WATER Alert! Disseminating Drinking Water Quality Information to South Africans

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CHI 2011, May 7–12, 2011, Vancouver, BC, Canada.
ACM 978-1-4503-0268-5/11/05.

Abstract
Drinking water quality, especially in many parts of South Africa, is far below acceptable standards. With an annual estimate of 43,000 deaths from diarrheal diseases, 3 million cases of illness, and treatment costs of over half a billion US dollars, the impact is critical [4]. This research addresses the challenge of reporting complex and critical water quality information in a way that is accessible to all South Africans as required by law. In a country with high illiteracy rates, 11 official languages and limited-to-no access to technology in many areas, this is no easy feat. We describe the details of *WATER Alert!*, a prototype mobile phone application designed to alert and report critical water quality information to consumers who subscribe to it. Our initial evaluation of this design with users suggests that such an application would help to improve consumers' understanding of water quality information. The symbol-based messages make critical water quality information more accessible to illiterate or low-literate users, or non-native English or Afrikaans speakers. Additionally, the use of a tool and interface design most of our users are familiar with (the mobile phone) lowers the learning curve.

Keywords
ICT4D, water quality, development, South Africa, low-literacy UIs, user-centered design, mobile phones, HCI

ACM Classification Keywords
H.5.2. [Information Interfaces and Presentation]: User Interfaces – User-centered design

General Terms
Design, Human Factors

Introduction

Safe drinking water is 'a source of life' [5]. Diarrhea, often cause by ingesting dirty water, is the third major killer among communicable diseases, preceded only by respiratory infections and HIV/AIDS [9]. In South Africa, the people most susceptible to waterborne diseases found in contaminated water are children and immunocompromised individuals who make up a large percentage of the population. For these individuals, safe drinking water *is* life.

The 1997 Water Services Act and the Compulsory National Standards for the Quality of Potable Water enacted protective measures which Water Service Providers (WSP) are required to follow: to (1) Monitor and report water quality to authorities, (2) Compare it to the national drinking water quality standards and (3) Report water quality information to consumers in a comprehensible format [5]. Together, these measures play a vital role in reducing the high number of deaths caused by drinking contaminated water. This is especially true in the townships and rural parts of South Africa where poor water quality is a major issue.

In this paper, we explore an initial prototype of the application *WATER Alert!*. This mobile phone application sends locally relevant symbol-based message alerts and information to subscribers via GPRS, multimedia text messages (MMS) or in plaintext format as short messages (SMS). We chose to design for this platform due to the availability and widespread popularity of mobile phones in South Africa and the low cost of mobile Internet. We foresee our design being useful to Water Service Providers who could populate the application with the latest reports and alerts and disseminate them to consumers in a graphical and highly visual format. We also discuss the user-centered design techniques we employed which are tailored for use with low-educated and low-literate participants.

Related work

While there are several projects that explore simpler, less technical and low-cost ways of collecting water quality information in rural areas and reporting it to water authorities, such as the Aquatest project [4,5], there has been very little discussion about disseminating water quality information to consumers. Currently in South Africa, the primary means of obtaining such information is to request a report from the area Water Service Provider, which is too complex to interpret even for the highly educated. Another means is for the consumer to bring water samples to the WSP to be tested, an option that is inaccessible to rural residents. Websites such as [2] and [8] provide urban consumers access to some water quality information. However, no online reports exist for water sources in informal or rural settlements where it is needed the most, nor is this medium accessible to those residents.

Figure 1: WATER Alert! prototype application on a Nokia handset

Mobile phones as information sources

Information and Communication Technology for Development (ICT4D) researchers have deemed the mobile phone as a promising platform for the dissemination of information to the general public since it is highly accessible, widespread and familiar to South Africans [3,4,6]. The same is true across Africa, where there has been an increase of mobile phone-based alert or information systems. In Botswana, for instance, HIV/AIDS information is sent to affected patients [7]. The *WATER Alert!* application would leverage the benefits of the mobile phone — speed, reach, familiarity, and lower associated costs of use over, for instance, paper-based alternatives to disseminating critical information.

Methodology

Conventional wisdom holds that user-centered design methods don't hold up well in developing county contexts – there are language and cultural barriers to overcome. We employed user-centered design for development (UCD4D) techniques based on the success seen by others working on similar projects [6,3]. Following an iterative design process, we conducted requirements analysis, prototyping and limited user testing. Contextual design is both user-centered and based on ethnographic information, which makes it useful in cross-cultural design, since it places an emphasis on understanding the user and the user's context [6].

Requirements Analysis

In the analysis phase of the design process, we conducted semi-structured interviews with 12 participants. Since we wanted to design an application that would be suitable for all South Africans, we chose as diverse a sample as possible within the constraints of the study. This included sanitary workers and university students. We used the data collected from the interviews to develop scenarios and models such as those shown in *Figures 2 and 3* which helped to guide the design of our initial prototype.

Findings

According to Beyer and Holtzblatt, people's actions are highly influenced by the culture in which they live [1]. The cultural model in *Figure 2* shows how water service providers take advantage of the South African community culture of 'viral communication' as a means of disseminating information. They provide information to conduits such as the media, heath providers and community leaders with the expectation that this information is passed on to consumers. This, of course, is only done when critical.

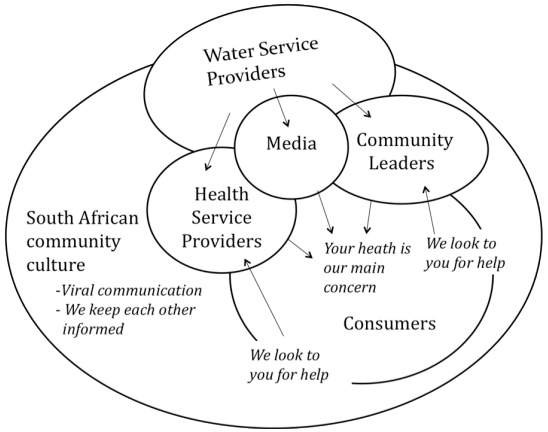


Figure 2: A consolidated cultural model showing how water quality information flows from water service providers to consumers via conduits (media, community leaders, nurses)

We observed that consumers in the Cape Town community seldom go directly to their WSP to obtain water quality information. Moreover, the water quality reports provided by the WSPs on paper, are so complex that conduits such as health service providers and the media are needed to put it into simpler terms. So, in creating our mobile solution, which would overcome the access problem, we could not base that solution on the design of the paper forms, as these were incomprehensible to the communities we were trying to reach.

The flow model in *Figure 3,* which is a consolidation of the responses received during our interviews, revealed that consumers in various areas of Cape Town obtained their water quality information from three sources: Health Care Providers/Community Leaders, Media, and other consumers. Consumers reported that they also assessed the safeness of their water simply by observing its appearance — a dangerous method since chemical and microbial contaminants do not necessarily affect the appearance of water.

Design and Prototype

The analysis of 87 photos taken of signs around Cape Town helped to guide the design of our symbol-based messages. This led to a set of symbols and a color palette that is locally and likely universally understood.

Figure 4 shows the three categories of symbols found:

- Warnings/bans: Red/black circle-slash over object; minimal/no text; white/amber background
- Caution: Amber triangle with black border; cross symbol for health caution signs; numbers and pictures instead of text

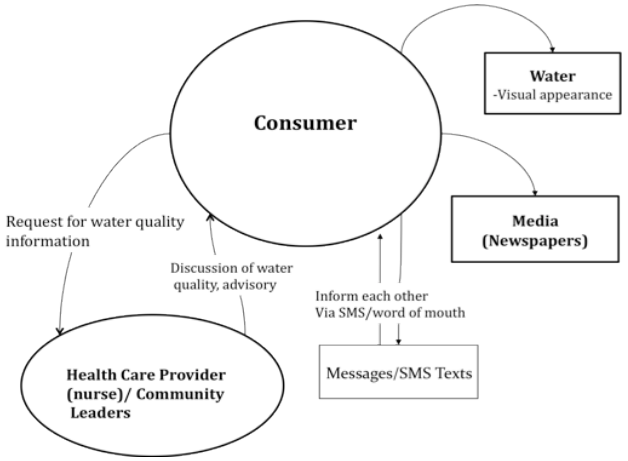


Figure 3: Consolidated Flow Model showing how the participants in our interview went about obtaining water quality information.

- Informational: Green background, white text; checkmarks affirm correct procedures; arrows show motion

With this information, we developed sketches (Fig. 5) of the graphics that accompany our messages. We showed this to two design participants to see if they understood it. This led to a redesign of some of the images and our first high-fidelity prototype (Fig. 6) which we showed to two new participants.

Figure 4: Categorized snapshots of 87 signs and symbols taken around Cape Town

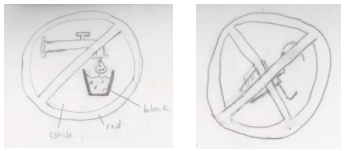


Figure 5: Paper Prototypes

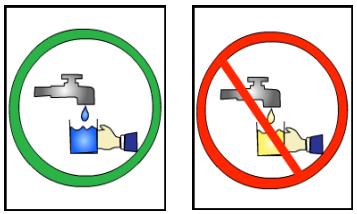


Figure 6: 1st iteration messages were very detailed colorful and no text; in this example users were confused by color of water and did not correctly interpret action as 'Do not drink'

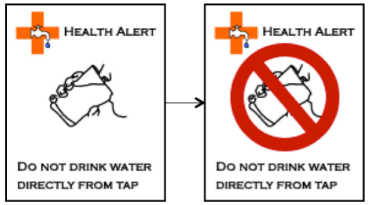
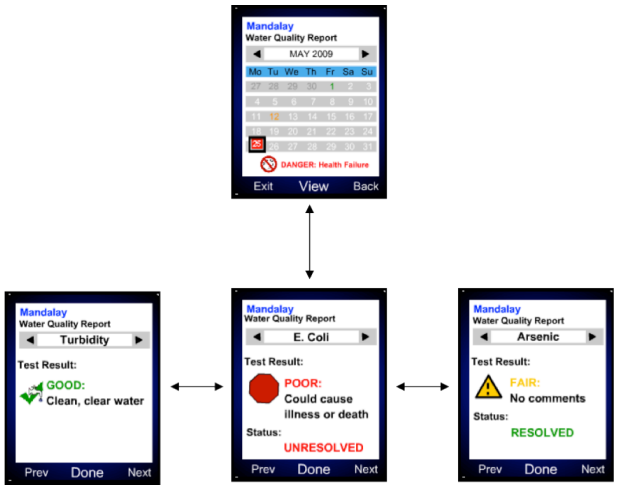


Figure 7: 2nd iteration messages were more abstract, used fewer colors, had minimal words, and were animated

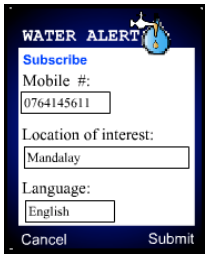
As a result of their comments, we animated the messages, changed some of the graphics, made it more abstract, and used less colors (Fig. 7).

Following this, we built an interactive prototype in which we employed several metaphors. Visual metaphors help the user to make meaning of information when there are similarities between the design and a familiar object. We describe two of those we used below:

a) Viewing the water quality report is like browsing through a mobile phone calendar application. Colored dates (red, orange or green) show what the overall status on a day testing was conducted and selecting that date shows detailed results:



b) Subscribing is like sending an SMS text message:



User Evaluation & Initial Findings

We ran our prototype on a basic Nokia handset and conducted an initial usability test and evaluation. Our participants included one male and three females, between 18 and 45 years of age. Three participants (blue collar workers) either completed or had some secondary-level education, while the other participant was a college student. Two users lived in a formal area in a city, one in a small town and one in a rural area or village.

We issued a set of tasks (each followed by a question) for participants to complete using a real paper-based water quality report and then a similar set of tasks to complete using our *WATER Alert!* prototype. Overall, based on the correctness of responses to the questions, three of four users experienced an increase in their level of understanding of water quality information using our prototype, while one experienced neither an increase nor decrease. We also found that participants completed all tasks using our prototype in less than two-thirds of the time it took them to complete a similar set of tasks using the paper-based water quality report. All commented on the usefulness and simplicity.

"I like that it just boils down the numbers. I mean I wouldn't care if E. Coli is at 75 or 73, I just want to know can I get it, what's my risk?" [P1].

Moreover, all participants were able to correctly interpret the current alert status (safe, caution or unsafe) of the drinking water, the potential danger (e.g. may cause illness) and the advice given (e.g. boil water before drinking). As for usability, we saw that making use of visual metaphors in our prototype design contributed to the effectiveness of the application and empowered users. We saw even our most novice user who did not own a mobile phone navigate through our application with few errors after minimal exposure to it. All offered positive feedback and eagerness to get such an application.

"I like the thing that you do here and I would like to have it on my phone to see what maybe if I'm sick today, my tummy is running, is the water okay to drink or what" [P2].

Discussion and Future Work

Clearly, the work here is highly preliminary, with a small user group. Our work is essentially a design exploration but from our experience with existing systems, the *WATER Alert!* application would be an enhancement over the existing paper-based water quality report. Our application provides time-sensitive information useful not just to the general consumer but also to advanced users such as health-care providers.

We hope to expand our research into more rural areas with the aim of developing a framework Water Service Providers could use to disseminate water quality information to consumers as required by law. Our next steps are to develop more symbol-based messages, specific to the area we conduct our tests in (rural vs. urban) and implement a functional version of the *WATER Alert!* application for the purposes of a formal evaluation. Additionally, we hope to integrate this with a phone-based data collection platform to allow for the real-time dissemination of water quality test information to consumers from the point of collection.

Acknowledgements

Many thanks to Dr. Chance Glenn, Dr. Anne Haake and Dr. Ulrike Rivett for their guidance and support.

References

[1] Beyer, H., Holtzblatt, K. (1998). Contextual Design: Defining Customer-Centered Systems. San Diego, CA: Academic Press.

[2] Department of Water Affairs (DWA) Republic of South Africa. http://www.dwa.gov.za.

[3] Jones, M., Marsden, G. (2006). *Mobile Interaction Design*. West Sussex, England: John Wiley & Sons Ltd.

[4] Loudon, M. (2007). Data Management and Reporting for Drinking Water Quality Monitoring in Community-Managed Supplies. South Africa: University of Cape Town.

[5] Mackintosh, G. S., de Souza, P. F., Wensley, A., Delport, E. (2005). Multidisciplinary Considerations for Satisfying Water Quality Related Services Delivery Requirements: A Practical Tool for Municipal Engineers. Stellenbosch, South Africa.

[6] Maunder, A. (2009). PhD Dissertation: Designing Appropriate Interactive Systems for the Developing World. Cape Town, South Africa: University of Cape Town.

[7] Microsoft Research (2007). HIV/AIDS Information System Taps Cell Phone Texting Capabilities. Microsoft Corporation.

[8] Rand Water South Africa. http://www.randwater.co.za/.

[9] WHO (2004). Water, sanitation and hygiene links to health: Facts and figures updated. Geneva: WHO.