SYNOPSIS

Reducing Risks to Rural Water Security in Africa

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INTRODUCTION

With increasing hydro-climatic risks in Africa all water resources will be affected (Vorosmarty et al. 2010; IPCC 2012). But the response to climate variability of groundwater will be slower than that of surface water. Groundwater resources are more resilient due to aquifer storage which acts as a buffer during periods of little or no rainfall. Despite the significant availability of groundwater resources across the major geological formations in Africa, the quantitative and qualitative distribution remains partly understood (MacDonald et al. 2012). Adapting to environmental change will likely require increasing use of groundwater for both domestic and productive uses. Information costs in recording longitudinal data on aquifer recharge and use are prohibitively high and point estimates from a limited sample of verifiable drilling sites provides partial information on whether shifting patterns of groundwater availability are attributable to environmental or operational factors. Sustainable use of aquifers is critical to inform and enforce appropriate policy responses to achieve rural water security for human development and environmental resilience in Africa (Bannerjee and Morella 2011; IPCC 2012).

Smart handpumps that harness Africa's expanding mobile network architecture provide a new technology to address the systemic informational deficit that limits accountability and increases risks of investments in and management of rural water supply (Thomson et al. 2012).

Automatically measuring and transmitting low cost, reliable and scalable data on handpump performance allows three inter-connecting risks to rural water security to be simultaneously addressed: (a) environmental, (b) operational, and (c) governance. By explicitly linking groundwater resource risks with operational and governance risks the overlapping objectives of the Sustainable Development Goals and Millennium Development Goals (MDG) can be linked to the United Nations' General Assembly recognition of the Human Right to Drinking Water and Sanitation.

RURAL WATER SECURITY AND HUMAN DEVELOPMENT

The MDG of halving the proportion of people without access to safe drinking water supplies has been reached (WHO/UNICEF 2012). Despite significant global progress over 780 million people remain without access to safe drinking water on a daily basis with high but avoidable costs to health, income and education, particularly for women and girls (Cairncross et al. 2010). While the future of planet is increasingly urban, current water access inequities are disproportionately rural with four out of five people without safe water living in rural areas (WHO/UNICEF 2012). The UN Secretary General, Ban Ki-moon, recently appointed the UN System Task Team to coordinate the post-2015 MDG agenda which will re-evaluate all global goals including drinking water supply. With the UN General Assembly recognizing a non-discriminatory and universal human right to water in 2010 (UN 2011), a proportional target to water access is less likely to be adopted as a future global water supply goal.

Fig. 1 Understanding rural water security risk as a principal–agent problem

Rural water insecurity is particularly acute in Africa where during the MDG monitoring period of 1990–2010 the number of rural Africans without safe water access *increased* by 38 million (WHO/UNICEF 2012). Handpumps remain the preferred technology for water supply in rural Africa as they can lift widely available and good quality groundwater at low cost. However, one in three handpumps does not function at any one time across Africa with many abandoned 1 or 2 years into a projected ten plus year life-span (RWSN 2010). An investment of over USD 10 000 million per year is required to achieve the water access MDG in Africa (Bannerjee and Morella 2011), improving the current low return on investment each year would accelerate and maintain water services and contribute to the enormous but avoidable human cost each year: 1.5 million *avoidable* child deaths linked to inadequate water and sanitation access, 40 000 million hours spent by women and girls collecting water, and 448 million school days missed due to children, generally girls, collecting water (Cairncross et al. 2010; Hope et al. 2012).

NO INFORMATION, NO PROGRESS

Operational risks relate to the technical and financial management of handpumps. The choice of handpump technology is commonly taken by relevant government departments and implemented by contracted agents, usually private sector drilling companies. After handpump installation and basic maintenance training, communities take charge. In theory, community water users have the right incentives to conduct

routine operation and maintenance activities following initial training (Arlosoroff et al. 1987). In practice, communities are heterogeneous with varying socio-economic, cultural, and water resource environments. The handpump may be the only water source available, though more likely, it is one of many used by different people at different times of the year. Forming a water users association, or the like, to coordinate access, payment and maintenance functions thus presents challenges for users with low and often variable income, who may use the handpump in different ways at different times. Predictably, communities' ability to collect and save money to pay for future repairs is often weak (Harvey and Reed 2007). It may be characterized as a common pool resource management challenge where boundaries for user groups may only be effectively set with a limited access arrangement such as through a pump attendant who levies a pay-as-you-go fee (Ostrom 1990). Even minor repairs requiring relatively low-cost spare parts can take weeks to months as communities attempt to collect sufficient money for the repair and then source the parts, which may not be available locally, often incurring disproportionate travel and time costs.

The financial risk of handpump failure thus falls squarely on each individual community. Where failures result in above average costs, communities may, and often do, abandon the handpump. Sharing risk across multiple handpumps would reduce likelihood of an individual community facing a low probability but unmanageably high repair cost. A supra-community model with potentially tens or hundreds of handpumps managed collectively would pool these risks and also have the potential to reduce

Fig. 2 Remote and automated handpump water use transmission via GSM network in rural Kenya

average repair costs through more efficient use of resources and economies of scale. Such a model would still require some payment mechanism unless a significant subsidy was provided by central government. In principle, a delegated management model could be regulated by government and the water service regulator if performance information was available in a timely and reliable fashion. Without verifiable information, a classic principal–agent model emerges with asymmetric information between the government (principal) and the maintenance provider (agent) in terms of ensuring the quality, timeliness, and value of repairs made (Fig. 1). Without a mechanism to cheaply generate sufficient and timely information to hold maintenance providers to account, it is predictable that risk of failure will be allocated to rural handpump users who have limited capacity to cope.

This challenge is ultimately a question of the appropriate scale of governing risk in an accountable and transparent way. Government and donors face lower accountability as the water service delivery is reached at the operational level due to the limited capacity of water users to hold government or donors to account for post-construction failures. Water users face higher service delivery risk as they must contract and pay pump mechanics with ambiguous incentives to perform repairs to a high standard without any independent oversight. Handpump users have to carefully weigh the risks of paying for

a repair without any service guarantee. It becomes a multi-party contracting challenge where higher repair costs reduce the likelihood of all water users contributing. Self-enforcing sanctions within community structures can be effective assuming the mechanic is professionally trained and has access to spare parts; if not, the mechanic faces a risky venture in attempting a repair beyond their capacity. From a public policy goal of non-discriminatory access to improved water services, the community model is a partial solution borne of expediency due to limited government accountability amplified by a systemic informational deficit.

INFORMATION ACCESS ALTERS THE CALCULUS OF RISK AND RESPONSIBILITY

Smart handpumps which automatically and cheaply transmit water use and handpump performance data over the mobile network offer a comprehensive and continuous approach to provide low cost, reliable, and universal information (Fig. 2). Pilot testing in Kenya and Zambia has demonstrated the technology is effective and robust (Thomson et al. 2012). At scale, the flow of automated data can bridge the manifest information gap between rural residents and distant policy-makers that disconnects the rights and responsibilities of water service delivery. As

well as enhancing accountability, performance and transparency in the rural water sector, groundwater abstraction data of finer temporal and spatial granularity can be generated to improve understanding and modelling of groundwater resources, promoting more effective decision making for groundwater ecosystems. Reducing information asymmetry is a fundamental and necessary step in achieving global sustainable development and human development goals within the unerring calculus of the human right to adequate, safe, and reliable water to everyone.

CONCLUSIONS

Achieving rural water security in Africa presents an enduring and elusive challenge and opportunity for institutional responses for the Sustainable Development Goals and MDGs (Biermann et al. 2012). With the recognition of the human right to water, mobile technologies that capture and transmit water user data can inform effective governance of groundwater resources and handpumps, and offer an approach to accelerate and maintain improved water services. This is not a vague question of securing “political will” but a promising and new way of responding to linked human development and natural environment challenges by reducing risk and increasing accountability through leveraging Africa’s new mobile network architecture.

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