Abstract Volume

World Water Week
in Stockholm
23-28 August, 2015

Water for Development

SIWI WORLD WATER WEEK

ABSTRACT VOLUME

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Workshop 7:
Information technologies for a smarter water future

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Workshop: Information technologies for a smarter water future

Mobile money technology, convinient for water bills payment in Uganda

Author: Ms. Agnes Namuli, MWODA, Uganda

Co-Authors: Mr. Andrew Mugerwwa, MWODA, Uganda

Keywords: Mobile money, technology, convenient, Water bills payment

Introduction and objectives

In the past, the public struggled to queue long hours and travelling long distances to pay water bills in Uganda urban centers. This made people become reluctant to pay for water bills leading to continuous cut offs and loosing trust in the National Water and Sewerage cooperation in Uganda. The use of mobile money technology has changed and made access to water in the urban centers more effectively and efficiently. The convenience of mobile money to the public came as a real time solution and has eliminated delays in updating customer accounts and reduction in physical movements of bill payments

Methodology approach

Mobile money is an electronic payment system that transfers money to and from an electric account that can be accessed via a mobile phone. Each customer account is linked to their mobile phone number by means of a built sim-card application. physical cash withdraws and deposits are facilitated by a network of rental agents.

To pay water bills by mobile money, you have to own a mobile phone and registered with a network. You go to menu and select mobile money, select pay bills and then select NWSC. Select the region, type customer reference Number and amount to be paid.

Analysis, results, conclusions and recommendation

The National Water and Sewerage Cooperation came into partnership with mobile money service providers like MTN and airtel to initiate the use of mobile money technology as a convenient method to pay water bills.

The NWSC wanted to ease lives of the customers whom they believe as the king. They phased out cash offices in a bid to concentrate on customer care and the provision of water which is their core business and it was the reason for the NWSC to partner with dynamic organizations like MTN to make water bill payment easier.

Results

- Bills are sent on people's individual phones.
- Reduced expenses on travel.
- Reduced time spent in long queues.
- Reduction in risks by the NWSC
- Water utility bills payment made simple
- Less physical movements by customers

- Convenience
- Increased reliability of water supply to customers.

Recommendation
I call upon the SIWI organizers and convening organizations to support me in creating awareness and sensitize the public on the use of mobile money to pay water utility bills. This is because many people in the urban areas who access water from the NWSC have telephones but do not know how to use this technology to pay for the water bills. Sensitizing these people will make more people have access to water and improved development.

Conclusion
Despite a compelling challenges like delayed reconciliation of billing systems, limited customer awareness and technological constraints hindering some customers' uptake mobile water payments, those customers paying their bills with mobile money enjoy considerable saving in time and money costs usually incurred when settling water bills at physical payments points. Identifying mobile money payment applicable could reach and benefit low income and vulnerable groups in both urban and rural areas to help tackle ongoing water service delivery challenges.

Assessing the Effectiveness of Malawi's Water Policy Using Mobile Technology

Author: Mr. Muthi Nhlema, Water For People Malawi, Malawi

Co-Authors: Kettie Harawa, Water For People Malawi, Malawi

Keywords: mobile technology, AKVOFlow, Malawi, Water, Functionality

Introduction and objectives
In 2005, The Malawi Government instituted the National Water Policy (2005) as a guide to achieving universal access or what is locally known as "Water For All, Always".
Malawi recognized that the "Always" part of their objectives required communities to own their water systems which involved operating, maintaining, replacing, and extending their water services without external assistance.

In 2012 and 2014, Water For People, and a local government partner, conducted district wide mapping of Chikhwawa, a district in the southern region of Malawi, which provided a comprehensive data-set for reviewing the effectiveness of the water policy approaches and strategies.

Methodology approach
The presentation will illustrate how effective the National Water Policy has been by reviewing data collected using a mobile phone app called AKVO Flow from between 2012 and 2014
Initially developed by Water For People, Akvo FLOW uses Android cellphones, combined with GPS software, to give users the ability to record data from thousands of water points around the world. This data is then used to determine the level of service (water quantity, quality, access, distance, etc.) and level of sustainability (financial management, spares available, etc.) of each system.
The analysis will be based on 4384 lines of data.

Analysis, results, conclusions and recommendation
Water For People, in collaboration with local government partners, collected data in 2012 and 2014 of over 2000 water points across the district of Chikhwawa. The data collected, not only helped provide an understanding of the current state of water supply across the district, but also helped assess some significant changes at a district wide level.

The results show that, despite significant investment by bilateral/multilateral agencies, International NGOs and foreign governments, there has still been an overall decline in functionality of water points by close to 2%. In addition to this:

- Only 26% of water committees collect tariffs on a monthly basis
- 82% of water points in some geographic location had serious problems requiring preventative maintenance
- Tariffs are decided by communities and are predominantly based on affordability and not life cycle costs
- Non-need based interests have distorted distribution of water systems

These results call into question the effectiveness of the strategies and approaches outlined in the Malawi National Water Policy (2005) and, thus, require a thorough re-think of what actually works and what should change.

As such, it is recommended that the standard approaches such as community-based management, for example, need to be re-designed with newer approaches that provide real incentives for communities to own, operate and sustain their water system over time. Such approaches could include borehole banking which converts tariffs into savings/shares managed by the local water point committee.

Mobile platform for water quality data management in Senegal

Author: Dr. Emily Kumpel, Aquaya Institute, Kenya

Co-Authors: Dr. Rachel Peletz, Aquaya Institute, Kenya
Dr. Ranjiv Khush, Aquaya Institute, United States
Mr. Mateyo Bonham, Aquaya Institute, Kenya

Keywords: water quality monitoring, information and communication technologies (ICTs), mobile phones, remote data collection, Senegal

Introduction and objectives

Water quality monitoring is key activity carried out by water suppliers and health surveillance agencies to help ensure access to safe drinking water; however, many institutions struggle to make the data accessible for immediate action or long-term decision-making. Mobile phone-based data management applications can aid in making data accessible and in collating data from multiple remote testing locations. The objective of this study was to design, test, and evaluate the efficacy and sustainability of a mobile phone-based data management system with the national health agency in Senegal, Service National de l'Hygiène (SNH) to improve information flows.

Methodology approach

SNH's monitoring program was established before the ICT intervention, in which health agents collected water samples and recorded source information and water quality measurements; they tested >2,500 water samples between July 2013-Septemter 2014. Each of 13 testing locations started recording data through an Android phone equipped with the CommCare application between September-December 2014. We collected and analyzed quantitative data to compare the accuracy of data collected through the paper vs. phone-based system and qualitative interview data to understand SNH's data management challenges and perceptions of the mobile platform.

Analysis, results, conclusions and recommendation

SNH health agents from the 13 sub-areas collected and tested over 400 water samples and simultaneously reported data through their traditional paper workflow and CommCare.
There are some notable lessons learned thus far:

1. Mobile phone data collection has improved the timeliness of aggregated data and introduced consistent data collection; previously, each multiple remote regions collected different data about water sources.
2. Benefits may be limited because sampling was only a few days per month, resulting in minimal phone use and reduced cost-effectiveness. For health agents for whom water quality is only one of many responsibilities, it may be advantageous to use the phone additional activities (e.g. sanitation, training, or equipment and inventory management).
3. While it was relatively easy to introduce the application onto existing workflows (collecting and testing water samples), it was difficult to introduce mobile data collection into workflows that were not standardized across regions (e.g. follow-up actions). This highlights the importance of establishing successful, standardized workflows before introducing ICTs.
4. One testing location was unable to test at all because of a damaged vehicle, highlighting the many other challenges faced in carrying out water quality testing.

The popularity of mobile phone data management applications has fostered the perception that all

field-based data collection activities will benefit from their use. However, in the case of regulated water quality monitoring, water quality data is almost always collected in laboratories, which promotes data entry on computers. We propose that mobile phone applications will provide the greatest efficiency gains among institutions that collect data from many remote laboratories (i.e. where smart phones are cost-effective alternatives to computers). Also, while this intervention focused on improving information flows within an organization, ICTs also have the potential to improve the sharing of results with local authorities and the public.

Fresh Water Watch: A Citizen Scientist Platform to Monitor Global Water Quality

Author: Dr. Neil Bailey, Earthwatch Institute, United Kingdom

Co-Authors: Mr. Malcolm Bradbrook, Earthwatch Institute, United Kingdom
Prof. Steven Loiselle, United Kingdom

Keywords: Citizen Science, Monitor, Web-Platform, Data

Introduction and objectives

Urbanization is impacting on freshwater ecosystems, yet managing this impact is limited by a lack of information on water quality. FreshWater Watch (FWW) addresses the need for these data by engaging a range of audiences (Corporates, Research Organisations, Environmental Groups and Communities) to monitor freshwater ecosystems around the globe. The platform enables citizens to act as a network of sensors who upload data via smartphone apps to an open database which can be interrogated and shared. The Platform already has over 6000 data points and is being utilised by both HSBC and Shell to engage their employees.

Methodology approach

The need for water quality data is particularly acute for small urban waterbodies (such as rivers, streams and ponds) which aren't typically monitored. FWW is engaging citizens around the globe to upload data on these water bodies and provide insights into the relationship between development and water quality. The Platform consists of a network of over 30 scientists and policy-makers who can access this data for dedicated research projects but the data can also be used by anyone. The Platform uses standardised parameters, whilst individual projects can add their own specific parameters to answer explicit localised issues.

Analysis, results, conclusions and recommendation

The Platform is just over two years old but has already engaged over 3000 Citizen Scientists who have generated more than 6000 datasets. This rapid uptake has been achieved by working with Corporates such as HSBC and Shell who have a large, global workforce and wish to engage employees in sustainability issues.

While the main benefits of this growing set of data occur in the medium term, the Platform has already acted as an early warning system at a local scale on numerous occasions (e.g. highlighting potentially toxic algal blooms in potable water supplies). Preliminary results provide important insights into urban water management and have revealed that smaller water bodies typically present better ecological conditions than larger waterbodies. This suggests the need for a fundamental shift in water management priorities.

The Platform continues to engage new participants and is seeking to double the number of Citizen Scientists engaged by 2017. This will be achieved via a novel model of engaging people through their work place, local organisations, schools or communities. Techniques on motivating Citizen Scientists are embedded into the Platform to encourage long term engagement. Participants can form collectives and networks with one another as well as with scientists and other policy makers. In addition, 'gamifica-

tion' techniques reward participants for the amount of data and level of engagement they undertake. In conclusion, recent advances in web and mobile technologies have enabled citizen science to become more widely adopted than ever before, with 'Mass Citizen Science' projects now becoming prevalent. Earthwatch will continue to utilise these technologies to grow the FWW Platform and engage with a variety of audiences to add to this already considerable scientific output to better inform decision makers about how to manage of our fresh water and associated ecosystems.

Lessons from implementing ICT applications in the African water sector

Author: Mr. David Schaub-Jones, SeeSaw, South Africa

Co-Authors: Ms. Laura Szczuczak, SeeSaw, South Africa

Keywords: ICT, Lessons, Africa, Water, Government

Introduction and objectives

The use of new ICT tools to support water services provision is expanding rapidly. Yet too often the focus appears to be on the tools themselves or the ability to collect data in different ways; insufficiently on what the data gets used for, or how the provision of data actually changes the dynamics on the ground. The paper looks to critically analyse existing case studies to see what drives ICT adoption, to see how this in turn affects the usage of new systems, and thence look at whether these systems actually change water delivery in practice.

Methodology approach

A case study method is followed, with a political science approach taken to in order to look at the different drivers that shape stakeholder's adoption (or disregard) of new ICT tools, particularly those seeking to improve the monitoring of water services. By critically analysing experience in South Africa, Tanzania and Mozambique, and interviewing those directly involved in putting systems in place (governments, regulators, NGOs, municipalities, users) lessons are drawn and recommendations made on how to design new systems in order to have maximum impact.

Analysis, results, conclusions and recommendation

Too often the focus is on "which tool" or "which technology", whereas it is crucial to pay great attention to what any data collected will be used for and how the provision of this data leads to actual actions that change the dynamics on the ground.

A political science approach helps clarify the different drivers for monitoring – from internal to external – for financial reasons versus 'efficiency-driven' approaches – helping to reveal why specific stakeholders will engage or disengage with new initiatives. The result is a slight 'reality check' to the implementation and adoption of ICT – with the intention of the paper to help ensure that positive contributions in this field are not lost through bad design, over-ambitious approaches or misaligned incentives.

Case studies from Tanzania, South Africa and Mozambique help to clarify that the use of ICT tools alone cannot solve issues; a number of accompanying activities are required, including the need to raise awareness about and to prioritise monitoring (from Mayor to Technician), to forge good communications between diverse role players, to put in place well-designed feedback loops. Above all, there needs to be commitment and capacity to turn data collection and interpretation into action.

When supported in this way, the application of ICT tools (whether cellphone or web-based) can:

- Offer real-time reporting of quality of service by municipalities and other service providers
- Provide a means to cross-check this information with customers, citizens and other groups
- Enable early or strategic intervention in areas facing significant problems (and possible public health threats)

- Lead to progressive improvement in water services

We conclude that by leveraging ICT significant improvements in water services can be achieved, even within existing capacity constraints, as long as holistic design principles are respected and accompanying actions put in place.

Real-time optimal operation computerized system, For large-scale water supply networks

Author: Mr. Ram Aviram, BIT-Consultancy and Department of Geography, Haifa University, Israel

Co-Authors: Mr. Daniel Cohen, Water Resources Dep. Mekerot, Israel
Mr. David Wizental, Water Resources Dep. Mekorot, Israel

Keywords: Optimal operation, real-time, computerized system, energy saving, supply network

Introduction and objectives

As treated waste water developed to be a major of water source for irrigation in Israel it called for investment in optimal operation systems. Israel's need to deliver about 170MCM/Y of treated waste water over vast spatial area through complex network brought MEKOROT (Israel's National Water Company) to develop a unique computerized system for real-time integrative operation of the network. The system gives solution to a good number of challenges and constraints from hydrological to geographical by evaluating dozens of thousands of variables and mange automatically in real time dozens of sources, intermediate system components and hundreds of supply points.

Methodology approach

The paper firstly reviews the development and implementation phases of the system "M.B.T- 3" while comparing it to other practices of development of such a system. The second part of the work is concentrating on the main characteristic of the system and their practical use. The last part of the paper is an evolution of the results of 4 years operation in order to consider the achievements and recommending further actions. The methodology used in all 3 parts is review of relevant papers, review of working meetings summaries in MEKOROT and in-depth interviews with key players.

Analysis, results, conclusions and recommendation

The waste water of Israel's main urban center is treated at 3rd stag, percolate and stored in an artificial aquifer. The main irrigated region is spread over vast area up to about 200 km from the artificial aquifer. The main bulk of water is extracted by 150 wells from this aquifer and distributes 170 MCM/Y, by consumption 200 million kWh. The water system consists of 57 pumps grouped at 16 pumping stations, 5 seasonal reservoirs, 6 operational reservoirs, and 6 operational tanks. In order to manage the system in the most efficient way MEKOROT used innovative "Agile development methodology" to develop its own complex software system "M.B.T-3". The development was done dynamically and adaptively with tight connection between the developers and the users, while all partners were defined as a joined team. "M.B.T-3" consists of 4 main modules which are grouped into a unified system. It dynamically collects measurements from all the plants. Hourly demands at each operational region are forecasted for 168 hours and for 1 year ahead. In real-time the system defines the optimal planned operation of each plant for a given planning period. It is achieved by solution of a large scale optimization problem with dual objective functions, 177,000 decision variables and 77,000 constraints. The M.B.T-3 has been successfully applied since January 2010. A comparative study was done during 2011, and indicated that, during 2010, in compare to year 2009, 3.5 million USD of the energy cost has been saved. Additional improvements can be impaled in water extractions from wells and in supply reliability level. The paper concludes that such system contributes dramatically to the optimal operation which can be applied in other large-scale water supply networks.

Online assessment system for water and sanitation services in India

Author: Ms. Jaladhi Vavaliya, CEPT University, India

Co-Authors: Mr. Dhruv Bhavsar, CEPT University / PAS Programme, India
Ms. Utkarsha Kavadi, CEPT University / PAS Programme, India

Keywords: Online system, benchmarking, assessment, capacity building

Introduction and objectives

Access to water and sanitation services in urban India is widespread, but little is known about the quality and level of service, and coverage of the poor households. A key challenge in the sector in India is the lack of adequate and reliable information. This poster describes the journey of 400+ cities in two states of India from a rudimentary paper based system to an online measurement and monitoring system, prepared under PAS project at CEPT University, funded by BMGF. Together, these cities house 76.5 million people, with cities as large as 12.5 million to cities as small as 4000.

Methodology approach

The performance measurement framework (PMF) has been developed for state-wide implementation with a focus on the 'real' context for benchmarking water and sanitation in developing country context, and includes aspects of equity and on-site sanitation. The data collection for initial two years was conducted through spreadsheet based questionnaires and required face to face interaction with city officials. The online data entry, analysis and monitoring system was deployed on the PAS portal, www.pas.org.in for the subsequent years, and was actively adopted by city and state officials. The portal now hosts six years of information for all cities.

Analysis, results, conclusions and recommendation

In the initial phase, there were serious gaps in data recording and management in cities. In some cases, there was no recording of relevant data at the ground level or if data was recorded, it was not collated or summarized to be analyzed and reported to higher officials. There were lapses and ignorance towards data collection at the ground level and reporting and analysis at the management level. Most of the records are paper based and fragmented. Where information existed, they were maintained in isolation and were not usually shared with each other.

In the first year, it took almost 15 months to collect and validate data. But, this exercise created awareness about benchmarking and its context amongst city and state officials. In the online system, respective city officials are authorised to enter data, with levels of validation/approval built in for city commission/chief officer, and state officials. The portal also helps cities to analyse and monitor trends, compare with their peers and track progress towards targets.

The results of the assessment are made available at the state level, across all classes of cities.
A comprehensive set of guidelines is prepared to assist city government in using online tool. Through a series of capacity building workshops, government officials are trained and made conversant with the online data entry tool. Subsequently they have started entering data online on their own and resulted in reduced timeline for annual performance assessment activity.

To disseminate the online tool, regional capacity building workshops were organised, as a result of which, the states of Chhattisgarh and Madhya Pradesh, with 150 cities, have bought in and adopted the online tool for monitoring performance of UWSS sectors.

The data from the online system has been used for various policy interventions and improvement actions at state and city levels.

GIS/GPS based Customer Enumeration, a tool for improving Water Utility's efficiency

Author: Mr. Babatope Babalobi, Bread of Life Development Foundation, Nigeria

Keywords: GIS, urban water supply,GPS, Nigeria, Information and Communication Technologies

Introduction and objectives

The Ebonyi State Water Corporation, conducted a three month GIS/GPS based Consumer Enumeration Exercise in 2014, in the Abakaliki town, South East Nigeria.
The objective of the exercise supported by Sustainable Water and Sanitation for Africa (SUWASA) a USAID funded project, is to enable the Corporation to know all the water consumers to serve them better, plan for extension of water supply to new and unserved areas,upgrade water supply to meet the needs of increasing population and help improve the relationship between the Corporation and its customers.
The author of this abstract was a Facilitator/Resource person of the Enumeration exercise.

Methodology approach

The 4 month exercise was conducted by trained 20 no enumerators in Abakaliki town using a combination of Geographical Information System software and Geographical Position System based computer tablets.
Prior to the physical enumeration, a GIS software was used to generate a Geospatial map which outlines all the streets in Abakaliki town, population 141,438, 2006 census. The map also highlighted existing water distributions and service lines.

Subsequently, 9no Geographical Position System based computer tablets were used to capture customers including geospatial information, service status, contact information and pictures of property.
The data was uploaded to a cloud and stored in a server.

Analysis, results, conclusions and recommendation

A comprehensive communication outreach programme embarked on before the commencement of the exercise helped in securing community support. The major challenge was getting customers to provide accurate data, and this was overcame by involving the utility staff (who are accustomed to the utility customers) to pair with the externally recruited trained enumerators.

Results
Over 16,500 households were captured over the four months duration of the exercise, conducted by Enumerators recruited and trained specifically for the assignment. The exercise increased the customer database of the utility from 4000 to 16500 for Abakaliki city with a potential to increase water revenues once water production increase. The customer enumeration exercise provided fresh and more detailed customer information, capturing data of existing, possible and potential customers. The exercise assisted in the development of EBSWC Billing Enterprise Software linked to the GIS and network mapping activities, and monthly printing of 7000 computerized utility bills and distribution to customers through short message service. The exercise improved the Non Revenue Water Management of the Utility as over 2000 customers who were accessing the public water supply, were not previously captured in the billing system, and as such were not paying water tariffs. The exercise improved billing efficiency as it provided accurate information on active and non active customers, physical structures of customers which helped to determine the tariff rate for the customer The new customer database updated the old one developed in in 2001. The exercise collected the telephone numbers of customers utility is now using this information to send SMS based messages to customers on service issues. The exercise provided the utility with feedback on various customers complaints and concerns

Conclusions and Recommendations
Water utilities need to harness Information, and Communications Technologies to improve their billing efficiency, customer service, leak detection, and general operational efficiency.

Harnessing ICT-enabled Citizen Observatories for Water Governance

Author: Dr. Uta Wehn, UNESCO-IHE Institute of Water Education, Netherlands

Keywords: Citizen observatory, citizen science, water governance, social innovation

Introduction and objectives

Citizen observatories, enabled by various information and communication technologies (ICTs) (e.g. sensors, social media, web technologies) facilitate the involvement of citizens - and not just scientists and professional - in the collection of data to address the persistent data gaps for environmental and water management. Advanced versions have the social innovation potential of presenting a new role for citizens in governance and a two-way communications paradigm between citizens and decision makers. We focus on the social dimensions of citizen observatories to understand how they can be embedded in existing governance processes to add to sound decision making and water governance.

Methodology approach

We examine the social dimensions of the citizen observatories of water (focused on floods) that are being implemented, tested and validated by the WeSenseIt project in three case studies: in the UK, Italy and The Netherlands. Following an action research methodology, face-to-face interviews and focus group discussions were carried out with a range of stakeholders in each case study location over a period of 2.5 years. These data collection activities were based on a conceptual framework derived from political sciences to analyse existing governance processes and how these have changed over time with the introduction of the ICT-enabled citizen observatories.

Analysis, results, conclusions and recommendation

The analysis shows how decisions are made, which stakeholders are involved, what their respective roles are as well as their influence on decisions, and reveals local patterns of participation in the cases: differing perceptions of the role of citizens, combined with the different strategies adopted by the three cases in response to relevant EU directives. These range from 'ad hoc' participation in The Netherlands, to 'selective' participation in Italy (preferring distinct, more 'reliable' stakeholder groups to collect data), to intense community engagement in the UK.

While citizen observatories, as a broader form of citizen science, have the potential to provide new ways (and perhaps even new paradigms) of citizen participation with significant impacts on existing governance processes, this research demonstrates that they are not 'plug and play' solutions. Tailored socio-technical systems are emerging, resulting in specific 'shapes and sizes' of citizen observatories that entail differing treatment and inclusion of data streams into existing decision support processes as well as various digital and hybrid (online and offline) interaction mechanisms for distinct stages of policy and decision making.

The appeal of an observatory, for the citizens, seems to be strongest if it is grounded in their current concerns while authorities are struggling to find a balance between the appeal of additional data streams and their concerns regarding the accountability and legitimacy of their decisions based on citizens' data. Similar to existing discussions about locally defining governance objectives, the extent to which such ICT-facilitated observatories will change the role of citizens in water governance depends on both, the role granted by authorities and that actually claimed by citizens. Our results provide a basis for recommendations on the conditions for reaping the expected impacts of ICT-enabled citizen observatories in terms of improved water governance and sustainability of distinct areas of environmental and water management.

DOWSER: A New Android App for Dissemination of Groundwater Information

Author: Mr. Ranjan Ray, Central Ground Water Board (CGWB) Govt. of India, India

Co-Authors: Mr. AVSS Anand, Rajiv Gandhi National Ground Water Training and Research Institute, CGWB, Govt. of India, India

Keywords: Android, Mobile app, Water Level, Groundwater, India

Introduction and objectives

According to a World Bank report, India is the largest user of groundwater in the world. Mass participation is considered the only possible alternative for effective groundwater management in India. An essential prerequisite to ensure effective mass participation is dissemination of usable information to the direct stakeholders. As per a survey, in the second quarter of 2014, India had nearly 111 million smartphone users. The smartphones can act as effective media to disseminate groundwater information. This paper presents a new app named DOWSER for the android devices aimed at disseminating water level data through smartphones to the direct stakeholders.

Methodology approach

The app DOWSER uses a database of nearly 20000 records. This database contains data generated and owned by Central Ground Water Board (CGWB). The database includes location details of the monitoring stations, their coordinates, measured water levels and dates of measurements. The app works in three steps: i) reads coordinates from the GPS of the mobile device, ii) calculates the distance of the mobile device from each monitoring station in the existing database and iii) reports the details of the nearest monitoring station and its last recorded water level. There is also provision for updating the database periodically.

Analysis, results, conclusions and recommendation

"Participatory groundwater management is a major component of the National Project on Aquifer Management (NAQUIM) that the Government of India has embarked upon. Empowering the direct stakeholder with usable information along with awareness and training is essential to ensure constructive mass participation. Water level data is one of the primary information for planning management interventions at local level. It is also the most sought after data by the users for digging of wells, installation of pumps, construction of buildings etc. Central Ground Water Board (CGWB), Government of India carries out monitoring of water levels using a network of nearly 20000 monitoring wells spread over the entire country. Such measurements are carried out four times a year.

The app uses a database derived from these data generated and owned by CGWB. The app provides two options to the user: i) Retrieve Water Level Data and ii) Update Database. The command 'Retrieve Water Level Data' reports the water level data corresponding to the monitoring station, which is nearest to the mobile device. Once the app is installed, the user can retrieve water level information without internet connectivity as the database resides on the mobile device itself. The 'Update Database' command connects to a server and downloads the updated database, if any. The app DOWSER for android devices is in validation stage and will be available to the users soon.

Using similar methodology and algorithm, groundwater quality and other usable hydrogeological information can also be made available to the direct stakeholders through the smartphones. Being first of its kind, the android app described here is expected to harbinger a paradigm change in dissemination of groundwater data in India, which is essential for effective management of groundwater resources.

Developing new application " WaterCheck24" used to increase water efficiency

Author: Mrs. Rewad Ashour, Carbon Disclosure Project - Water Disclosure, Palestinian Territories

Co-Authors: Dr Basheer Obaid, Carbon Disclosure Project - Water Disclosure, Palestinian Territories

Keywords: ArcGIS, WaterCheck, Gaza, GIS, Water quality

Introduction and objectives

This research provides a new technology for checking water supplied by ground water. This application is based on huge amount of database related to water quality including chloride and nitrate concentrations. This application combine between several dataset like meteorological data , groundwater level, water quality. This research application is based on data sharing between several departments to serve the end user. The end-user can know the real status of water based on the location of his smartphone. This application has been designed based on ArcGIS software.

Methodology approach

WaterCheck application will be useful to share water information in the internet such as pH and the concentrations of chlorine and alkalinity.

WaterCheck application is based on mobile ArcGIS software. Gaza Strip map has been uploaded in to application and location system is programmed using python language (GIS language programming) . Farmers can use this technique to know the real situation of water used in the area. Water quality specialist can also enter new data in new locations about the quality of water. These entered data could be sharing between customers.

Analysis, results, conclusions and recommendation

This application provides new techniques in reading and analyzing of water data. Integration of these features with one application in smart phones can make a new development with data mobility and usability. Moreover the research project provides the ability to know the water quality based on the nearest located points. Using spatial analysis tools in the application can give the user the general situation of water quality and water level in required zone.

WaterCheck application can be used in municipalities, water authorities, water companies and end customers. Data provided from this application improves human health and safety comparing it with international standards.

Distributed Monitoring of Shallow Aquifer Level using Community Handpumps

Author: Mr. Patrick Thomson, OUCE, United Kingdom

Co-Authors: Dr David Clifton, United Kingdom
Ms. Farah Colchester, United Kingdom
Ms. Heloise Greeff, South Africa

Keywords: Monitoring, Handpumps, Machine Learning, Groundwater, Mobile

Introduction and objectives

Achieving the post-2015 target of "improving the sustainable use and development of water resources" requires new approaches to understanding those resources. We demonstrate a novel method of measuring groundwater level using handpumps, which could revolutionise groundwater monitoring across Africa, where handpumps are many, but monitoring infrastructure is scarce. We show that the static water level beneath a handpump can be estimated by measuring movement of the pump handle. Consequently, the handpump infrastructure across Sub-Saharan Africa can be transformed into a large-scale, distributed monitoring network, providing much-needed data on shallow aquifer levels, while simultaneously improving the sustainability of community water supplies.

Methodology approach

The Waterpoint Data Transmitter used in Oxford University's "Smart Handpumps" project uses a low-cost accelerometer to measure the movement of the handle of a handpump in order monitor pump usage and estimate the volume of water abstracted. Using machine learning models derived from data generated by operational handpumps in Kenya, and a handpump installed in Oxford, we characterised dynamics in the time-series obtained from the accelerometer. By comparing these with measured depth-to-water, over a period of varying groundwater level, we aimed to determine whether these data can be used to measure changes in aquifer level and absolute depth.

Analysis, results, conclusions and recommendation

This approach has proven successful. We characterised appropriate features of the accelerometer signal from different combinations of users and pumping periods using various classification methods (support vector machines, Gaussian processes). We were able to determine the level of a shallow aquifer with an average error less than 10cm. These results show that, within the limitations of our proof-of-principle experiments, it is possible to estimate aquifer level non-invasively using accelerometer data from a single pump to a level of accuracy comparable to that of current standard methods.

That said, a handpump in normal operation will have multiple users, and will be subject to failures and other confounding factors. Therefore, data generated from individual operational handpumps will not be sufficiently accurate or reliable when taken in isolation. Our field tests in southern Kenya confirmed this. However, for pumps in close proximity, these other confounding factors will be largely independent, while the property of interest, change in aquifer level, will be closely correlated. Therefore by combining weighted estimates of depth-to-water from a small cluster of nearby pumps, it is possible to generate a single, accurate measure of the aquifer level in that area. As well as providing much-needed environmental monitoring, the data generate immediate information on handpump usage and functionality, which has enabled faster pumps repairs and improved rural water service delivery.

The implication of this is that the thousands of community handpumps across sub-Saharan Africa have the potential to act as a distributed groundwater monitoring network. This is especially important in areas that currently lack monitoring infrastructure. Increasing our understanding of groundwater fluctuations using this method will help meet the target of "improving the sustainable use and development of water resources", while simultaneously improving rural water services to help meet the post-2015 target on "access to safe drinking water".

Stockholm International Water Institute

The Stockholm International Water Institute (SIWI) is a policy institute that contributes to international efforts to combat the world's escalating water crisis. SIWI develops and promotes future-oriented and knowledge–integrated policies, towards sustainable use of the world's water resources leading to sustainable development and poverty eradication.

Stockholm International Water Institute, SIWI
Box 101 87, se-100 55 Stockholm, Sweden • Visitng Address: Linnégatan 87A
Phone +46 8 1213 60 00 • Fax +46 8 1213 6001 • siwi@siwi.org • www.siwi.org