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Managing water resources using information and communication technologies

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ABSTRACT

The purpose of this paper is to present the possibilities of applying information and communication technologies in the function of water resource management. Information and communication technologies record a significant development dynamics, so their application should be greater in the function of better management and use of the resources at our disposal, among which water plays an important role.
For the management segment, apart from the analysis and planning process, the key role is to provide timely and accurate information, which is the primary task of information and communication technologies, and it is estimated that the application of ICT in the function of resource management will be increasingly used.
Throughout the paper, apart from basic information on applied ICT technologies, an example of their application in the function of better water resource management is described.

Keywords: Information and communication technologies, application of ICT, resource management using ICT, sensors, digital switchboard, alarm panel, computer network, video surveillance, telemetry centre.

Introduction

Awareness about the importance of water as a resource and its adequate use and management, regardless of all the challenges from the aspect of deficiency and quality, is still not sufficiently developed and we must emphasise that it is not managed in the way that it represents not only a resource but also a blessing which can be taken away if we have an unsuitable relationship towards it, making life on this planet impossible. Therefore, a change of awareness from the aspect of using and managing the existing resources, among which we emphasise water, is becoming an imperative for sustainable development. Resource management is increasingly challenging due to the ever-growing need for it, a lack of the same, further development, an increasing cost of the stated resources, its usage possibilities, etc. In this context, the use of contemporary information and communication technologies in the function of optimal water resource management is applauded.

The possibilities of applying ICT technologies in the function of managing water resource quantity and quality are primarily seen in fast delivery of precise information, their analysis and undertaking adequate measures, so the application of ICT technologies represents only one of the measures necessary for managing water as a resource in the best possible way. We live in a time of change where the most significant change dynamics is seen in information and communication technologies, and it would be necessary to continuously observe and analyse the possibilities of applying them in the function of improving usage and managing the quality of life, and therefore managing the resources directly influencing not only the quality, but also their existence. The aim of improving and developing the water resource management process using ICT is to improve monitoring, speed and accuracy of information acquisition, and using them in real time, all in the function of more efficient and effective management of this resource.

Due to the high intensity of changes in the field of ICT, it is necessary to continually improve the possibilities of applying them in the function of preserving and using available resources in a better way.

The main characteristics of water resource management

Water resource management is a process of managing a complex system where attention must be paid to a lot of parameters impacting the quantity and quality of the distributed water.

The system contains a spring, water preparation and treatment plants, supply lines, distribution lines, filtering stations, pump stations, reservoirs, measuring points and access points for connecting end users. In order to manage such a system, it is necessary to provide a series of precise real-time information from differentparts of the system, coordinate activities and undertake preventive and corrective measures.

Through an implemented example, this article aims at illustrating how applying contemporary ICT technologies on a restricted segment of reservoir management canprovide timely and accurate information and efficient and effective management with the goal to rationally use and save water resources.

The implemented ICT technologies can also be used in the function of introducing systematic water resource surveillance and management which would surely contribute to more significant results, both in economic benefits, and in saving the increasingly important clean water resource. The following shows a visual surveillance system for observing the water level and overflow alarming, implemented for monitoring and control in large reservoirs of water inflow and outflow. The example presents not only the application possibilities, but also the benefits arising from implementing such projects, as well as a potential for systematic usage and implementation of ICT equipment and infrastructure in the function of more efficient and effective resource management.

Water level visual surveillance mode of operation and overflow alarming

In the brown coal mine Banovići, a need for better water management arose due to the increasing necessity of both the drinking and technical water for their own use, as well as for other users utilising the stated infrastructure, and due to the appearance of landslides detected in the vicinity of the reservoir overflow which, in the experts' opinion, could potentially impact the adequate reservoir overflow stream management. In order to remedy the consequences, it was important to alleviate the causes thatpossibly lead to them, so one of the suggestions was to try introducing ICT equipment and infrastructure, as well as improve the process of managing the water in the reservoir and thus, provide a greater amount of water in the system and remove the negative consequences. Equipment for visual control, surveillance and reservoir overflow alarming was installed and built in at the site of the brown coal mine Banovići water reservoir. At the relay station facility, an alarm-detection unit connected to a waterlevel sensor by a Cat6E UTP cablewas installed together with a warning light located at the water reservoir facility. In case of a reservoir overflow, the water level sensor enters the alarm state and signals the alarm unit which, through a GSM warning device, calls the previously memorised telephone number (pump station) and delivers a voice message that there is a high water level in the reservoir. An IP high resolution camera which visually monitors the water reservoir is installed in the water reservoir facility. The IP camera is connected to the network infrastructure in the relay station facility by a Cat6E UTP cable from where the video signal is, through the existing wireless network infrastructure, connected to the main network infrastructure of the brown coal mine Banovići. The pump station is also connected through a wireless infrastructure with the Čubrić warehouse facility and, in this way, it is linked with the main network infrastructure of the brown coal mine Banovići, thus enabling access to the camera installed at the water reservoir.
Through the main network infrastructure, the telemetry department will also have visual surveillance for observing the water reservoir.

The connection mode for the pump station and reservoir, as well as the telemetry centre, pump station and the reservoir, using the implemented ICT infrastructure and ancillary facilities, is shown in the following image.

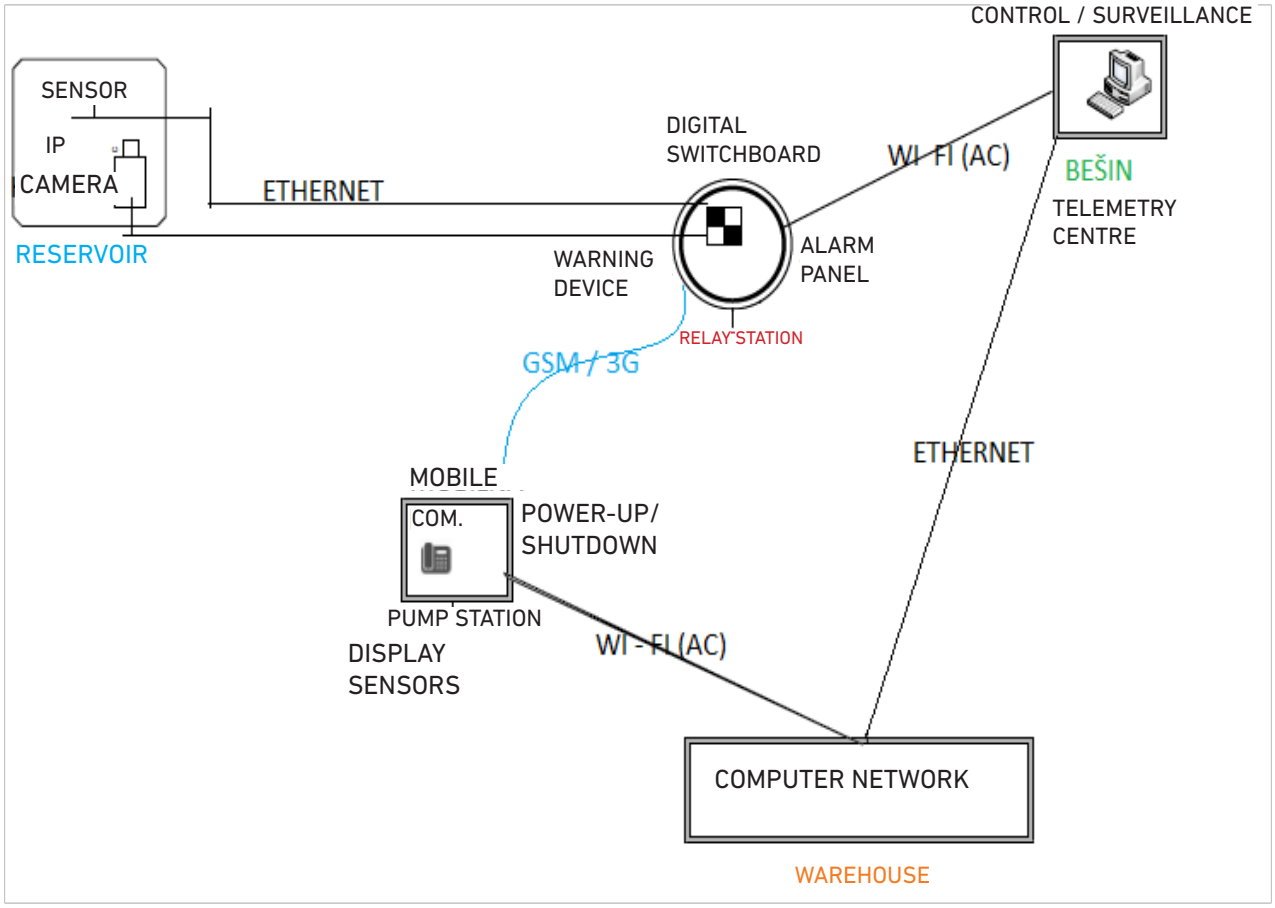

Image 1: The schematics of water flow and water accumulation surveillance, management and control

Using such a way to manage the water flow is shown in the following steps:

1. In case the water level in the reservoir reaches the overflow point, the sensor detects the water level and warns the unit which, through a GSM warning device, calls the control station (pump station Čubrić), as well as the telemetry centre Bešin.
2. In addition to the telephone signal, there is a signal warning in the pump station facility and the water level in the reservoir is monitored in real time through video surveillance in the telemetry centre.
3. Upon receiving the telephone call with the message "high water level" being heard, the pump is shut down by signalling, an additional call.
4. After the pumps are shut down, they are not restarted until the water level drops below the sensor detection level.
5. When the water level drops below the limit covered by the sensor, the alarm unit returns to the idle state until the next rise of the water level in the reservoir.
6. At the reservoir site, apart from the alarm unit and ancillary equipment which is designated to call, i.e. report that there is an overflow, that is, to state that the water reservoir inflow should be shut down, an IP camera transmitting a video signal to the telemetry centre is installed, enabling monitoring of the water level in real time.

7. The real-time system indicates the water level in such a way that, in case of an overflow detection by the camera which forwards the information in video format to the telemetry centre in Bešin, those on call at the organisational unit (OU) Površinska should telephone the supervisor at the pump station Čubrić in case the overflow is not stopped in a short period of time (e.g. several minutes).
8. Through this integral solution, apart from the insight into the state of the reservoir by both informing the pump station via an automatic call and monitoring the state in real time at the telemetry centre, the ability to communicate between the telemetry centre and the pump station Čubrić is provided.

ICT equipment and infrastructure

Within the above mentioned company where the described case study was implemented, there is a series of information systems and ICT services communicating through the implemented ICT infrastructure, so, for the purpose of managing the reservoir function and water flow at the stated location, a large part of the existing ICT infrastructure was used, greatly reducing investments and stating its justification. Brown coal mine Banovići has a telemetry centre for managing the production process, so the existence of the equipment and personnel at the telemetry centre was used for introducing water state monitoring in real time through implementing a part of the equipment, as well as the option of surveying and coordinating the activities with the pump station related to the water flow management process and possible overflow.

A better part of ICT computer network infrastructure, optical, Ethernet and wireless technology which was established between and within buildings was used to implement the project managing and monitoring the reservoir water level in real time. In addition to the computer network infrastructure and associated cabinets, backup power supply systems were implemented through UPS, as well as protection against atmospheric and switching overvoltage.

The relay station site is, apart from installing and powering the below stated devices, also used for establishing a data transfer connection through a Wi-Fi connection towards the telemetry centre and a GSM/3G signal towards the pump station Čubrić. Apart from this connection, the existing ICT infrastructure (optics-Ethernet) is used between the telemetry centre and Čubrić warehouse from where the Wi-Fi connection is implemented towards the pump station Čubrić.

Image 2: Water level sensor

Image 3: IP video camera for visual surveillance

The water level sensor is placed in the reservoir at the position for detecting an overflow, functioning as a detection device for water appearance at the position after which excess water will appear in the reservoir and overflow, being lost in the system. Through the Ethernet infrastructure and Cat6E STP cable, it is connected for transferring information and powered by the Power over Ethernet module. It is important that the sensor is implemented in line with the protection standards, including the IP67 standard, in order to provide dust and water protection which can negatively influence its functionality and affect the safety of people with access to the reservoir, At the reservoir site, an IP video camera is installed and connected to the relay station by using Ethernet, and, through the Wi-Fi AC standard compatible APs, it is connected to the building where the telemetry centre is located, enabling monitoring of the water level in real time.

Based upon the information delivered by the video surveillance, it is possible to configure a warning system and manage it in real time through a mobile or radio connection. In addition to the IP67 standard, it is important to provide the standard IK10 protection against mechanical impacts for the IP camera in order to minimalize the negative effects of vibration and extend its operating lifetime. In case the IP camera is disconnected or the connection with the computer network is severed for whatever reason, there is a possibility of saving the content on a Micro SD/SDHC/SDXC card, with the corresponding memory even up to 128 GB.

Image 4: Alarm panel

The alarm panel continuously monitors the state, connects to the sensor on one side and, on the other side, to the warning device to which it forwards the information when it needs to be activated. Upon receiving the information by the alarm-warning panel, the audible warning device calls the predefined numbers and sends generated messages stating that the water rose to the monitored level and what the operator should do. The audible warning device could be programmed to perform several functions and it can generate multiple different messages which are most frequently used in the function of protecting material goods in its immediate vicinity.

Benefits from ICT usage in water resource management

The value of clean water as a resource, both because of the increasing demand and due to the ever growing number of negative "contamination" effects, is becoming all the more pronounced, so managing such a resource not only provides economic benefits but also becomes an imperative for the sustainability

The IP camera is chosen in such a way that it can operate in real, extreme temperature conditions, that it has the option of high-quality recording even in reduced visibility conditions (IR diodes), as well as that is supports H.264/MJPEG video compression standards for compatibility with reproduction and recording devices. At the location where real-time data necessary for the telemetry surveillance is recorded, saving and backup is conducted at the defined time of the video produced by the camera recording the state of the water in the reservoir. Introduction of GSM/3G communications provides communication between the transmitter, switchboard, telemetry centre and pump station.

Image 5: Audible warning device

of life on earth since clean water represents one of the prerequisites for life on earth, not just for people, but generally, for life on our planet. Application and implementation of ICT equipment and infrastructure on a relatively small project have clearly produced the following results. In relation to the previous period of providing the service to the same number of users, the demands were lowered by approximately 25 percent which could be redirected towards building a water supply network and supplying an additional number of users with clean water. In addition to the satisfaction expressed by new users for having access to drinking water, the existing users have had regular water supply, even during the period when water shortages used to happen. It is clear that, in the water supply system for the end users, there was an additional 25% of water which could have been charged, so the whole investment in introducing ICT technologies in the water resource management process has, for the illustrated example, provided an economic benefit from the 25% of chargeable water, which is the basic measure for economically assessing an investment, resulting in the fact that it was paid according to the payment dynamics for the period spanning 14 months.

Apart from social and economic benefits, benefits are also expressed through an increase of responsibility from the aspect of management representatives, improved communication and an insight into everyday activities, the delivery of timely and accurate information for making the right decisions which can later be used for needs analysis, further planning and introducing improvements, etc. In addition to the stated benefits, the landslide problem is solved, and its further escalation could have caused significant damage for both the transportation infrastructure and ancillary facilities which would, apart from impacting the everyday life of citizens and the economy, cause great material damage that would have to be repaired and there would be legal repercussions for those held accountable.

We can only imagine the results that would arise from the introduction and adequate usage of ICT equipment and infrastructure, as well as telemetry surveillance and management into the water resource management systems where a larger amount of water resources are at disposal and it is necessary to manage several parameters and at several points starting from the spring to the end user, both in terms of quantity and quality. When it comes to quality measures, if we would implement certain sensors for measuring quality and design real-time information distribution, we could act in case the water quality is below the expected level and undertake corrective steps, but if we acquired the information on time, we could also undertake some corrective steps, add a corresponding additive measure, etc. and avoid minimal water distribution below the quality defined by the standards. In this way, apart from the stated responsibility towards the system users for providing them with the quality and quantity of the agreed upon service defined by the contract, we protect the health of the end users which is of immeasurable significance, and ultimately, we can provide drinking water to a larger number of people and living beings which is, even if we exclude the above mentioned benefits, in a way some sort of mission and obligation.

By applying data in the analysis and planning process, we can obtain significant savings and benefits both in the optimal planning and in the process of managing these resources in real time.

If we introduce the practice of implementing the best technical solutions in this area and raise awareness of both the end users and public goods concession holders, we could reach the goal of rational consumption and usage of water and other resources which would ultimately result in improving the quality of life, a sustainable development in this implementation segment, cost-effective solutions, a larger number of satisfied users, etc. Introducing automation technologies and artificial intelligence in certain segments would further emphasise all of the above stated benefits, both in the short-term and long-term. From the above illustrated example, it is clear that a series of negative consequences can arise by inadequate water resource management, including landslides, and by applying the most effective practices, methods and management techniques, it is possible to avoid unprecedented consequences, both material, those impacting the flora and life in general. What is continuously needed is building and developing awareness of not only the end users, but also people responsible for exploiting water resources, both through stimulative and penal policy in order to place the relationship towards the resources (blessings) put at our disposal and in our custody at a higher level on a daily basis.

Concluding remarks

- Due to the importance of managing water and other resources, it would be necessary to implement certain legal and incentive legislations that would encourage the introduction and use of ICT technologies and a contemporary management concept.

- On a simplified example, it is clear that the social benefits are seen in a larger number of users with access to water, and the economic ones are seen through savings and collecting more funds, avoiding potential damage, a prospect for a better analysis and planning, preserving resources and complying with the element of sustainable development.

- By introducing a larger number of different sensors, actuators and automating the process in a certain segment of artificial and business intelligence, the systems could be provided with complete manageability, both in real time and in the process of analysis and planning.

- By examining the above stated benefits of adequately using ICT technologies in the water resource management process, we can conclude that they are manifold, both for the state, the manager and water resource distributer, as well as for the end users, not only through a cheaper and more available litre of drinking and technical water, but also due to the possibility of providing more effective water delivery.
- It is necessary to continuously work towards developing the awareness of all the actors starting from the state, concession holders and end users through the legislation, incentives, the media, providing positive examples of its application, etc.

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Upravljanje vodenim resursima koristeći informaciono komunikacione tehnologije

SAŽETAK

Zadatak ovog članka je prikazati mogućnosti primjene informaciono komunikacionih tehnologija u funkciji upravljanja vodnim resursom. Informaciono komunikacione tehnologije bilježe načajanu dinamiku razvoja, pa bi primjena istih morala biti veća u funkciji boljeg upravljanja i korištenja resursa koji su na nam na raspolaganju, među kojima voda imaznačajnu ulogu. Za segment upravljanja osim postupka analize i planranja, ključnu ulogu ima dostavljanje pravovremnih i tačnih informacija, što informaciono komunikacionim tehnologijama je prvoshodni zadatak, te je procjena da će primjena IKT-a u funkciji upravljanja resursima se sve više koristiti. Kroz članak su osim osnovnih informacija o primjenjenim IKT tehnologijama opisan i primjer primjene istih u funkciji boljeg upravljanja vodnim resursom.

Ključne riječi: infomaciono komunikacione tehnologije, primjena IKT-a, upravljanje resursima koristeći IKT, senzori, digitalna centrala, alarmni panel, računarska mreža, video nadzor, telemetrijski centar

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