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Small-scale piped water supply: end-user inclusive water research in arsenic affected areas in India and Bangladesh (DELTAP)

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ABSTRACT: DELTAP is a multi-disciplinary research project, where geologists, water treatment scientists and industrial design engineers join forces to develop an integrated approach towards small-scale piped water supply (SPWS) systems in the arsenic-affected Ganges-Brahmaputra-Meghna Delta. The project has started in 2016 with a field study in Bihar (India) with a focus on water quality mapping with mobile crowd participation. The coming years the research will continue with 3 PhD candidates, both in India and Bangladesh, with the ultimate aim to develop blueprints for end-user inclusive SPWS systems.

1 INTRODUCTION

Arsenic-contaminated groundwater causes serious health risks affecting millions of people living in the Ganges-Brahmaputra-Meghna Delta. Mitigation attempts for this unresolved problem have taught critical success factors to be: true local embedding (social, technical and economical), adaptability and dynamics. DELTAP's integrative approach (Fig. 1) aims for sustainable innovation to reduce contaminant exposure with Small-scale Piped Water Supply (SPWS) and active end-user participation through mobile crowd participation (MCP) and Do It Yourself (DIY) Laboratory. SPWS combines the attractiveness of socially/economically feasible tap connections with smart targeting of safest sources, centralized treatment and end-user inclusion.

In urban laboratories in Bangladesh and India, DELTAP integrates MCP with:

- Dynamic geological models for prediction of arsenic patches in deltaic systems (Donselaar *et al.*, 2017),
- Blueprints for source-to mouth safe water supply, and,
- Development of DIY materials and products which take human practice and local sources as the main drive in the design process (Rognoli *et al.*, 2015).

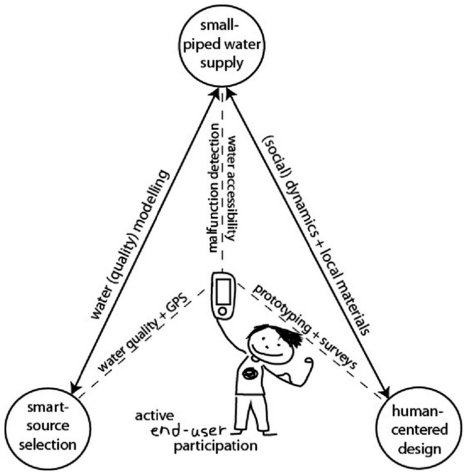

Figure 1. DELTAP's integrative approach for small-scale piped water supply with active end-user participation through mobile crowd participation and DIY practices.

2 METHODS

2.1 *Mobile crowd participation*

The first focus of the DELTAP research team – in close collaboration with A.N. College Patna and UNICEF

Bihar – was to investigate arsenic distribution in groundwater wells in Bihar (India) by combining traditional laboratory analyses with new approaches for mobile crowd monitoring of water quality (Mink, 2017). For this purpose, the Akvo.org Caddisfly app was used, in combination with HACH test kits for iron and phosphate.

2.2 *Geological survey*

Arsenic concentrations in the aquifer are highly variable, and directly linked to the geomorphological setting of the affected areas. Satellite imaging surveys, in combination with ground-truth data from sediment cores and electric logs from shallow wells, and ground-penetrating radar surveys will yield detailed maps and predictive 3D models of As-polluted and As-free areas.

2.3 *DIY materials and water*

As an initial exploratory study with DELTAP, it was investigated whether plastic waste could be used to create new materials to be potentially used in making water and/or hygiene products in Dhaka, Bangladesh. For this research, through the 'material-driven design' approach, the mechanical performance of the plastics as well as their experiential qualities (i.e. how they are appreciated by people) have been explored. The machines developed by www.preciousplastic.com were used for DIY manufacturing of the end products.

2.4 *Co-production: engaging end-users*

Stakeholder co-production has a dominant role in the research methodology, at all levels: End-users produce MCP data through interactive apps; SMEs co-develop apps and DIY products; NGOs build SPWS for pilot research; joint science/NGO policy briefings. This co-production results in strong embedding of results, optimizing feasibility of highly needed impact for sustainable and inclusive development: creating pathways for safe drinking water for millions.

3 RESULTS

3.1 *Mobile crowd participation*

A surprising high number of households in rural Bihar owned a 4G-connected smartphone and was willing and capable of executing the smartphone water quality test independently. With this survey a first step is taken towards development of mobile crowd participation as an innovative methodology for water research and monitoring. The results of 346 household tube-wells will feed into the development of a predictive geological model to visualize arsenic-free aquifers in deltaic systems.

3.2 *Geological survey*

Sand-prone fluvial point-bar deposits surrounded by clay-filled former meander bends in a Holocene fluvial and deltaic setting are the most common geomorphological type in all As-polluted areas. The sediment type differences have inherent porosity and permeability heterogeneity, which is the cause of the large spatial variability in As concentration in the aquifer space. Generic models taking into account the geomorphology-pollution relation have the potential to be applied world-wide in similar settings.

3.3 *DIY materials: water container lid*

The new approach of linking human-centered design with local materials and DIY practices to water products; has resulted in a spin-off product that prevents Kolshi containers from microbial contamination. This innovative process of local material reuse is an example of end-user inclusive water supply, although the potential water quality risks of plastic reuse need further investigation.

4 CONCLUSIONS

The DELTAP project is focusing on demonstrating the opportunities of end-user inclusive water research in arsenic affected areas. Initial results have shown the potential of mobile crowd participation Bihar (India) and DIY reuse of local materials in Dhaka (Bangladesh) as new methods to support sustainable safe water supply.

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