



Pump-Priming Payments for Sustainable Water Services in Rural Africa

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Summary. — Locally managed handpumps provide water services to around 200 million people in rural Africa. Handpump failures often result in extended service disruption leading to high but avoidable financial, health, and development costs. Using unique observational data from monitoring handpump usage in rural Kenya, we evaluate how dramatic improvements in maintenance services influence payment preferences across institutional, operational, and geographic factors. Public goods theory is applied to examine new institutional forms of handpump management. Results reveal steps to enhance rural water supply sustainability by pooling maintenance and financial risks at scale supported by advances in monitoring and payment technologies.

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Key words — drinking water security, handpumps, public goods, payment behavior, Africa, Kenya

1. INTRODUCTION

An enduring puzzle in achieving progress toward universal and reliable water service delivery in Africa is overcoming barriers to sustainable water user payments for community-managed handpumps (Harvey & Reed, 2004). The nonfunctioning of one third of the handpumps in rural Africa (RWSN, 2009) has resulted in an uncertain return on the USD 1.2–1.5 billion of infrastructure investments in the last two decades (Baumann, 2009). Increasing water service coverage has failed to translate into a guarantee of reliable service delivery (Hope & Rouse, 2013; Therkildsen, 1988; Thompson *et al.*, 2001). The long repair times that contribute to high handpump failure rates in rural Africa are essentially associated with weak payment systems (Foster, 2013; Harvey, 2007; RWSN, 2009). Community management of water services has been widely identified as a dominant but failing model in rural water service delivery in Africa (Bannerjee & Morella, 2011; Hope, 2014) with growing evidence that improved payment systems promote handpump sustainability (Foster, 2013). Increasing opportunities to exploit the new, inclusive, and low-cost mobile infrastructure offer new but untested approaches to accelerate and maintain reliable water services for the 273 million rural Africans without improved water coverage (Hope, Foster, & Thomson, 2012; WHO/UNICEF, 2014). The policy implications are relevant to the post-2015 debate on the Sustainable Development Goals (SDGs) and may increase momentum for universal and sustainable water services within the framework of the Human Right to Water and Sanitation (UNGA, 2010).

In this paper, three major barriers to achieving regular rural water user payments to promote financial sustainability are identified and empirically examined. First, *institutional barriers* indicate that the organizational structure of the user group influences the regular collection of user fees from all handpump users. Second, due to *geographic barriers*, handpump density in certain areas can negatively impact payment behavior. Third, *operational barriers* frequently cause handpumps to remain unrepaired for an extended period, discouraging users from paying, as the source is considered unreliable. This constitutes a vicious cycle with the risk of long-term failure in service delivery.

The paper makes novel contributions to the literature by (a) drawing on unique hourly data on observed handpump usage

over a 12-month period, (b) relating water use estimates to current and future payment preferences, and (c) applying public goods theory to community water management structures to examine new approaches to overcome financial sustainability barriers. In conclusion, an output-based payment framework is outlined as a potentially replicable approach to support the Government of Kenya's and the global drive to universal and reliable water services.

2. CONTEXT

(a) *The rural water challenge*

Since the latter years of the Decade of International Drinking Water Supply and Sanitation, 1981–90, community management of rural water supply has been advocated by international organizations, governmental and nongovernmental alike (Briscoe & de Ferranti, 1988; Carter, Tyrell, & Howsam, 1999; Churchill *et al.*, 1987; Harvey & Reed, 2004; Jiménez & Pérez-Foguet, 2010; Therkildsen, 1988; Whittington *et al.*, 2008). The empowerment of communities is based on the principles of participation, decision-making, control, ownership, and cost-sharing (Briscoe & de Ferranti, 1988; Lockwood, 2004). However, despite the positive characteristics of community management, operations and maintenance have barely improved (Blaikie, 2006; Lockwood, 2004). Failure is largely blamed on poor planning and service delivery (Carter, Harvey, & Casey, 2010; Carter *et al.*, 1999;

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The World Bank Water Demand Research Team, 1993), limited community financing (Carter *et al.*, 2010; Harvey, 2007; Harvey & Reed, 2004; Skinner, 2009) and shortcomings in the institutional design of management models (Sara & Katz, 2010; Whittington *et al.*, 2008). Consequently, rural water supplies are in danger of falling into a spiral of decline in the post-construction phase (Rouse, 2013). Adoption of simplified infrastructure asset management principles can increase cost-effectiveness and reduce interruptions in service (Boulouvar & Schweitzer, 2015). While maintaining the community-based model, new approaches are therefore required which acknowledge the communities' inability to maintain their water supply without support in the long term (Harvey & Reed, 2004; Lockwood, 2004).

(b) *Deconstructing the rural water challenge*

(i) *Institutional choices*

Institutions, "the humanly devised constraints that structure political, economic and social interaction" (North, 1991, p. 97), evolve over time and are adapted to specific human needs. This study focuses on those institutions that have been created for the management of groundwater resources, and specifically for managing handpumps in rural areas. Due to its delineation of management systems along the lines of rivalry of consumption and exclusion, the theory of public goods, building on Samuelson (1964), is chosen for analyzing the institutional design at community level. Two versions of the theory are applied – Ostrom's (1990) understanding of common pool resources (CPRs) and Buchanan's (1965) definition of club goods. While the nonexcludable and rivalrous CPR is a "natural or man-made resource system that is sufficiently large as to make it costly... to exclude potential beneficiaries from obtaining benefits from its use" (Ostrom, 1990, p. 30), the excludable and nonrivalrous club good determines a membership margin at "the size of the most desirable cost and consumption arrangement" (Buchanan, 1965, p. 2). Ostrom (1990) defines principles for robust common pool resource institutions, requiring clear institutional rules and solution mechanisms. Buchanan's (1965) criteria for the management of club goods expand on the public-private spectrum and emphasize consumption/ownership/membership arrangements. Consumption-sharing models, tariffs, and membership levels are determined by the local communities according to their particular requirements to prevent "congestion".

If adapted to handpump management, the institutional design is a response to varying group preferences with implications for payment behavior: Some groups prefer higher payments at household level to be able to limit abstraction levels by reducing the number of users (with the tendency of organizing themselves as "handpump clubs" with a more exclusive membership); others prefer lower individual payments but with higher membership numbers to ensure that enough money is available to pay for maintenance bills (acting more as common pool resource groups). Agrawal and Gibson suggest that communities must be examined "by focusing on the multiple interests and actors within communities, on how these actors influence decision-making, and on the internal and external institutions that shape the decision-making process" (1999, p. 629). It is beyond the scope of this research to analyze these aspects, as the focus is on the group's collaborative decision-making on willingness-to-pay. However, it is acknowledged that the institutional structure of user groups may change in response to internal power relations or external factors, such as population growth or increasing aridity. The latter may reinforce a potential tendency toward excludability,

which some groups pursue to counteract congestion and over-abstraction. Only by understanding the institutional design of rural user groups can payment models be adapted to local needs.

(ii) *Geographic challenges and infrastructure decisions*

A problem specific to sub-Saharan Africa is that low population density encourages broad spatial distribution between handpumps and the clustering of systems around existing infrastructure (Harvey & Reed, 2004). This implies high opportunity costs for users, often women, who have to walk long distances to the next-best pump alternative when their usual pump breaks (Van Houweling, Hall, Diop, Davis, & Seiss, 2012). As the most urgent demand tends to occur in areas of widely scattered pumps, geography appears to have an important impact on payment behavior. Another geographical aspect is the distance of handpumps to spare parts outlets, which impacts the reliability of service delivery (Harvey & Reed, 2006). Similarly, Foster (2013) found that distance from the district/county capital city is significantly associated with nonfunctionality of handpumps in a study covering 25,000 pumps across three countries in sub-Saharan Africa.

(iii) *Demand and service level*

Since the Dublin Principles of 1992 (ICWE, 1992), the demand-responsive approach has provided the template for most rural water supply services. It focuses on both financial and managerial sustainability through participatory planning, informed choices, community management, and cost recovery or cost-sharing arrangements (Sara & Katz, 2010). It involves households in the choice of technological and institutional arrangements, while requiring them to pay for the service (Whittington *et al.*, 2008). According to this approach, communities rather than donors or governments make informed choices about the preferred service level, which is reflected in their willingness-to-pay. They also decide on service delivery mechanisms, operation and maintenance of services as well as the management of and accounting for funds and the degree to which the private sector is involved (Deverill, Bibby, Wedgwood, & Smout, 2001; Lockwood, 2004; The World Bank Water Demand Research Team, 1993). To best serve the users' preferences, economic and social constraints are considered in the user group's institutional design. These comprise informal constraints, including sanctions, taboos and codes of conduct, as well as formal rules (North, 1991), including property rights.

However, in practice the success of the demand-responsive approach can be thwarted through lack of acceptability, feasibility, or the limited capacity of communities to sustain the chosen option (Harvey & Reed, 2004; Skinner, 2003). The failure of communities to speedily repair their handpumps results in longer term nonfunctionality causing discontent among water users, who then look for alternatives and refrain from paying fees – a process that leads to a downward spiral in water services (Cross & Morel, 2005). To counter such a downward development, supra-communal management options should be considered for rural water services recognizing the critical importance of the interface between a community-based model and the local community it is meant to serve (Blaikie, 2006). Bannerjee and Morella (2011) demonstrate that central, regional, or local governments play a dominant role in all aspects of energy, road, and water infrastructure provision across Africa. However, it is only in the area of providing and maintaining water services where local communities are given a leading role – precisely the area

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