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MONITORING THE DANUBE WITH ADCON TELEMETRY EQUIPMENT – A CASE STUDY FOR OTT HYDROMET AND ROWATER COMPANY

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Abstract
Water Monitoring on the Danube river is crucial for ensuring an efficient management of the river. The previous situation of monitoring efforts has resulted in experimental data logging equipment that does not fulfil requirements of reliable GSM transmission and sustainable power supply. Furthermore, the existing equipment is scattered in few locations and low GSM signal and roaming problems occur nearby the borders of the Romanian country. This paper presents how BEIA Consult has during November 2013 installed along the Danube and some of its tributary rivers a monitoring system entirely consisting of telemetry equipment and software provided by Adcon Telemetry GmbH Vienna – an OTT Hydromet Company. Beneficiary of the system is the National Administration „Apele Romane” (ANAR / ROWATER), a state institution managing water resources all over the Romanian territory. The BEIA approach is to use renewable energy power supply (solar panel), low power sensors and an innovative measurement and transmission architecture. This paper briefly describes the system, the equipment utilized, construction techniques utilized at some of the installation locations as well as some trends revealed by the system so far in water levels and water temperatures. Furthermore, the system is able to monitor the humidity inside its enclosure and other water quantity parameters, besides level and temperature of the Danube river. The main contribution of the paper is to present a system that can be extended to monitor also quality parameters of the Danube river, Delta and Black Sea water and environmental data of soil / air around the Danube river, Delta and Black Sea coast. Finally, the paper discusses the main findings of rapid and dangerous changes of the water level and temperature.

Keywords: water level monitoring, temperature monitoring, telemetry, tele-monitoring system, river monitoring, Danube.

1. INTRODUCTION

Lately there has been an increasing interest regarding water resources and activities related to it, such as pollution and hydro-morphological alterations, risk of failing the environmental quality for the surface water, biological functionality and productivity, climatic changes, drainages of the water level etc (P. Gastescu, et al. 2012). The water resources are also subject of several human pressures, given activities like intensive agriculture and extensive farming, irrigations, insufficient treated industrial wastewaters. Another topic of raising interest is the activity among the Danube river, within which we can remember the analysis of the long-term dynamics of the dates of the ice phenomena and their duration on the Danube river and its Kiliysky channel (G. Liudmyla, et al. 2012). Furthermore, research is focused on the analysis of the chemical composition of the sediments from the river bed and the water chemistry of the Danube river or regarding the estimation of the Danube river bed morphological modification (V. Dumitrescu, et al., 2012).

All the issues mentioned above can be somehow controlled through an intensive monitoring activity for the water resources (E. Tuchiu, et al., 2012). The monitoring process can be focused on several aspects such as water quantity, water level, temperature, but also quality parameters for the water and soil.

Telemetry means a communication established between several equipments, performed by executing and transmitting measurements at a distance. The data captured from different environments, such as water parameters, are remotely transmitted form that environment to an accessible location, through different medium (G. Suciu et al., 2012). Most used communication medium for telemetry measurements is the radio band of the electromagnetic spectrum, due to the scalability nature of the link that can be established (G. Suciu et al., 2013). The system we describe in this paper uses the GSM-GPRS and Internet, or the UHF band to transmit data. We will detail the main components of the telemetry system and also the data acquisition techniques in the remote monitoring installation.

The paper is organized as follows: section 1 describes the methodology and architecture of the telemetry system, considering the state of the art; section 2 presents some details regarding the remote monitoring installation and the embedded sensors. Further, section 3 takes into consideration some construction practices for some monitoring installation sites, taking into account the existing mounting infrastructure that team has found and utilized, while section 4 presents some examples of the observed evolutions. Finally, section 5 concludes the paper.

2. METHODS AND SYSTEM ARCHITECTURE

BEIA Consult International SRL Bucharest has recently installed along the Danube and some of its tributary rivers a monitoring system entirely consisting of telemetry equipment and software provided by Adcon Telemetry GmbH Vienna (A. Vasilescu, 2014). Beneficiary of the system is the National Administration „Apele Romane" (ANAR) (www.rowater.ro), the institution managing water resources all over the Romanian territory. The project was conducted under the framework of Romania-Bulgaria Cross Border Cooperation Programme (V. Grama, 2011) and proposes an open system for hydro tele-monitoring applications.

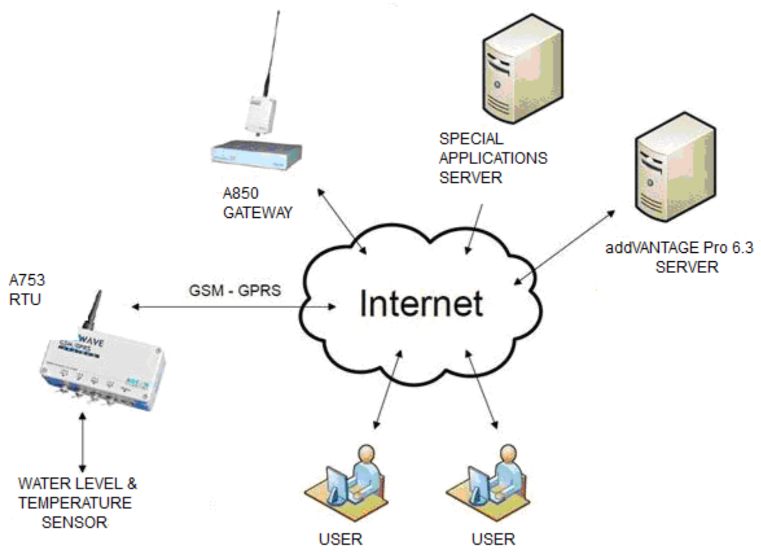

Figure 1. General structure of the system

The system mainly consists (see figure 1) of remote monitoring installations (A753 RTU & sensor), an A850 data concentration unit (Gateway) and the central addVANTAGE Pro 6.3 server. A special applications server will be utilized for tasks eventually situated outside the possibilities of the Pro 6.3 server. Communication between mentioned system parts as well as towards the Users goes through the Internet, so that everything is reconfigurable and removable easily and in any possibly desired way.

A continuous and extremely safe data export is ensured from the addVANTAGE Pro 6.3 server towards the central data processing systems of ANAR.

3. DETAILED FEATURES OF THE TELEMETRY SYSTEM

Each remote monitoring installation consists of an Adcon A753 GSM-GPRS remote telemetry unit (RTU) (K. Nemeth, 2013), a water level and temperature sensor which is connected to the RTU through an atmospheric pressure relief box and the solar panel that powers the RTU and the sensor. An example of how these parts are mounted on an aluminum mast and how the sensor cable is being led through a plastic pipe to the water is given in figures 2 and 3.

Figure 2. Trial remote monitoring installation at Afumati

Figure 3. Closer view of the A753 RTU, solar panel and pressure relief box (from up to down)

A753 GSM-GPRS is the workhorse of the Adcon assortment of RTUs (K. Nemeth, 2013). Compact and robust, Adcon RTUs are probably the best in Europe and beyond in what concerns reliability, sensibility to radio signal and energetic efficiency – the Bosch solar panel that usually powers an Adcon RTU is only a little bit larger than an A5 paper format. Only two of the 12 analog sensor inputs existing on the A753 are used for the level and temperature sensor utilized in this application. 10 analog sensor inputs and one standard SDI-12 port remain available for further developments, with sensors like the high-performance Pluvio2 rain gauge from OTT, the SEN-R air temperature and relative humidity sensor from Adcon, the BP1 barometric pressure sensor from Adcon, the SM1 soil moisture sensor from Adcon (B. Pacher, 2011) etc.

The PR36XWT level and temperature sensor especially manufactured for Adcon by Keller from Switzerland is also a masterpiece of reliability, stability and precision. Water pressure is accurately transformed by this sensor in water level by means of a piezoelectric transducer. This is placed in free air, brought inside the sensor's stainless steel body through an air thin pipe accompanying the wires in the sensor cable. It is a standard arrangement for this kind of sensors, which ensures that water pressure alone is measured and not water pressure plus atmospheric pressure. The upper part of the air thin pipe ends in the pressure relief box (see figure 3), which has a special design that precludes ingress of water and atmospheric impurities but allows free air circulation.

The A753 RTU measures water level and water temperature at every 3 minutes and calculates an average from 5 measurements at every 15 minutes. The 4 average levels and 4 average temperatures are sent at every hour to the A850 gateway and furthermore to the addVANTAGE Pro 6.3 server (see figure 1), where data in graphic and/or table form are prepared for easy and even pleasant use by the users, any time and anywhere, through the Internet.

Locations of the 14 remote monitoring installations are shown below in figure 4. A number of 9 installations are located on the Danube itself, while the remaining 5 are located on tributary rivers, the most important of these rivers being Arges (monitoring installation near Oltenita) and Vedea (monitoring installation at Contesti).

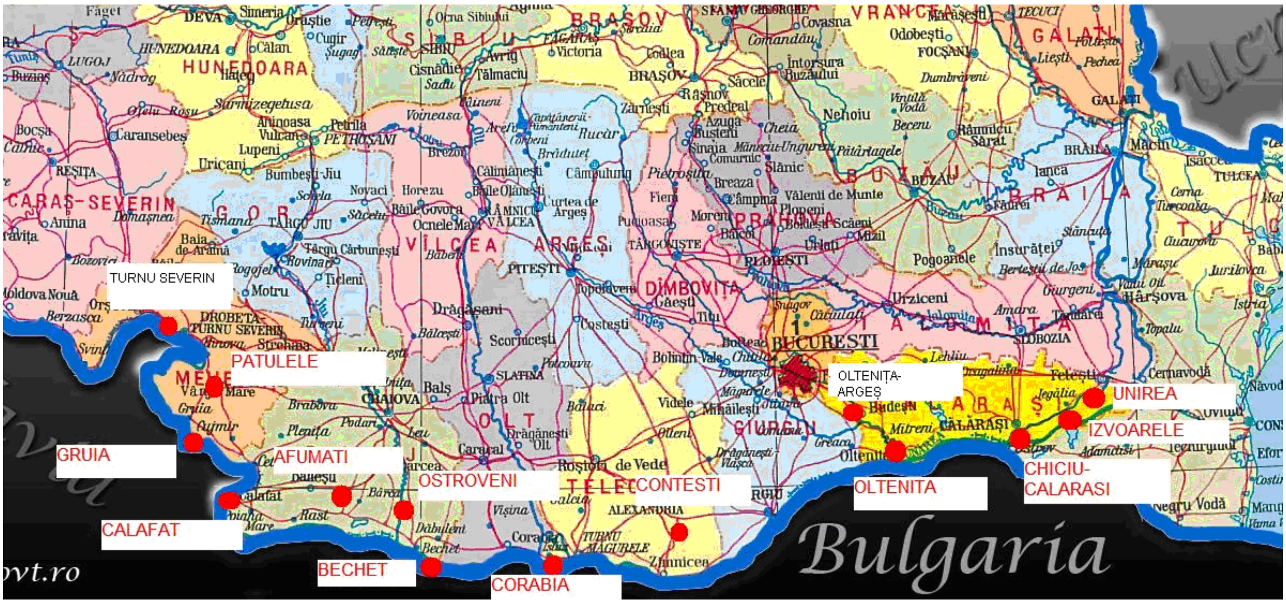

Figure 4. Locations of the 14 remote monitoring installations along the Danube and some tributary rivers

From the very beginning, provision of sustainable machine-to-machine (M2M) GPRS communication was seen by the BEIA team as a very important issue. As ANAR has requested to deal with only one service provider, a detailed coverage analysis was made for all locations in figure 4, after which Orange was finally chosen. Analysis has however revealed that even Orange has a serious coverage problem at Bechet. The problem was partially solved with an high-gain Yagi antenna, but the very good transmission parameters (Data delay and Error rate) exemplified in figure 12 were never obtained at Bechet.
Another project particularity that could create problems was the presence in nearly all locations of strong GSM signal from the neighboring countries (Serbia and Bulgaria). The very sophisticated Adcon Telemetry system was fortunately provided for such situations with an effective solution: all RTUs were instructed (configured) in the A850 gateway to reject any roaming offer.

4. CONSTRUCTION PRACTICES AT SOME MONITORING INSTALLATION SITES

At some of the monitoring installation sites, the BEIA team has found and utilized already existing mounting infrastructure. Conditions at the remaining installation sites were however very diverse and so were the utilized infrastructure solutions and construction methods. A very few of these solutions and methods are illustrated by the photos below (figure 5 and figure 6).

Figure 5. Specially-trained climbers have performed the installation on bridge pillars

Figure 6. Re-adjustable foundation screws were utilised at locations where the Danube is known as strongly either erode or sediment its banks

5. EXAMPLES OF OBSERVED EVOLUTIONS

In this section we present the main findings starting with the evolutions at Unirea that lag behind evolutions at Bechet with something like 2-3 days (figure 7). Levels indicated are height of water above the reference line engraved on the body of the level sensor. Corrections in order to match the official Danube levels are also performed by the addVANTAGE Pro 6.3 server (figure 8)

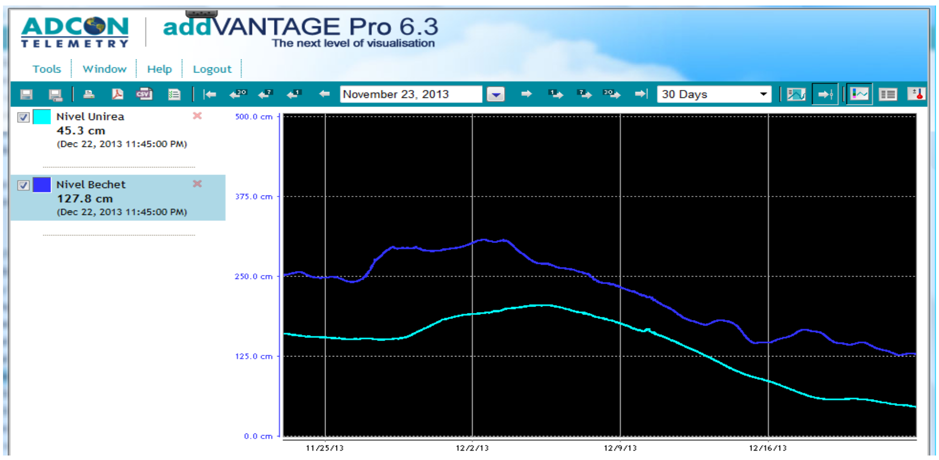

Figure 7. Water level comparison - the huge mass of water at the monitoring station Unirea (close to Cernavoda) makes level changes slower than at a monitoring station situated upstream, at Bechet (November –December 2013)

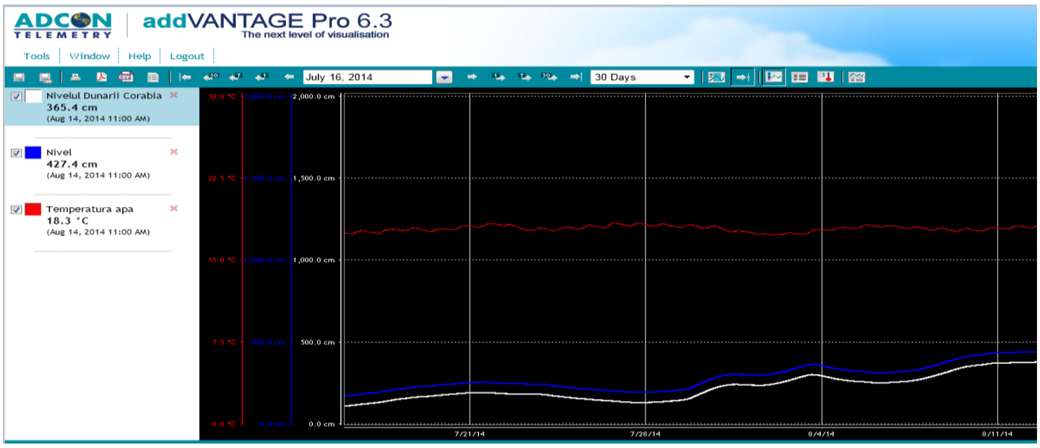

Figure 8. Levels actually measured above the reference line of the level sensor (blue) and values corrected to match official Danube levels at Corabia (white) – July 2014

At Turnu Severin, water level evolutions are obviously influenced by the Portile de Fier hydro plant dam (figure 9). Daily oscillations are specific to this site, while max and min values situate themselves only slightly above and below the average value.

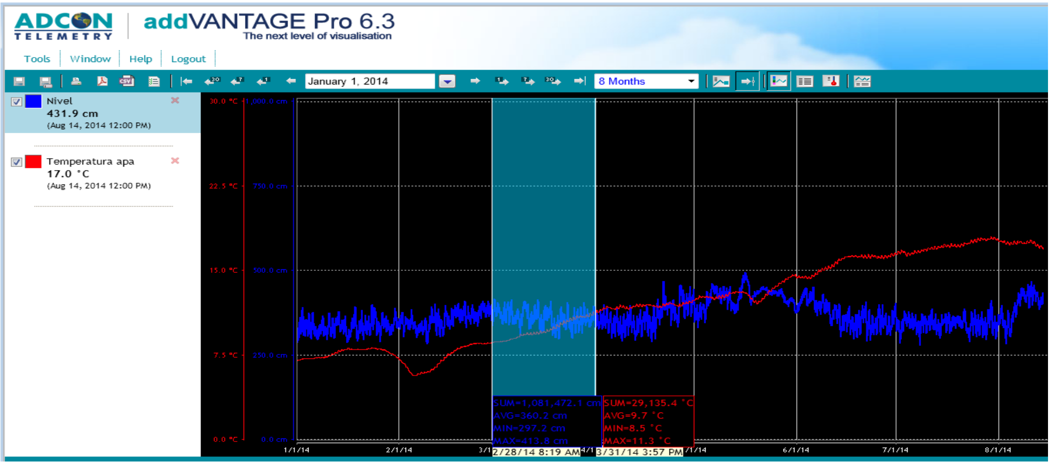

Figure 9. Turnu Severin water level and temperature evolutions (January – July 2014)

In clear contrast to what happens at Turnu Severin (figure 9), max and min levels have at Calafat considerable deviations from the average (figure 10).

Figure 10. Calafat water level and temperature monitoring (January – July 2014)

During dramatic floods in spring-summer 2014, the monitoring station on the Vedea river has revealed spikes of nearly 5 meters for a level that barely amounts to 50 cm under normal weather and hydrological conditions (figure 11).

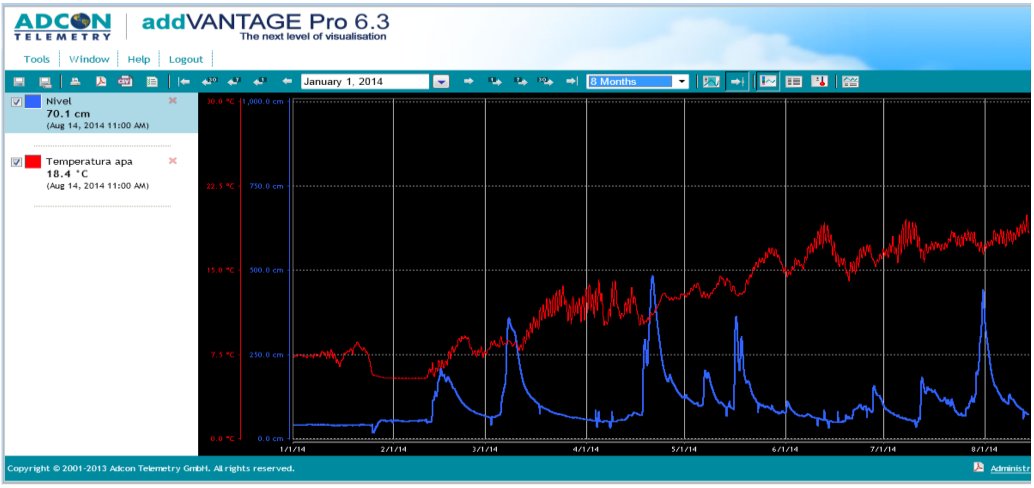

Figure 11. Vedea river water level and temperature measurements (January – July 2014)

Besides accurately processing and transmitting data from the sensors, the Adcon A753 RTU also transmits data about its own functioning. At about 1 PM, August 10, 2014 , for instance, internal battery voltage was of 7,06 V, internal temperature was of 43,4 grade C, internal air humidity was 39,3 %, data transmission delay was of only 24 seconds and the radio error rate was about 10 % (figure 12).

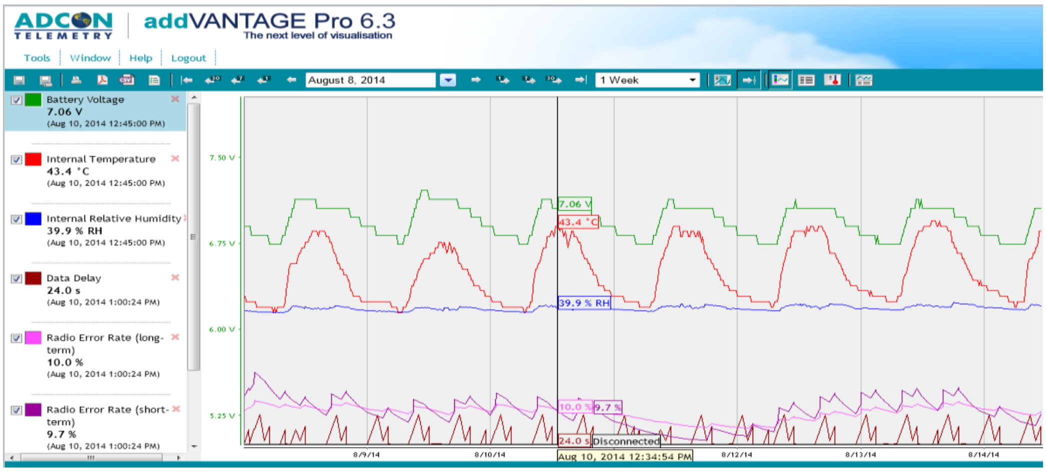

Figure 12. RTU internal parameter monitoring

6. CONCLUSION

At the time of writing (August 2014), the BEIA – Adcon – ANAR system above-described was already being in function from about nine months. It is a lapse of time that encompasses difficult winter months for the outdoor equipment and also difficult summer months. In spite of that, data have continuously arrived at the ANAR headquarters, hour after hour and with utmost precision. This is being seen as a good reason to hope that ANAR will order further developments of the system with remote monitoring installations in some new locations and also, eventually, with additional sensors at existing installations.

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