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CASE STUDY

Information and Communication Technology in Water Management: A Case Study

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ABSTRACT

Smartphones, smart watches, smart cars, and smart grids - everything is smart nowadays, even water. Living in the smart city, Bhubaneswar, I have never encountered a lack of fresh water. However, the global picture looks quite different. Water scarcity affects every continent. According to a UN investigation, around 1.2 billion people live in areas of physical water scarcity. A further 1.6 billion people face economic water shortages (where countries lack the necessary infrastructure to take water from rivers and aquifers). There is enough fresh water on the planet for 7 billion people but it is distributed unevenly and too much of it is wasted or polluted. This study will find a solution of this problem.

Key words: Information, communication, water management, case study

INTRODUCTION

There has been very little work done in this information and communication technology (ICT) for water. Singh *et al.* used artificial neural network technique for modeling of evapotranspiration for Nagini watershed of Uttarakhand.[1] According to a UN investigation, around 1.2 billion people live in areas of physical water scarcity. A further 1.6 billion people face economic water shortages (where countries lack the necessary infrastructure to take water from rivers and aquifers). There is enough fresh water on the planet for 7 billion people, but it is distributed unevenly and too much of it is wasted or polluted. This study will find a solution of this problem.

RESULT AND DISCUSSION

Smart water management

ICT is a strategic enabler in the process of developing innovative solutions to address the problems of water scarcities. By facilitating the collection and analysis of environmental data, ICT enables researchers and climatologists to build more accurate models for weather forecasting. The main areas where ICT can play a pivotal role in water management are shown in Flowchart 1.

As water resources are finite, water authorities must be able to assess current water supply to determine how to meet future water demands. Mapping of water resources is therefore becoming increasingly important for water utility companies. Radio-based ICT systems such as remote sensors are a major source of information about the earth's atmosphere and environmental conditions. Remote sensing technologies coupled with satellite radiocommunication systems, global positioning systems, and GIS have been instrumental in identifying new freshwater sources, building models of watershed basin areas, and analyzing environmental problems.

The science of weather forecasting and climate monitoring has benefited greatly from development in the ICT, notably the World Weather Watch system of World Meteorological Organization (WMO). The World Weather Watch system is made up of three core components:

- The Global Observing System provides high-quality, standardized observations of the atmosphere and ocean surface from all parts of the globe and from outer space. This system

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Flowchart 1: Mapping of water resources, weather forecasting, and climate monitoring

is based on the use of satellite and ground-based remote sensors (active and passive) employed by the meteorological satellite, earth exploration satellite, and meteorological aids radiocommunication services. These services play a major role in climate monitoring and weather forecasting.

- The Global Telecommunication System provides for the real-time exchange of meteorological observational data, analysis, warnings, and forecasts between national meteorological and hydrological services.
- The Global Data Processing and Forecasting System provides meteorological analysis, warnings, and forecasts, generated by a network of the World Meteorological Centers.

Major roles for ICT in water management [Figure 1]

Mapping of water resources and weather forecasting

- Remote sensing from satellites
- *In situ* terrestrial sensing systems
- Geographical information systems
- Sensor networks and internet.

Asset management for the water distribution network

- Buried asset identification and electronic tagging
- Smart pipes
- Just in time repairs/Real time risk assessment.

Setting up early warning systems and meeting water demand in cities of the future

- Rain/Storm water harvesting
- Flood management
- Managed aquifer recharge
- Smart metering
- Process knowledge systems.

Just in time irrigation in agriculture and landscaping

- Geographical information systems
- Sensor networks and internet.

The role of ITU and its standards

The ITU radiocommunication sector (ITU–R), as the international steward of the spectrum, allocates the necessary radiofrequencies to allow the interference-free operation of the radio-based applications and radiocommunication systems (terrestrial and space) used for environment (including water) and climate monitoring and prediction, weather forecasting, and disaster early warning and detection. The frequency bands allocated to radiocommunication services and used by environmental monitoring systems are described in the international treaty status Radio Regulations. ITU-R Study Group 7 (Science services) carries out studies and develops the remote sensing (RS) series of ITU-R recommendations and reports, and these are used for the design and operation of the radiocommunication systems that monitor climate change.

Study Group 7, in cooperation with the WMO, has also developed the ITU/WMO handbook, Use of Radio Spectrum for Meteorology: Weather, Water, and Climate Monitoring and Prediction. The handbook describes modern radiotechnologies, tools and methods employed by the World Weather Watch system.

The standardization work carried out by ITU-R study groups has played a key role in the development and use of:

- Weather satellites that track the progress of natural phenomena such as hurricanes and typhoons;
- Radar systems that track weather systems (e.g., tornadoes and thunderstorms) and events such as volcanic eruptions and forest fires;
- Radio-based meteorological aid systems that collect and process weather data;
- Radiocommunication systems (satellite and terrestrial) that can be used in emergency situations to communicate information concerning natural and man-made disasters.

Recognizing that the radiofrequency spectrum is a critical resource for the remote sensing carried out by the Global Observing System, the World Radiocommunication Conference

2007 (WRC-07) allocated additional spectrum to radiocommunication services involved in environmental observation, and requested ITU-R to carry out new studies for the future development of remote sensing applications and systems under Resolution 673 (WRC-07) on "Radiocommunications use for Earth observation applications." The results of the studies will be considered by the next WRC in 2012.

To improve environmental monitoring, ITU has established and strengthened strategic partnerships with WMO and other United Nations agencies, International and National Organizations, as well as non-governmental organizations, and the private sector involved in climate change monitoring.

Smart grids

Within ITU's Telecommunication Standardization Sector (ITU-T), study Group 15 has developed home networking specifications under the ITU-T G.hnem banner for smart grid products. G.hnem is the new project "Home Networking Aspects of Energy Management" initiated by ITU-T and the Joint Coordination Activity on Home Networking in January 2010. The main goal of the project is to define low complexity home networking devices for home automation, home control, electrical vehicles, and smart grid applications. Among the smart grid application that will benefit G.hnem are-changed to Among the smart grid application that will benefit are:

- Utility-based demand response programs through broadband Internet communications or advanced metering infrastructure systems;
- Remote troubleshooting to minimize cost;
- Support for real-time demand response systems that compensate users depending on their usage;
- Flexible control of appliances to reduce power consumption during peak periods.

In February 2010, ITU–T set up the Focus Group on Smart Grid to identify potential impacts on standards development in the field (e.g., ICT and climate change) and investigate future study items to support smart grid development.

Asset management for the water distribution network

To manage assets, water companies need to have maps of water distribution networks. Having the maps in electronic format rather than on paper enables water companies to carry out more sophisticated analysis and respond faster. With the standardization of Geography Markup Language and the geospatial web already under way, information about water distribution networks can also be provided over the Internet through mobile devices. This enables field workers to access operation and maintenance information more effectively [Figure 2].

Setting up early warning systems and meeting water demand in cities

Cities that are located in low-lying regions close to the coast or along river deltas face the danger of flooding. These areas are often secured with water-retaining infrastructure (levees).

Early warning systems have an important role in mitigating risks through early detection of conditions that might lead to a disaster and by providing real-time information during an event. Sensors can also help in monitoring the structural integrity of levees and dams. The ability to predict whether water-retaining infrastructure can withhold the mounting pressure of rising waters is essential to be able to give enough time for a large-scale evacuation if the need arises. For example, in

Figure 1: Mapping of water resources and weather forecasting

Figure 2: Field workers to access more effectively

the Netherlands, the IJkdijk Foundation has been working on building smart levees (levees with an in-built network of wireless sensors).

By digitizing information obtained from remote sensing satellites about the geography and hydrology of the land, data on such aspects as rock structure, land use, and drainage basins can be analyzed in the context of water table conditions and rainfall levels. This makes it possible to produce composite maps showing suitable sites for the construction of artificial recharge structures. In 2008, for example, managed aquifer recharge contributed 45 gigaliters to irrigation supplies and 7 gigaliters to urban water supplies in Australia.

Smart water-metering technology can enable water utility companies to track usage more accurately at the consumer end and implement water-pricing plans to encourage water conservation. Rather than receiving their water bills at the end of the quarter or the month, consumers will be able to track their water usage in real time and thus be able to take action much earlier in case of leakages. Developing countries lose as much as 50% of treated water as a result of leaks in the distribution system or theft. This loss could be partly prevented using better measurement techniques. In developed countries, installing a meter in a house so that people can see how much water they are using can reduce consumption by around 10%.

Water use in manufacturing plants can also be managed more efficiently using ICT. Every manufacturing plant, whether making steel, paper, oil, or microchips, uses water in some capacity during its operations. Industrial water is essential for the businesses that use it. For example, cooling water systems are essential in many industrial plants. Proper operation of the cooling system is needed to minimize the impact of total operational costs related to water and energy consumption, chemicals, and wastewater discharge. Process software can be used in managing automation and control systems, including turbine control systems that help improve plant performance and thus optimize water consumption. Such systems also provide information in real time about current conditions, sending alerts about potentially dangerous events.

Just in time irrigation in agriculture and landscaping

Agriculture accounts worldwide for about 70% of all water use. The key to avoiding water wastage is to know the right time to irrigate and the volume of water to be used. Wireless sensors can be placed on crops and in the soil to monitor humidity levels and soil moisture. Such sensors can automatically activate the valves of the irrigation system on a need basis.

When connected to the Internet, sensors monitoring factors such as soil moisture, crop water retention, weather information, and plant characteristics allow for remote management of the system. This type of sensor network is also applied in landscaping and in sports ground maintenance, for example, in football grounds and golf courses [Figure 3].

Looking ahead

ICT can bring enormous benefits to water authorities in mapping and monitoring natural water resources, as well as in forecasting river flows and giving advance warning of water-related emergencies such as flooding.

In particular, smart metering technologies will play an important role in measuring water consumption in real time, identifying leaks at the consumer level, and making consumers more conscious about their water usage. The scope of the ITU-T Focus Group on Smart Grid could well be extended to include water-metering technologies. With developments in plug and play sensors, the semantic sensor web, the geoweb, geographical 3D modeling, and mobile communications, this field has great potential for water authorities, and there could be new areas of standardization work for ITU-T Study Group 16 in collaboration with other standards bodies such as the Open Geospatial Consortium, the World Wide Web Consortium (W3C), and the Institute of Electrical and Electronics Engineers.

ITU-T Study Group 5 (Environment and Climate Change) could work closely with, for example, ISO and the Water Footprint Network to look into developing model standards that enable countries to understand how their water management policies affect both their water and energy footprints. The issue is directly linked to ITU-T Study Group 5's new Question 23 "Using ICTs to enable countries to adapt to climate change."

Developing countries could make use of GIS tools for better decision-making in water management policies to meet the Millennium Development Goal targets for water. However, many of these

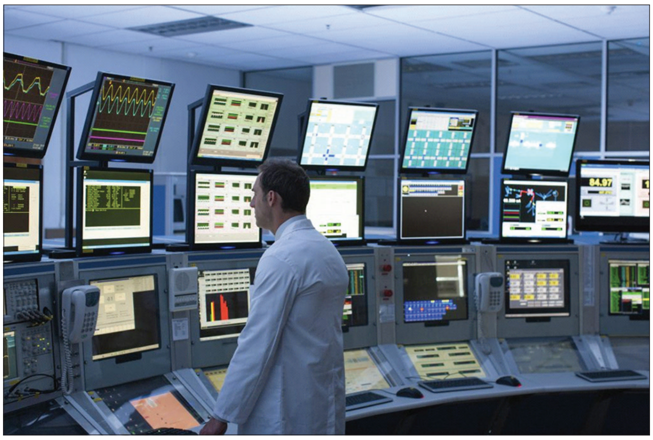

Figure 3: Sensor network in sports ground

countries lack the resources and know-how to strategically exploit the GIS tools. This is another form of the digital divide.

ITU jointly with the UN Water Task Force could play an important role in enhancing the capacity of developing countries to exploit GIS through the development of a standardized geoweb toolkit. They should consider establishing a capacity-building programme on GIS and spatial data analysis for water stakeholders in developing countries.

"Water for life" and the millennium development goals

The Technology Watch Function is managed by the Policy and Technology Watch Division of ITU's Telecommunication Standardization Bureau. The report "ICT as an Enabler for Smart Water Management" and other Technology Watch Reports are available at http://www.itu.int/ITU-T/techwatch.

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