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MONITORING THE DANUBE WITH EQUIPMENT FROM ADCON TELEMETRY, AN OTT HYDROMET BUSINESS UNIT DISTRIBUTED BY BEIA CONSULT BUCHAREST

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ABSTRACT
BEIA Consult International SRL Bucharest has installed along the Danube and some of its tributary rivers a monitoring system entirely consisting of telemetry equipment and software provided by Adcon Telemetry, the OTT Hydromet business unit operating in Vienna-Klosterneuburg. Beneficiary of the system is the National Administration „Apele Romane" (ANAR), the state institution managing natural water resources all over the Romanian territory. This paper briefly describes the system and some of the problems encountered, the Adcon and OTT equipment engineered and installed by Beia as well as some trends in Danube water levels revealed by the system so far.

Keywords: Danube River, Ground Telemetry, GSM-GPRS data Transmission, Hydrometrics, Sensors, Water Level Monitoring, Water Temperature Monitoring.

1 INTRODUCTION

Telemetry is the science and technology of automatic measurement and transmission of data by wire, radio, or other means from remote sources, as from space vehicles, to receiving stations for recording and analysis. A modern ground telemetry and command system has the main function to act as a gateway between the spacecraft and its associated ground support segment. The telemetry gateway system is intended to be a bridge between data communications networks and also it is needed to act as a translator between each network's distinct interfaces and protocols (Kato et al, 2015). Its interface to the ground support segment generally requires connection to Local Area Networks (LANs) and Wide Area Networks (WANs) to connect to a server for cloud computing (Chou, 2011).

In this paper we present a telemetry monitoring system which provides data relating to the Danube parameters. For example, parameters like ground-water levels can be measured continuously by this system, continuing the measurements presented in a previous paper (. These data can be transmitted by land-line telephone, cellular phone, land-based radio frequency technology, satellite telemetry, or a combination of these technologies. The real time ground water data shows significant advantages compared to traditional methods: timeless, data quality, data availability, and the cost.

The telemetry monitoring system was installed along the Danube and some of its tributary rivers by BEIA Consult International SRL Bucharest (Vasilescu et al, 2014). Telemetry equipment and software was provided by Adcon Telemetry (Adcon, 2016), a business unit of OTT Hydromet (OTT, 2016). Beneficiary of the system is the National Administration „Apele Romane" (ANAR, 2016), the institution managing natural water resources all over the Romanian territory, as part of a cross-border cooperation project (Water, 2016).

2 METHODS

Exactly as in the definition, the system that will be described does have in selected places along the Danube remote monitoring installations consisting from appropriate sensors and Adcon A753 remote telemetry units (RTUs) (Fig. 1). Data sent by the RTUs arrive through GSM-GPRS and Internet to the Adcon A850 gateway and furthermore to the Adcon addVANTAGE Pro 6.4 server. From the addVANTAGE server, processed data are periodically exported towards other "Apele Romane" (ANAR) IT systems and also made available to remote individual users at their request.

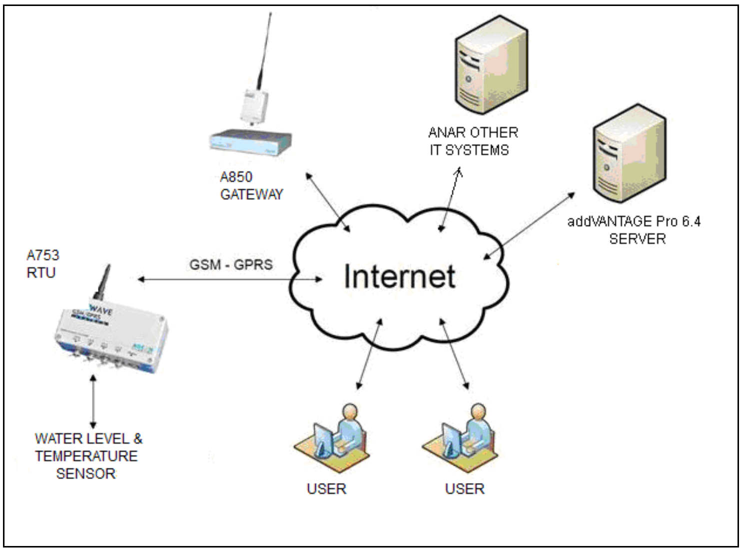

Figure 1. General structure of the installed system.

Communication between various system parts as well as towards the users goes through the Internet, so that everything is easily reconfigurable and relocable in any possibly desired way.

As in any other telemetry system, it is of utmost importance the way in which the physical parameters being monitored (water level for instance) are being transferred to the server and final users. It is a question of precision, stability in varying measurement conditions and also stability in time. Sensors utilized by Beia in the described project (Water, 2014) are first class in all these respects. And they do also have the characteristic of being perfectly linear all over the measuring range. That means that defining these sensors in the A850 gateway is a very simple process; two points on the transfer characteristic (usually the lower and upper end of the measuring range) are sufficient. The A850 gateway is however able to also deal with non-linear sensors, mainly by approximation of the sensor transfer characteristic with as many linear segments as necessary.

3 SYSTEM FOR MONITORING THE DANUBE

Each remote monitoring installation communicates with the A850 gateway through an Adcon A753 GPRS Remote Telemetry Unit (RTU). This unit is usually mounted on an aluminium mast, together with the solar panel powering both the RTU and all attached sensors (Fig. 4).

At some of the installations, water level is measured by means of a water pressure sensor, immersed in water through a stably-mounted aluminium pipe (Fig. 3). At other installations, a radar water level sensor hanged above water surface (Fig. 2) was preferred.

The pressure sensor immersed in water offers the advantage of being possibly accompanied by a water temperature sensor or by other sensors requesting water direct contact, such as water quality sensors for instance. The radar sensor has, in turn, the advantage of being totally immune to problems that ice, sand, mud, floating objects and other matters accompanying water could create.

The tube bringing atmospheric pressure as reference for the water pressure sensor has its upper end in the box situated under the solar panel.

Besides the water pressure or radar sensor, a combo sensor for air temperature and air relative humidity was also installed at some of the remote monitoring installations.

All sensors attached to a certain RTU are powered and read during short periodic time intervals. At every 15 minutes, the RTU computes from periodic measurement results an average value. At every hour, the 4 average values for every of the monitored parameters is sent by the RTU through GSM-GPRS to the A850 central gateway.

A753 is the workhorse of the OTT-Adcon assortment of RTUs (Suciu et al, 2016). Compact and robust, Adcon RTUs are extremely reliable, very sensible to radio signal and very energy efficient: The Bosch solar panel, that powers the A753 and all attached sensors, is only a little bit larger than an A5 paper format.

Figure 2. Installation with radar sensor

Figure 3. Installation with water pressure sensor

Figure 4. Adcon A753 GPRS RTU and solar panel.

Only a small part of the A753 sensor input capacity is actually utilized. 8 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 (Colli et al, 2014), the BP1 barometric pressure sensor (Suciu et al, 2015), the Hydrolab HL4 Multiparameter Sonde from OTT-Hydrolab (Scott et al , 2016) etc. As required for precision farming (Phillips, et al, 2014), a multiple sensor recently developed by Beia for accurate and cost-effective soil temperature and soil moisture measurements can also be utilized (BEIA, 2016).

Besides accurately processing and transmitting data from the sensors, the Adcon A753 RTU also transmits relevant data about its own functioning, such as battery voltage, inner temperature, data delay, quality of received GSM signal.

The LEV2 water level and temperature sensor especially manufactured for OTT-Adcon by Keller from Switzerland is also a masterpiece of reliability, stability and precision (OTT, 2016). Water pressure is accurately transformed by this sensor in water level by means of a piezoelectric transducer. Measurement of water pressure alone (instead of water pressure plus atmospheric pressure) is ensured by means of an air tube incorporated in the sensor cable, which brings free air pressure as reference to the pressure sensor. The upper end of this air tube finds itself in the pressure relief box (visible in the lowest part of Fig. 4), which has a special design that precludes ingress of water and atmospheric impurities while allowing free air circulation.

The OTT Hydromet RLS radar (Suciu, 2015) is a very accurate tool, offering not only a very precise measure of the distance to water surface, but also technical parameters, such as the quality of the RF signal received after being reflected by water surface.

Levels measured by water pressure sensors or radar sensors are for each monitoring location aligned in the system to the standard ANAR levels officially recognized for each location.

3 RESULTS and DISCUSSIONS

At the end of 2015, the number of remote monitoring installations installed by BEIA for the National Administration “Apele Romane” has amounted to 21. As indicated in Fig. 5, the most Western installation can be found at Lugoj (on the Timish river), while the most Eastern finds itself on Danube’s Chilia arm, not far from the Black Sea coast.

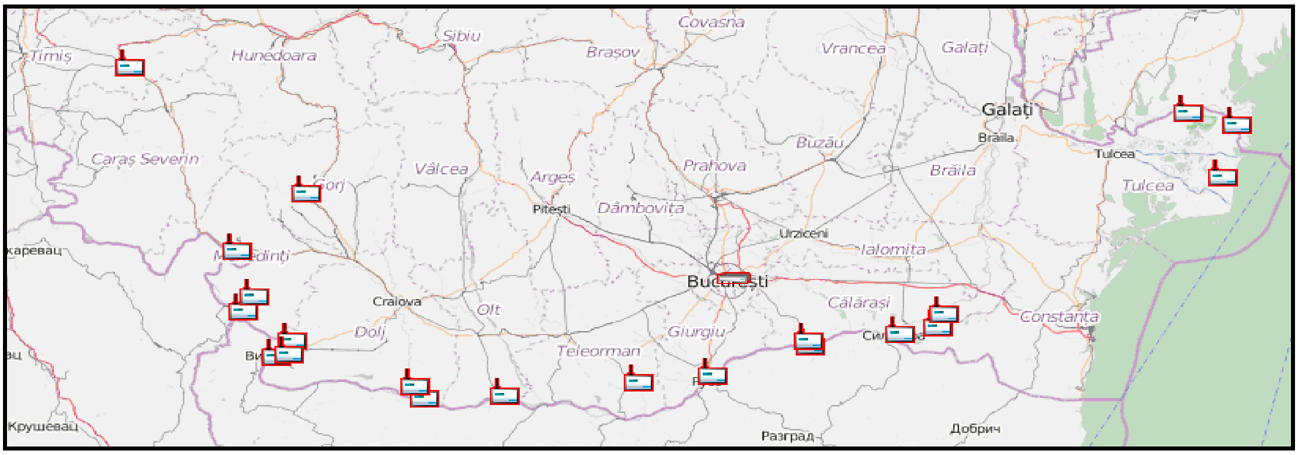

Figure 5. Locations of the remote monitoring installations

From the very beginning, provision of sustainable machine-to-machine (M2M) GSM-GPRS communication was seen by the BEIA team as a very important issue. As ANAR has requested to deal with only one GSM provider, a detailed coverage analysis was made for all locations in Fig. 5, after which Orange Romania was finally chosen. At the few locations with poorer GSM coverage, high-gain Yagi antennas were successfully utilized.

Another project particularity that could have created problems was the presence in nearly all locations of strong GSM coverage from neighboring countries (Serbia, Bulgaria and Ukraine). The very sophisticated Adcon Telemetry system was fortunately provided for such situations with an effective solution: all RTUs were configured in the A850 gateway to reject any service offer other than the one chosen from Orange RO.

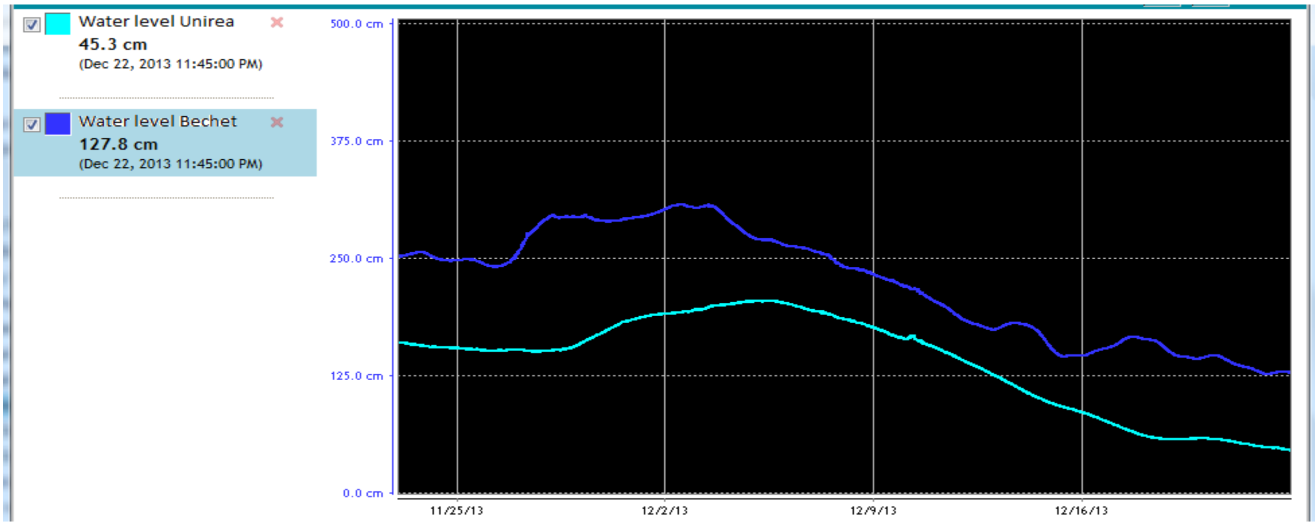

Figure 6. The monitoring station Unirea (close to Cernavoda).

Figure 6 exemplifies how the great mass of water at the monitoring station Unirea (close to Cernavoda) makes level changes slower than those at a monitoring station situated about 300 kms upstream, at Bechet. Evolutions at Unirea are lagging behind evolutions at Bechet with something like 2-3 days.

Furthermore, Fig. 7 contains recorded data at the station from Turnu Severin and it can be seen that water level evolutions are obviously influenced by the Portile de Fier hydro plant dam. Daily oscillations are specific to this site, while max and min values situate themselves only slightly above and below the average value.

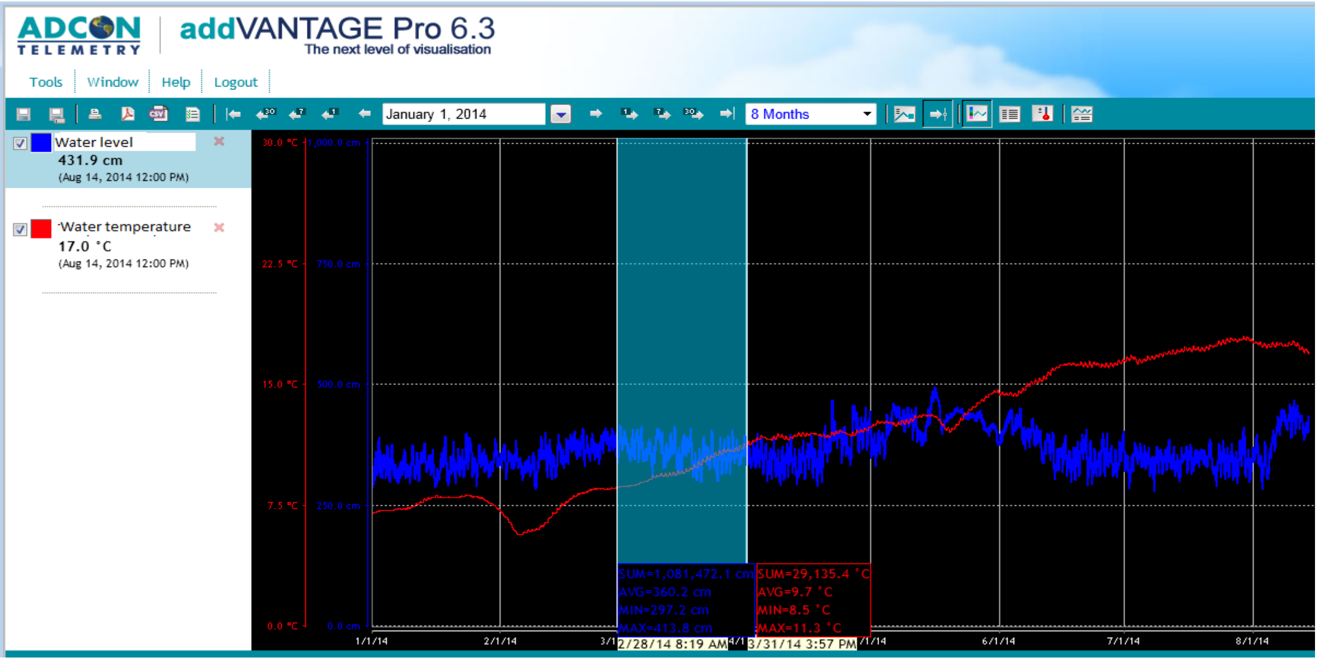

Figure 7. The monitoring station at Turnu Severin

As presented in Fig. 8, in clear contrast to results from Turnu Severin, shows how max and min levels at Calafat have considerable deviations from the average.

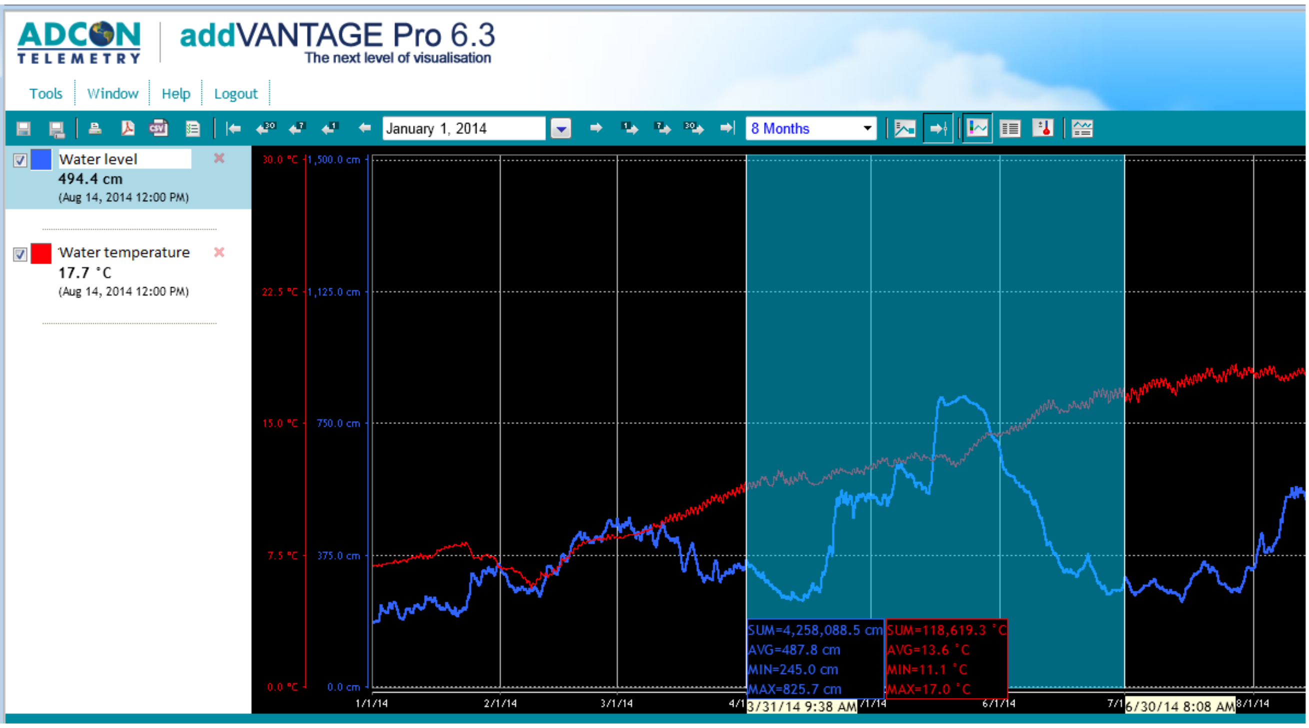

Figure 8. The monitoring station at Calafat

Moreover, Fig. 9 shows that 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.

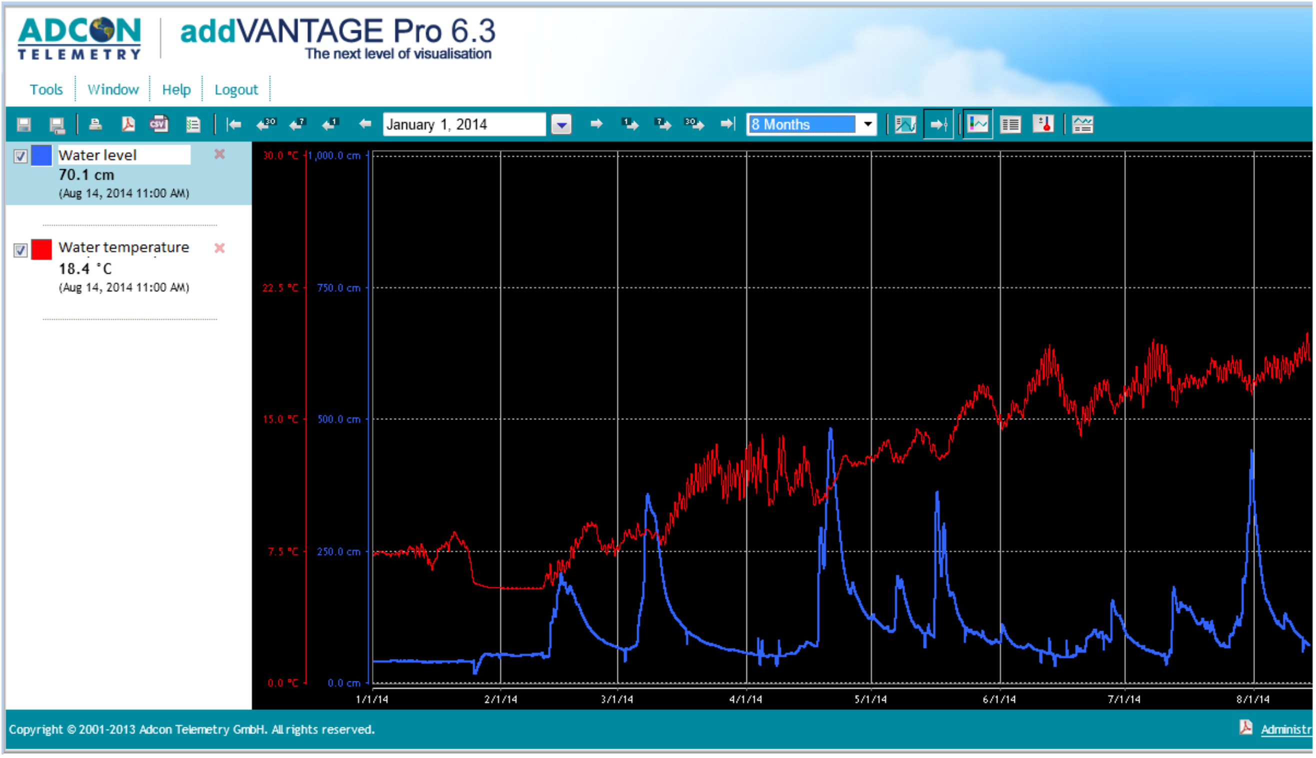

Figure 9. The monitoring station on the Vedea river

Moreover, Fig. 10 has recorded data of the radar on the Danube's Canalul Plantelor arm at Giurgiu and shows that in 2015 were about 3 summer months with negative levels, but also negative levels during November 2015 and January 2016. Vertical flaws indicate moments when the radar beam has only met the river bed.

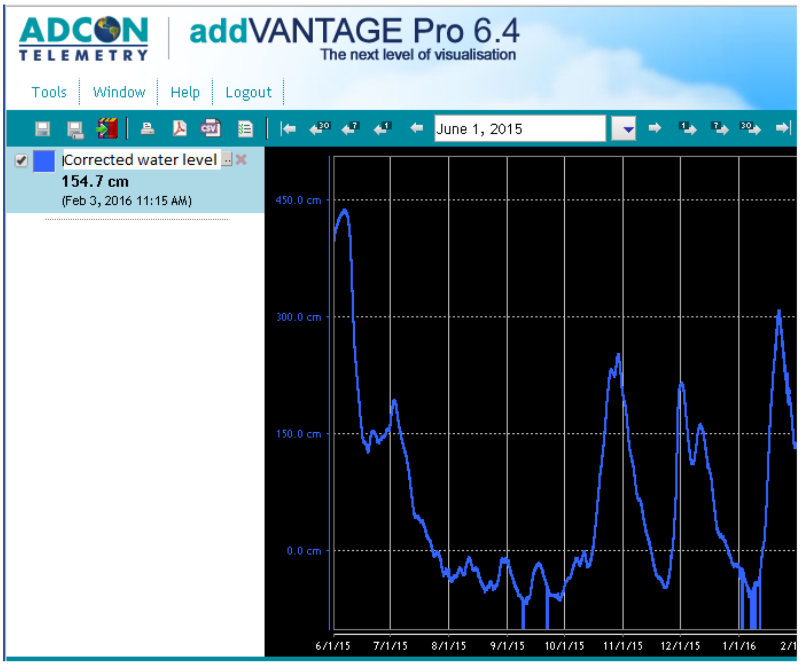

Figure 10. The radar on the Danube's Canalul Plantelor arm at Giurgiu

Finally, Fig. 11 shows that during some days of extreme frost (20-26 January 2016), the Danube level indicated by the Giurgiu radar did have oscillations with amplitudes possibly proportional to the ice layer thickness.

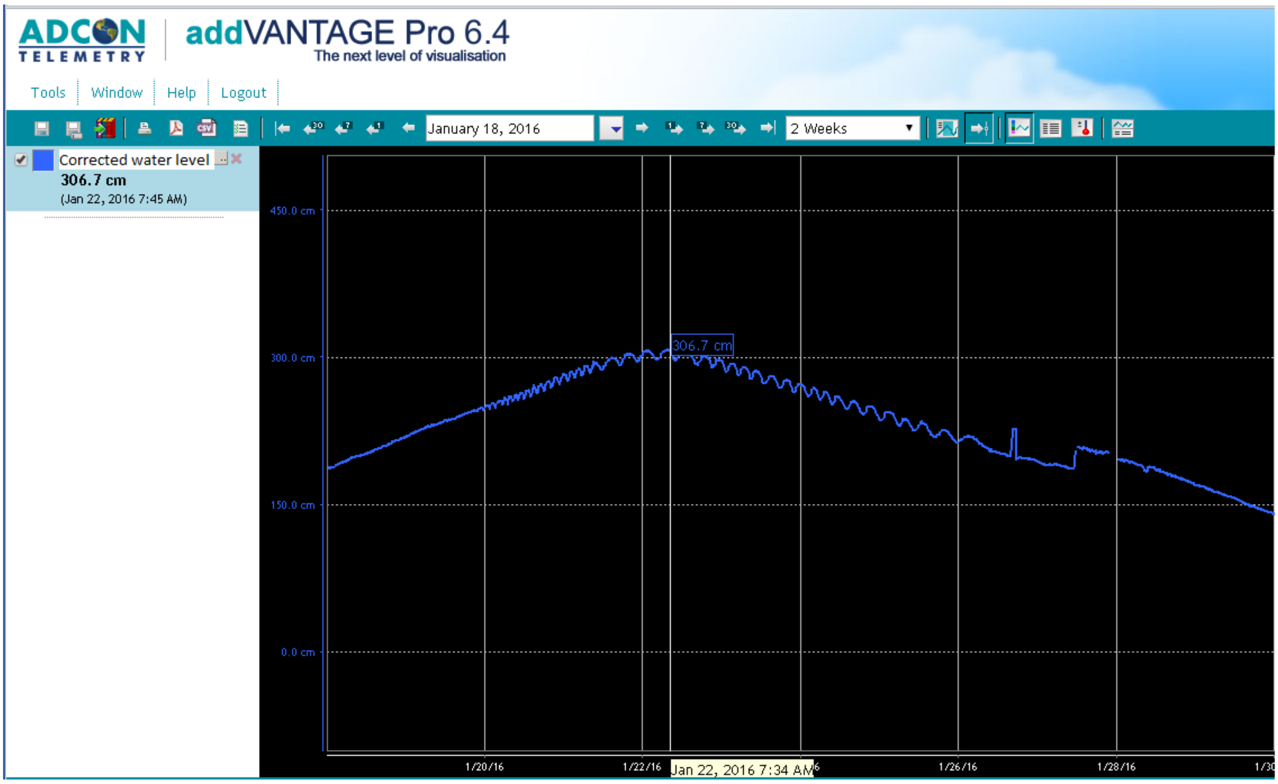

Figure 11. The radar station at Giurgiu.

As future work we envision to update the current system with improved visualization tools and add new sensors for monitoring the water quality.

4 CONCLUSIONS

In autumn 2016, most of the BEIA – Adcon – ANAR telemetry system above-described will have three years of uninterrupted functioning. It is a lapse of time that has encompassed difficult winter months for the outdoor equipment and also difficult hot summer months. In spite of that, we presented 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 the system will continue to grow with new remote monitoring installations and also, eventually, with new sensors added to existing installations.

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