca

-*weekly observations and measurements:*

✓ measuring water level in wells;

✓ recording data on manometers, piezo-dynamometers, tele-thermometers, transducers to open the joints in the injection gallery and aqueduct gallery.

Figure 2. Apparatus for weekly observations

- *monthly observations and measurements;*

✓ opening of joints in the injection gallery and water filtration in the gallery;

Figure 3. Injection gallery

- *annual and multiannual observations and measurements.*

The graphs show water level evolution in the wells located in sections over time.

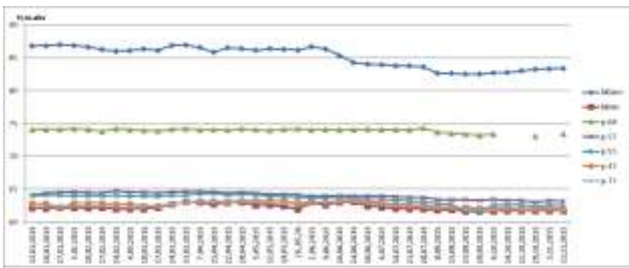

Figure 4. Cross section I (PC16+87).

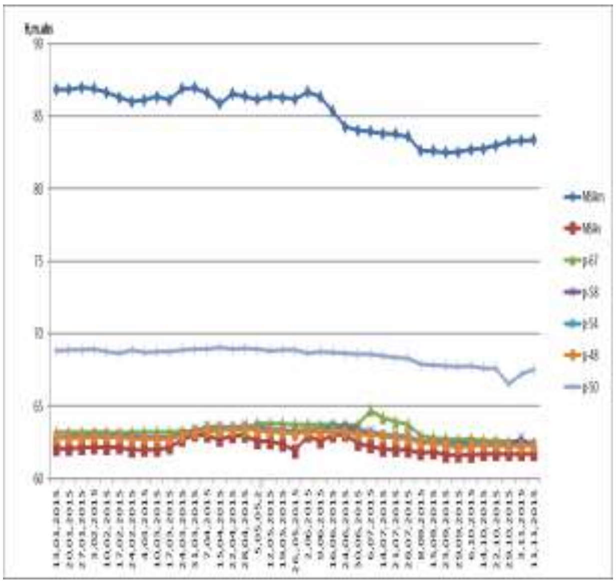

Figure 5. Cross section II (PC15+96)

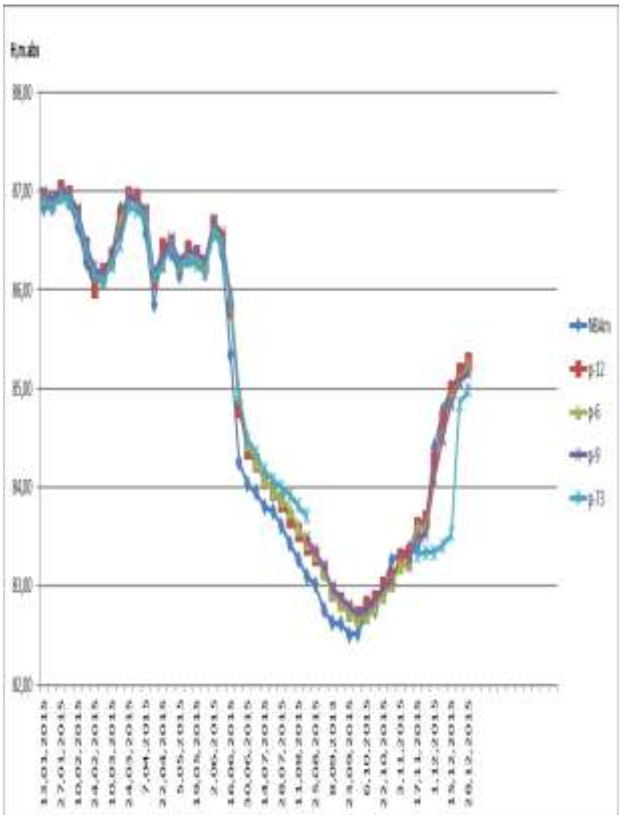

Figure 6. Cross section XI (PC1+55).

Implementation of the monitoring information system.

The structure of the information system at Costesti - Stanca Hydrotechnical Node. First of all, devices are installed to record water level and temperatures in the reservoir, the data are recorded every 10 minutes and transmitted to the State Hydrometeorological Service.

Figure 7. Apparatus to record water level and temperatures in the reservoir

Water level measurement shall be carried out using level transducers or pressure transducers, as appropriate, with output current signal, connected to programmable automatics fitted with compatible analogue inputs.

Figure 8. Level transducer

Because of the long distances between drillings, we have 9 zones and a data box is installed in each one.

Figure 9. Data box

The information about the level from data boxes can be viewed on the main screen of SCADA application.

Figure 10. The main screen of the soft SCADA

The main screen allows the operator to monitor the information of those nine data boxes as well as to access and modify some parameters of the system functioning. The system monitors nine data boxes, CDs, numbered from A to I, mounted in the site, which collect information about water levels and pressures in wells.

The boxes are mounted over the entire length of the accumulation dam.

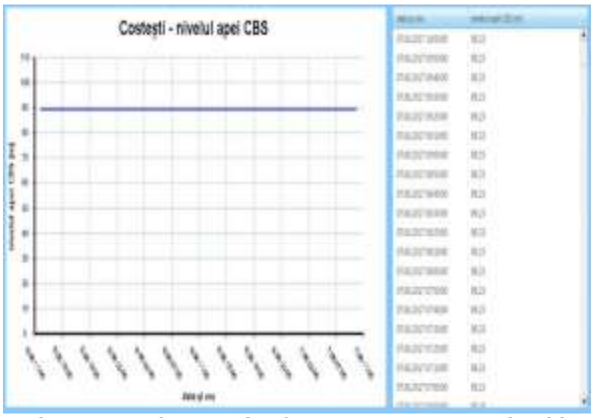

Figure 11. The graph of a measurement point (the reservoir)

The 24-hour reports are stored in text files (TXTs) and can be further processed by any program that uses databases.

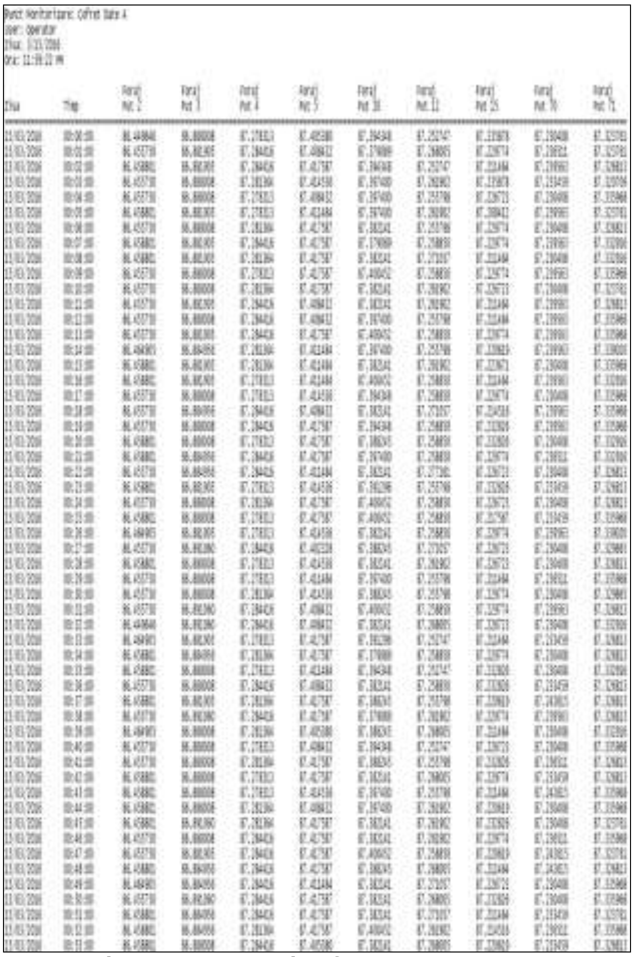

Figure 12. Example of a CD – A report

CONCLUSIONS

During 40 years of exploitation of the Hydrotechnical Node, a part of the remote sensors stopped working and the rest has well exceeded the warranty period (10 years).

According to a feasibility study conducted by the JSC «AQUAPROIECT» Romania, a new type of information system has been designed. Based on the project, the frequency meter was changed and also free and hydrostatic pressure sensors were installed.

The drafting of the monitoring system was started, at the current level the devices of this type (digital display, internal memory of the results with the possibility of direct delivery to the computer, etc.) has not yet been finalized and has not been put into operation. Approximately 20% of the planned volume was left in order to complete and finish the project.

If you take into account that the failure rate of the dam fillings and especially of earth dams is higher than of the concrete dams, it is necessary to monitor all the measuring points in order to be aware of the Hydrotechnical Node status. In this context, the advanced monitoring systems are very helpful to carry out this task and should be implemented, especially in important and strategic places. The monitoring is mainly reduced to the measurements of piezometric levels and remote sensors.

Within the project, the monitoring of 55 open piezometric drillings is performed, which are arranged in 12 sections.

Piezometric drillings have been made in the gallery of injections being equipped with manometers and sensors, displaced in pairs upward and downward, in 6 sections.

In the areas with a higher retention front (the main dam with filling and the "Cariera Veche" dam), a number of measuring sections were equipped, out of which 4 are located in the main dam.

The properly organized and configured information system will help to monitor the status of hydrotechnical facilities with the help of special devices and visual observations, and it helps to discovery dangerous occurrences over time and to develop effective measures in order to prevent damage.

It is necessary to further develop the information system regarding the monitoring of the remaining piezometric drillings, to equip the hydrometeorological station with new apparatus and to purchase modern geodetic equipment for the observation of the measuring points.

REFERENCES

Craciun I.,Giurma-Handley C.R. 2014. *Hidrologie specială. Aplicații,* Ed.Performantica, Iasi.

Giurma I., 2003 – *Viituri și măsuri de apărare. Ed.”Gh. Asachi”, Iasi.*

Popovici A.,2002 - *Baraje pentru acumulari de apa. Ed.Tehnica, vol.II, Bucuresti*

Studiu UCC, 2015-2016 - *Urmărirea comportării în timp a obiectivelor de la nodul hitrotehnic Costesti-Stanca.*

Studiu UCC, 2013-2014 - *Urmărirea comportării în timp a obiectivelor de la nodul hidrotehnic Costesti-Stanca.*

Aquaproiect, 2008 - *Urmărirea comportării barajului Costesti- Stanca în perioada viiurii din iulie-august 2008.*

***2013 - Regulamentul privind monitorizarea și evidența sistematică a stării apelor de suprafață și a apelor subterane.

***2016 - Raportul tehnic anual a Direcției Nodului Hidrotehnic Costesti-Stanca în exploatarea lacului de acumulare.

*** 1984 - Regulamentul de exploatare. Moscova. Soiuzghiprovodoz, 161 p.