World Academy of Science, Engineering and Technology
International Journal of Environmental and Ecological Engineering
Vol:14, No:04, 2020

A Digital Clone of an Irrigation Network Based on Hardware/Software Simulation

Authors : Pierre-Andre Mudry, Jean Decaix, Jeremy Schmid, Cesar Papilloud, Cecile Munch-Alligne

Abstract : In most of the Swiss Alpine regions, the availability of water resources is usually adequate even in times of drought, as evidenced by the 2003 and 2018 summers. Indeed, important natural stocks are for the moment available in the form of snow and ice, but the situation is likely to change in the future due to global and regional climate change. In addition, alpine mountain regions are areas where climate change will be felt very rapidly and with high intensity. For instance, the ice regime of these regions has already been affected in recent years with a modification of the monthly availability and extreme events of precipitations. The current research, focusing on the municipality of Val de Bagnes, located in the canton of Valais, Switzerland, is part of a project led by the Altis company and achieved in collaboration with WSL, BlueArk Entremont, and HES-SO Valais-Wallis. In this region, water occupies a key position notably for winter and summer tourism. Thus, multiple actors want to apprehend the future needs and availabilities of water, on both the 2050 and 2100 horizons, in order to plan the modifications to the water supply and distribution networks. For those changes to be salient and efficient, a good knowledge of the current water distribution networks is of most importance. In the current case, the water drinking network is well documented, but this is not the case for the irrigation one. Since the water consumption for irrigation is ten times higher than for drinking water, data acquisition on the irrigation network is a major point to determine future scenarios. This paper first presents the instrumentation and simulation of the irrigation network using custom-designed IoT devices, which are coupled with a digital clone simulated to reduce the number of measuring locations. The developed IoT ad-hoc devices are energy-autonomous and can measure flows and pressures using industrial sensors such as calorimetric water flow meters. Measurements are periodically transmitted using the LoRaWAN protocol over a dedicated infrastructure deployed in the municipality. The gathered values can then be visualized in real-time on a dashboard, which also provides historical data for analysis. In a second phase, a digital clone of the irrigation network was modeled using EPANET, a software for water distribution systems that performs extended-period simulations of flows and pressures in pressurized networks composed of reservoirs, pipes, junctions, and sinks. As a preliminary work, only a part of the irrigation network was modelled and validated by comparisons with the measurements. The simulations are carried out by imposing the consumption of water at several locations. The validation is performed by comparing the simulated pressures are different nodes with the measured ones. An accuracy of +/- 15% is observed on most of the nodes, which is acceptable for the operator of the network and demonstrates the validity of the approach. Future steps will focus on the deployment of the measurement devices on the whole network and the complete modelling of the network. Then, scenarios of future consumption will be investigated. Acknowledgment— The authors would like to thank the Swiss Federal Office for Environment (FOEN), the Swiss Federal Office for Agriculture (OFAG) for their financial supports, and ALTIS for the technical support, this project being part of the Swiss Pilot program 'Adaptation aux changements climatiques'.

Keywords : hydraulic digital clone, IoT water monitoring, LoRaWAN water measurements, EPANET, irrigation network
Conference Title : ICWM 2020 : International Conference on Water Management
Conference Location : Lisbon, Portugal
Conference Dates : April 16-17, 2020