Case Study

INCREASED EFFICIENCY IN WATER PURIFICATION

SUMMARY

In Spain, the vast majority of reservoirs are characterized by being stratified, which means that, during the warm seasons, there are areas at different depths in which the various layers of water have different physical and chemical properties and are affected by nutrients and algae.

The deterioration of water quality is a serious environmental, economic and social problem.

Given that one of its uses is the production of drinking water for human consumption, there is a clear need to extract water at source of the highest possible quality in order to reduce the necessary drinking water treatment, thus economizing on the process and reducing the impact on the environment and the possible consequences on the health of consumers due to the use of chemical products and their derivatives.

To achieve these objectives, an automatic system for monitoring the quality of the reservoirs is proposed, which allows a real-time evaluation at different depth levels, making it possible to establish the best depth for capturing raw water in order to optimize and save on the treatment of drinking water.

BENEFITS

- **Improve** the potabilization process by determining the best depth of raw water intake from reservoirs, based on the quality of the water resource.
- **Contribute** positively to the health of consumers, through a reduction of chemical products, guaranteeing a more natural and higher quality water.
- **Save costs** and resources due to a reduction of reagents and energy.
- **Increase** environmental and socioeconomic security, by restricting waste generation and improving the carbon footprint.

Francisco Javier Fragoso
Mayor of Badajoz
Spain

"The quality of the water for the citizens will not change, it remains the same, but the amount of reagents and the efficiency with which we are going to make the water drinkable will change, which is tremendously important when it comes to managing and saving resources."

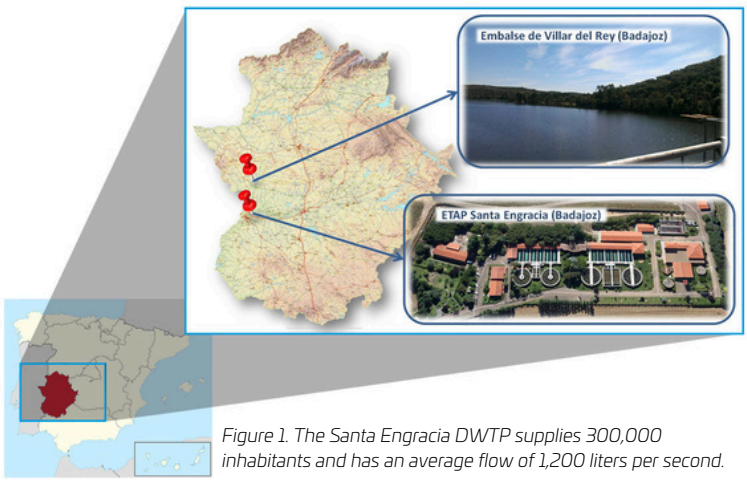

Figure 1. The Santa Engracia DWTP supplies 300,000 inhabitants and has an average flow of 1,200 liters per second.

In Spain, in 2012, drinking water treatment plants (DWTPs) supplied public urban supply networks with more than 4,400 Hm3 of water.
Most of this water came from reservoirs.

Analyzing the behavior of typically stratified Spanish reservoirs, in the warm seasons of spring and summer a thermal and density imbalance can occur between the surface layers and the lower layers of the water in the reservoir.

In summer the waters are divided in two: the surface waters (epilimnion) and the deep waters (hypolimnion), separated by a strip of water where the temperature changes rapidly (thermocline).

"The costs derived from potabilization are conditioned by the characterization of the water bodies and, therefore, it is key to define the optimal extraction point."

Figure 2. Santa Engracia drinking water treatment plant (Badajoz).

The physical and chemical characteristics of these three layers can be totally different and will also depend on the inputs received by the reservoir - rainwater, water from sewage treatment plants, industries, runoff from agricultural fields and livestock - as well as its own history - periods of drought that empty the reservoir or periods of heavy rainfall that cause an almost complete renewal of the water.

In autumn and winter, however, this situation changes: the drop in ambient temperature can cause the water in the two layers to mix again and thus regain homogeneous characteristics.

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After the necessary treatment to make it drinkable (pre-oxidation, coagulation with aluminum salts, decantation, filtration, disinfection...), the DWTPs supply the network with water that meets the quality required to be considered drinking water - as determined by Royal Decree 140/2003.

Consequently, the deterioration of water quality is a serious environmental, economic and social problem and the need to extract water at source of the highest possible quality is evident.

In this way, the necessary treatment can be reduced, saving in the process and reducing the impact on the environment and the possible consequences on the health of consumers due to the use of chemical products and their derivatives.

In the traditional management of a dam, water is taken for the DWTP from a determined and fixed depth, either because the quality of the water at different depths is unknown, or because there are no facilities available, or because there are no technical facilities for extracting water at variable depths.

Most of the dams on the Iberian Peninsula are located in areas with stratified reservoirs, i.e., with layers of different quality.

Consequently, the costs derived from drinking water treatment are conditioned by the characterization of the water bodies and, therefore, it is essential to define the optimum extraction point.

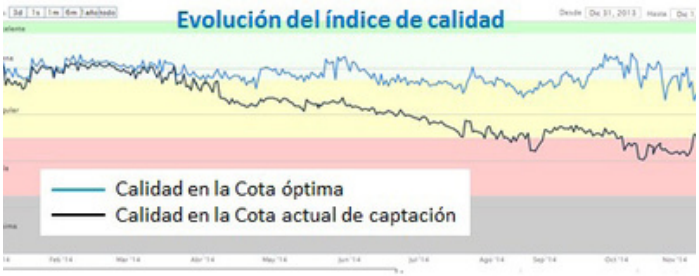

Figure 3. Evolution of the water quality index of the Villar del Rey reservoir (Badajoz).

With this premise, the main objective of the Smartic project **'Real Time Water Monitoring System with Smart Technology'** is to optimize the current drinking water treatment processes by means of an advanced control system that allows selecting the best catchment point in a reservoir, as well as automatically determining the dosages of the main reagents and monitoring the evolution of the water throughout the treatment process, guaranteeing the suitability of its quality for consumption.

To this end, an automatic system has been installed to measure the quality of the Villar del Rey reservoir, which supplies water to the Santa Engracia drinking water treatment plant in Badajoz.

"Higher quality index in the catchment, lower cost of water treatment."

"Objective: To optimize current drinking water treatment processes by means of an advanced monitoring system to select the best catchment point in a reservoir, determine the dosage of reagents and guarantee the quality of drinking water."

This system evaluates the quality in real time and at different levels which, combined with an adjustable water intake system at different depths, makes it possible to select the water strata with the best characteristics.

Thanks to this information, managed by a decision support system based on a numerical model, it is possible to determine the point with the lowest water treatment cost and to define, in real time, the best raw water intake depth.

This combination improves the potabilization process, in relation to economic aspects - chemicals and energy - and public health - reduction of chemical doses, as well as increasing quality and reliability at a lower cost.

This system makes it possible to visualize the DWTP process from any location remotely and enables plant operators to interact and plan tasks in the event of any setback, in a more optimal and effective way.

In the words of Ángel Encinas, the researcher in charge of the project at Aqualia, **"monitoring by means of different sensors located in different places during the drinking water treatment process and at the plant's output, means greater control"**. **"Obtaining instantaneous information on the quality of the water in the reservoir and in the plant allows us to act more quickly, to create alarms and, therefore, to comply with the law as we have been doing up to now, but with greater control"**, he reiterates.

"The project has allowed us to be much more efficient in the management of public resources when it comes to water purification."

Francisco Javier Fragoso
Mayor of Badajoz

For his part, the mayor of Badajoz, Francisco Javier Fragoso, affirms **"thanks to this project it will be possible to know how the water is coming out of the reservoir"** and this, in turn, **"be much more efficient in the management of public resources when it comes to making the water drinkable, since we will not depend on laboratory analysis at all times because we will have automatic parameters"**.

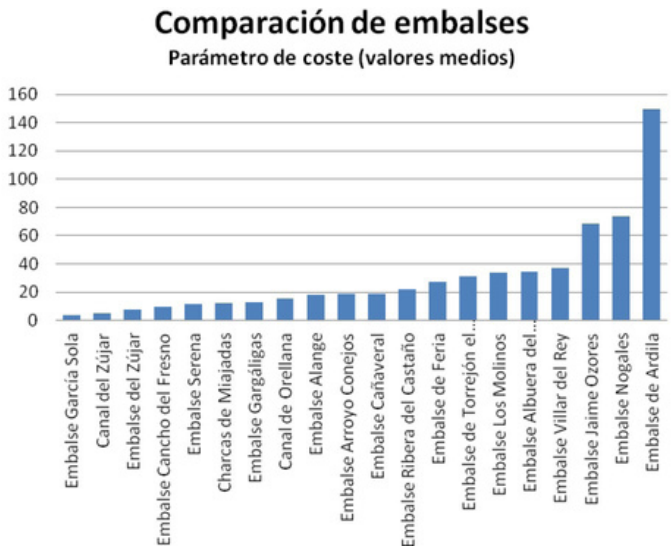

Figure 4. Comparison of the drinking water treatment cost parameter for raw water from different catchments in Extremadura (period 2007-2013).

On the other hand, thanks to an environmental and socioeconomic impact study, it has been concluded that the application of this system represents an improvement, from the process of capturing raw water from the reservoir to the application of the main chemical reagents involved in the drinking water treatment process.

Figure 5. Automatic system for measuring the quality of reservoir water at different depths. Technician checking values.

This improvement in quality and lower consumption of reagents translates into a reduction in waste generation and higher environmental quality, implying an improvement in the carbon footprint of the overall process.

Consequently, environmental and socioeconomic health and safety is enhanced by the consumption of a more natural, higher quality water.

"The better the quality of the water taken at source, the less need for products to treat it we will need in the water treatment plants", Fragoso pointed out, and clarified that **'the quality of the water for the citizens will not change, it will remain the same, but the amount of reagents and the efficiency with which we will make the water drinkable will change, which is tremendously important when it comes to managing and saving resources'**.

In the comparative study carried out between the Ávila and Langreo DWTPs, it was determined that it is possible to reduce consumption by 51% of energy, 45% of chlorine and 68% of coagulant thanks to the treatment of optimum raw water.

These results also translate into less waste and a decrease in greenhouse gas emissions related to energy, chlorine and coagulant production.

**This project has been developed by the Consortium formed by Adasa, Aqualia, Coveless Ingeniería, Homeria Open Solutions, Enmusa y Gestiona Global.*

1. Source: INE
http://www.ine.es/prensa/np872.pdf

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