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Characterising Intermittent Water Systems In Data-Scarce Settings Using A Citizen Science Approach

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EXTENDED ABSTRACT

Introduction

Intermittent Water Systems (IWS) provide water discontinuously in both time and space. Delivery is unreliable and the water itself is often unsafe for direct consumption. Costs borne by the consumer to overcome these issues reach as much as 7.6% of reported income (on top of the cost of water utility bills), revealing a personal concern for safe and reliable drinking water [1][2]. The lack of relevant data on the failures of water infrastructure inhibits research in the direction of remediating IWS, and, by association, improving public health [3].

This paper discusses implementing a citizen science approach that leverages the personal concern of citizens to gain information on the quantity and quality of services provided by IWS - data which would otherwise be intractable, laborious or costly, for developing countries to gather [4].

In the first instance, this paper discusses the development of the citizen science approach and the supporting data-collection tool – a smartphone application and website. It then ascertains: (i) the feasibility and reproducibility of the method, and (ii) the reliability of the collected data by auto-validating the results using internal consistency tests, the split-half method and truth-finding algorithms. Finally, the paper reports on the acceptance of the method as a decision-support tool to develop evidence-based solutions to IWS.

Methods and Materials

The method consisted of recruiting citizen scientists and instructing them on how to record data on the cuts in their water supply. Interested participants were directed to an informative website (www.networkingwater.com) to learn more about the project, and encouraged to get involved through social media (namely, Facebook https://www.facebook.com/NetworkingWater/). Final participants attended an information session where they were taught to use the custom-built mobile phone application and website to record their water cuts (Figure 1). Before the two-week data-collection phase of the study began, the participants filled in a survey about the frequency and length of water cuts, which provided information for validating the data's reliability. It also provided complementary information on the participants' personal circumstances, which was used to identify trends in the characteristics of their water supply. A pilot study was initially conducted in Nepal on a group of 18-22 year olds from Nepal Engineering College.

Figure 1. A researcher explains the purpose of the research at an information session for participants at Nepal Engineering College

Results and Discussion

The data obtained from the phone application and survey was analysed to determine the general feasibility of the method and the reliability of the collected data. Results showed that the methodology was feasible (i.e. it is practical and reproducible) but that the dataset collected was occasionally sparse, as illustrated in Figure 2.

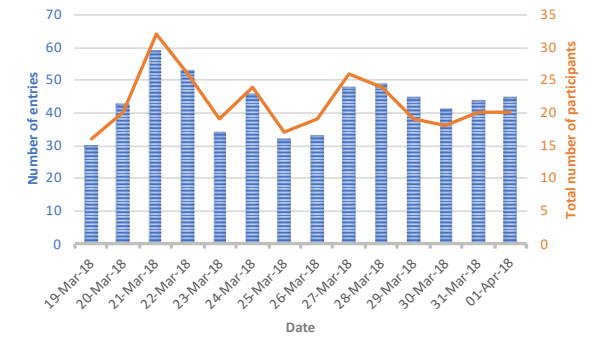

Figure 2. Variations in data supply over time

While this sparsity did not present a problem for investigating the reliability of the data, it did reduce the sample size significantly and limited the ability to identify trends in the IWS' operation. Internal consistency tests (between the survey data and the collected data), and the split-half method (applied to the collected data), both revealed the data to be largely reliable. However a trend was identified where participants who declared a higher frequency of water cuts tended to be slightly less reliable, statistically speaking. This highlighted the need for complementary techniques to further ascertain the reliability of the data and of the individual participants, e.g via truth-finding algorithms [5].

Precautions to increase sample size and reduce sample sparsity of future datasets were subsequently put in place, and other statistical methods which can be used to accommodate missing information in data sets, have been trialed, which will be presented at the conference.

Preliminary interviews with water officials showed a general resistance to admitting the failures of the water system and an aversion to investigating the characteristics of the IWS.

Conclusions

In the context of developing countries, citizen science can be used in conjunction with personal communication technology to bridge the information gaps on the characteristics of intermittent water supplies. It is a feasible and validated data collection method but requires the application of appropriate statistical analyses to be able to gain useful insights from the sometimes sparse and incomplete data sets that are gained from this approach.

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