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Exploring User Incentive Mechanisms for Sustainable Water Infrastructure Management

——An Institutional Analysis of Rural Water Supply Systems in Senegal——

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Abstract

Faced with a poor record of community management of rural water supply infrastructure in sub-Saharan Africa, motivating water users to make sustained contributions toward infrastructure management remains a challenge. This paper examines the incentive mechanism of water users' tariff payment behavior by relying on a theoretical framework of common pool resources (CPRs). Using five motivating factors that were examined in the author's previous work as mediators linking contextual variables and resource management outcomes; a) *preference* in the choice of water; b) *satisfaction* from consuming water; c) *trust* among peer resource users, d) perceived *sanctions* for non-payment, and e) perceived *cooperative benefits* from participating in infrastructure management, the present paper attempts to verify, through case study method, whether these are useful in understanding the real-world cases in rural African settings. Two Senegalese villages were studied over different periods of management by relying on an institutional framework of analysis focusing on changes in motivating factors and resource management outcomes. The analysis demonstrates that preference to use the water, satisfaction with the water provided and trust among peer users are related to presence and absence of users' tariff payment behavior in the two villages; therefore confirming the validity of the conclusion presented in the previous work. The analysis also reveals that sanctioning and collective benefits can function as motivating factors under certain circumstances.

Keywords: Rural Water Supply Infrastructure, Common Pool Resources (CPRs), Motivating Factors

1. Introduction

Sustainable management of rural water supply infrastructure remains a challenge in most sub-Saharan African (hereinafter African) countries. According to estimates made for 20 African countries, the average ratio of non-functioning hand pumps is somewhere between 30% and 40%, sometimes even more than 60% in some countries (RWSN, 2009). Various approaches — community management, simplified technologies, health and hygiene education, water demand studies — have been applied to address this issue since the 1980s, with only limited success to date (Harvey & Reed, 2004, 2007; Subramanian et al., 1997). Community members may make voluntary contributions (be

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it material, monetary or any form of participation) to sustain the infrastructure soon after handover, but incentives to do so are lost in the long term (Harvey & Reed, 2007: 368). Thus ensuring ongoing motivation for water users to make continued contributions for water infrastructure management is a matter of concern for both policymakers and development practitioners.

Water and sanitation utilities share important characteristics with common pool resources (CPRs), and services are often seen by users as non-excludable unless rules are put in place to regulate right of access. Negative externalities such as depletion of aquifers and infrastructure breakdown may arise if users treat them as open access resources and free ride in paying the cost of reproduction (Subramanian et al., 1997: 104). Water users' sustained participation in management of rural water utilities can be treated as a form of collective action in CPR management (e.g., Subramanian et al., 1997; Sara & Katz, 1998; Madrigal et al., 2011; Naiga & Penker, 2014).

Past studies of CPR management, through numerous case studies and laboratory experiments, have established that resource users are likely to self-organize when a majority of users conclude that the expected benefits from following their rules exceed the immediate and long-term expected costs (Poteete et al., 2010: 245). They have also identified a vast number of conditions affecting collective action: these relate to characteristics of resources, resource users, resource units, institutions governing resource use and management (e.g., Baland & Platteau, 1996; Ostrom, 1990; Wade, 1987, 1988). However, it has also become clear that these conditions affect collective action only contingently and indirectly, as impact often varies according to physical and socio-economic contexts (Agrawal, 2001, 2002; Meinzen-Dick et al., 2004).

Diagnosing how these conditions affect user-perceived benefits and costs in a particular resource management situation is equivalent to clarifying the incentive mechanism facing individuals to take collective action in a CPR situation (Stern et al., 2002). Since the turn of the century, there has been a growing interest in understanding incentive mechanism of collective action by linking contextual/policy conditions and outcomes through the effect of mediators or intervening variables (Agrawal, 2001, 2002; Stern et al., 2002; Poteete et al, 2010). However, empirical study from this perspective, especially with respect to rural water supply infrastructure management, is still very much limited.

As an effort to fill this gap, the author once attempted to evaluate quantitatively what different perceptions, treated as mediators, motivate users to contribute financially to the management of rural water infrastructure in the context of Tambacounda region of southern Senegal (Hanatani & Fuse, 2012). However, further study is needed to confirm whether these motivating factors are useful in understanding actual cases.

This paper therefore attempts to contribute to the discussion of incentive mechanisms of collective action for sustainable resource management with a particular focus on rural water supply infrastructure in Africa. The analysis relies on the author's previous work and applies tested factors to two rural communities in Tambacounda region of Senegal. The research question asked in this paper is: what

different incentives affect water users' tariff payment behavior and how are they formulated within a particular context and process?

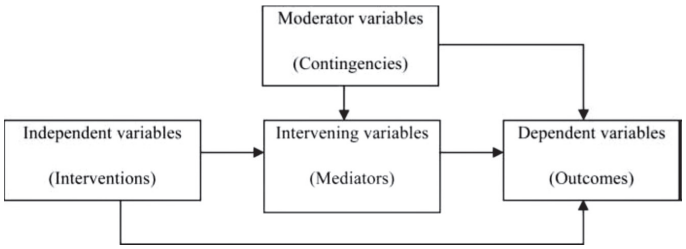
2. Theory, Materials and Methods

2.1. Theoretical Framework

Stern et al. (2002) once presented a causal model to explain how certain characteristics of the resource and user groups are linked to resource management outcomes (see Figure 1). In this model, *independent variables (interventions)* are defined as factors that can be altered by policy interventions. They include institutional arrangement and technology choice. *Dependent variables (outcomes)* are the outcomes of collective actions. *Moderator variables (contingencies)* are factors that cannot be altered by short-run policy interventions, such as characteristics of users and resource systems. Finally, *intervening variables (mediators)* are those that directly affect dependent variables but are influenced by independent and moderator variables. They cover, for example, user adherence to shared norms, ease/cost of monitoring the resource system and user behavior, and ease/cost of enforcing rules and sanctions, all of which directly influence resource management outcomes.

The theoretical significance of this framework is that it distinguishes types of variables in terms of the functions they perform and clarifies their causal path to the outcome. By including intervening variables, it helps to clarify the indirect nature of relationship between, for example, resource and resource user characteristics and resource management outcomes (*ibid*.).

Figure 1 Schematic Causal Model Proposed by Stern et al.



Source: Adapted from Stern et al. 2002

While much work has been done to investigate the effect of independent and moderator variables on resource management outcomes, the role of intervening variables has been much less considered. The previous work of the author, therefore, focused on the effect of the latter and evaluated how resource user perceptions regarded as intervening variables affect collective actions for rural water supply infrastructure management (Hanatani & Fuse, 2012).

Using household survey data collected in 10 sites in Tambacounda region, logistic regression analyses were performed using water tariff payment as dependent variable and five intervening

variables as predictors. The results indicated that preference for borehole water use, satisfaction with water supply and trust among users proved to be strong predictors of water payment, while sanctions and cooperative benefits did not prove to be statistically correlated with payment behavior, nor any of the moderator and independent variables when controlled for other variables. Building on this effort, this paper attempts to confirm the explanatory value of these intervening variables by applying them to actual cases.

2.2. Materials

2.2.1. National and Regional Background

Senegal is known for its extensive reliance on motorized boreholes and piped water supply systems with public standpipes (WSP, 2010). Today, there are more than 1,300 such systems throughout the country — most publicly owned but managed by user communities. These systems serve approximately 4.4 million people in 5,100 villages. The country is said to have the highest level of functionality of water supply infrastructure in Africa; and systems last longer than elsewhere in the region (UNDP, 2013: 13). Hence it is reasonable to study the Senegalese experience, as there should be useful lessons to learn.

The Tambacounda region (including Kédougou[1]) in the south-eastern province of Senegal was selected for in-depth examination to maintain consistency in terms of contextual conditions with the author's earlier work. The region is relatively humid compared to other parts of the country and alternative sources of water are available. In a multi-ethnic society composed of more than 20 ethnic groups nationally (Vilallon, 1995), the region is even more ethnically heterogeneous because it borders multiple neighboring countries. Thus, resource scarcity and homogeneity of resource users, two important conditions identified by previous studies (e.g., Agrawal, 2001) as conducive to successful collective action, are lacking. Nonetheless, the actual behavior of the residents diverges among villages.

2.2.2. Case Selection

The case study method is adopted for this research. The case study method is preferred when control on the subject is neither feasible nor desirable (Norgaard, 1994). In the case of rural Senegal, there is a high level of variability among villages as each village has its unique historical and contextual conditions. The research also deals with multiple levels of enquiry such as individual water users, water management committees and government technical offices from which multiple sources of evidence are sought. These conditions do not lend themselves to rigorous comparative analysis.

In qualitative research of this nature, purposive sampling is permitted (Soniya & Howard, 1997); and two villages using motorized boreholes with piped water supply system with contrasting performance in management outcomes were looked for to test the replicability of the thesis proposed

in the previous study. These cases were selected not necessarily for the purpose of comparison, but for verification in different cases: the validity of the thesis should be higher if it is verified in more than a single case. Bearing this intention in mind, two cases with contrasting performance — one with positive record of tariff collection and the other with poor record of the same — were identified to elucidate the effects of the factors under study. Following the consultations with the government and villagers as to acceptability of the survey, two villages — Koar and Dialakoto — in the Tambacounda region were finally determined. Outline of the surveyed villages is given in Table 1 below.

Table 1 Outline of the Surveyed Villages

	Koar	Dialacoto
Administrative location	Missirah rural community, Missirah division, Tambacounda department, Tambacounda region	Dialacoto rural community, Missirah division, Tambacounda department, Tambacounda region
Geographical location	13°19' N, 13°33' W	13°18' N, 13°16' W
Population (2008 census)	1,329 persons	3,567 persons
Number of compounds	158	277
Main ethnic groups in the village	Fulbé (55%), Bambara (15%), Serèr (15%), Diola (10%), Wolof, Diahanké, Bassari	Socé (43%), Diahanké (40%), Fulbé (7%), Serèr, Wolof
Religious affiliation	Muslims: 95% Christians: 5%	Muslims: 100%
Average precipitation	700–1000 mm	700–1000 mm

Source: Prepared by the author

2.3. Data Used

This paper relies on data from a qualitative survey conducted by the author during the period of September-November 2009. The survey included historical trend analysis of infrastructure management, focus group discussions with officials of water users associations (WUA) and participant observation of villagers engaged in water collection, storage and use, and other social and economic activities. Key informant interviews were also conducted with village heads and religious leaders to triangulate the information obtained from other sources. The survey also included semi-structured interviews with individual villagers (mostly heads of compound accompanied by one of the married female members of the compound[2]). Villagers were disaggregated based on ethnicity in the case of Koar and location of residence in the case of Dialakoto to reflect major dimensions of social cleavages in the society, and one or two households were selected randomly from each group depending on their availability.

Secondary data were also collected from the Government of Senegal, primarily from ministries in charge of the rural water sector, and development partners that were supporting the rural water sector in Senegal. The latter included socio-economic survey conducted for both villages in 2007 (JICA and DEM, 2007a; 2007b). These were used to complement data and observation obtained in the field.

2.4. Motivating Factors and Method of Analysis

In the previous paper of the author[3], water tariff payment was regarded as a result of collective action necessary for successful water infrastructure management; hence as dependent variable. Water tariff payment was then hypothesized to be fostered by user motivation to *use* borehole water as well as to cooperate in *managing* the infrastructure. The former was further divided into their *preference* in the choice of water and their *satisfaction* from consuming water; while the latter was divided into *trust* among resource users, perceived *sanctions* for non-payment, and perceived *cooperative benefits* from participating in infrastructure management. These correspond to intervening variables presented in Figure 1 above.

Some moderator and independent variables were also examined which were considered to influence users' payment behavior. These were: i) household expenditure level as a proxy for income level, ii) existence of private water connection, and iii) type of WUA to which the household belongs.

In this paper, intervening variables will be called "motivating factors", moderator and independent variables as "contextual conditions", and dependent variable "outcome" as this paper relies on qualitative method for survey and analysis. Assuming that the framework of the previous analysis still holds in real cases, the present paper applies the same set of factors to actual cases and assesses how these factors affect users' water tariff payment behavior in the historical process of infrastructure management.

To analyze and understand more systematically the complexity and dynamism of such situation and to help structure the empirical information, a multi-tier ontological framework called Social-Ecological System (SES) is employed (Ostrom, 2007; 2009)[4]. SES is composed of four core subsystems, which are, namely: resource systems, resource units, resource users, and governance systems; which influence the process of interaction to produce outcomes. Understanding of factors critical to success or failure of resource management must come from the analysis of process of interaction where multiple interests and actors interact and produce resource management outcomes (Naiga & Penker, 2014).

By relying on this framework, detailed description of each case is presented first, which is followed by the assessment of the hypothesized motivating factors. Results of user interviews on water use, preference of water sources, perceptions on management body and peer users, reasons for payment/non-payment, etc., coupled with examination of social relationship and process of infrastructure management, are used to see to what extent the factors are present/absent and how they are related to the outcomes in each case.

3. Case Study 1: Koar Village

3.1. General Background

Located on the banks of the river Gambia, Koar is a settlement village established in 1981 as a banana plantation project supported by a donor development program. As of 2008, the village population is approximately 1,329 (57% male, 43% female) and consists of 158 compounds which extends within the radius of 500 m in diameter. There are a total of seven ethnic groups — Fulbé (55%), Bambara (15%), Serèr (15%), Diola (10%), Wolof, Diahanké and Bassari. The village chief is selected from among the initial settler families who are Fulbé. In terms of religious affiliation, 95% of villagers are Muslim while the remaining 5% are Christian.

With the exception of a handful of Fulbé residents who rely on livestock husbandry and farming, most villagers own individual plots of banana fields. There are four blocks of banana fields covering a total area of 84.5 ha, each managed independently by a cooperative run by the farmers. Both men and women are eligible to cultivate the banana field plots. In addition to banana plots, villagers are allocated pieces of land by the village chief to cultivate staple food crops (millet, maize, beans) and cash crops (groundnuts, cotton).

Average amount of monthly expenditure per compound used as a proxy for personal income level is 38,000 CFA francs, which is equivalent to 150 CFA francs per person per day. The village is covered by BPF (*Brigade des Puits et Forages*), the government office responsible for providing technical and managerial support for the operation and maintenance of water supply facilities, in Tambacounda, which only visits the village upon calls for assistance and advice.

3.2. Resource User Characteristics

The village is a new settlement populated by people of seven different ethnic groups. One implication of this is that there are only limited kinship relationships beyond the boundaries of the compound, which is basically occupied by extended family members. Labor exchange for cereal and traditional cash crop production is practiced mainly within the compound, rarely extending beyond its limits. Banana cultivation is largely an individual or household matter within the compound as land for that purpose is allocated on an individual basis. When there is a need for supplemental labor for banana cultivation, the main recourse is to hire labor.

The second implication emanating from the village's mixed social composition is that different people hold different attitudes toward water use. For example, villagers who migrated from more urbanized areas, including those of Serèr and Wolof origin from western Senegal (together comprising nearly 20% of total village population), clearly show a higher preference for borehole water because their urban experience has accustomed them to this water. On the other hand, earlier migrants from nearby villages are accustomed to using traditional water sources and have low levels of hygienic

awareness due to their mostly rural-based life experience.

One unique aspect of social relationships in Koar is that all banana producing farmers belong to at least one of four banana cooperatives, each of which was created for one of the four blocks. Cooperatives are responsible for joint sales of produce, for operation and maintenance of irrigation pumps, and for purchase of agricultural inputs such as fertilizers and pesticides. They sell the produce to visiting buyers once fortnightly and jointly participate in cooperative management.

3.3. Resource System Characteristics

Average annual precipitation in this area ranges from 700 to 1000mm. Before the motorized water supply system was installed in 2001, a public shallow well constructed by the government had been the main source of water in Koar, with additional water available from the river and, during the rainy season, from marshland. Even at present, the shallow well, available throughout the year, is still widely used by the villagers (n=13), especially for such purposes as washing clothes and bathing (43% of survey respondents), and for drinking and cooking (29%).

The main facilities constituting the motorized system include a water tower with a capacity of 50m^3, five public standpipes and a livestock water point, all equipped with water meters. There have been no major mechanical breakdowns with this system since service inception in 2001. The only breakdown to date was recorded in May 2009, when there was a problem with the starter motor of the generator, but supply of water was not interrupted.

3.4. Resource Unit Characteristics

People use jerry cans and water basins to collect water from public standpipes or shallow wells. For 90% of the population, public standpipes are located within a distance of 100m. Villagers use approximately 11 liters of borehole water per person per day, equivalent to 44% of total water consumed per day.

According to a survey conducted in 2007 (n=10), 56% of respondents chose borehole as the main source of water including drinking and cooking, while 44% chose shallow well as the main source, and 70% of respondents found borehole water good in taste and 80% clean (JICA and DEM, 2007a).

When asked a similar question in 2009 (n=13), 80% of respondents showed a clear preference for borehole water for drinking and cooking. They also identified water "quality" as the main reason for this choice (77%)[5], suggesting a high level of awareness of "safe water" use among the Koar villagers.

3.5. Governance System

Since 2001, there have been three generations of management committees. The first committee, under the previous CdG (*Comité de Gestion*)[6] arrangement, was managed by a male farmer from 2001 to 2005. The second committee was installed in 2005 when the first president left the village and

transferred responsibility to a male livestock keeper from 2005 to October 2007. ASUFOR (*Association des Usagers des Forages*)[7] was introduced in November 2007 and the current president is a housewife from a famer household.

During the term of the first CdG president, a unit price per container was used rather than a water meter. Reading meters and calculating fees were regarded as too complicated and cumbersome. Until October 2007, the water tariff was set at a seasonal subscription fee of 1,000 CFA francs per compound, with an additional container-wise water tariff of 10 CFA francs per 20–liter container.

After the introduction of ASUFOR, the water tariff was fixed at 400 CFA francs per m^3, measured by water meters, with a rate of 15 CFA francs per 20–liter container used at public standpipes. When this unit tariff is multiplied by the amount of water consumed, average amount of expenditure for water accounts for approximately 4.6% (standpipe users) – 6.9% (private connection users) of monthly expenditures of villagers. People take it rather expensive as no one answered the tariff rate appropriate when interviewed[8].

A user committee (*Comité Directeur:* CD) and secretariat (*Bureau Exécutif:* BE) members were selected through a standard electoral process as stipulated by government regulation. Social and functional differences (including gender) are duly reflected in the composition of these committees. A bank account for savings to cover future maintenance has been in use since 2001. At the start of ASUFOR, a membership fee of 100 CFA francs was collected from each villager. Since October 2007, CD has met 7 times (once in 2007 and three times in 2008 and 2009 respectively) and the average ratio of attendance is about 70%; and BE has met every month attended by all key members.

3.6. Process of Interactions

The first CdG president recalls that only some 50% of the fees were actually collected. This was due partly to nonpayment by users and partly to theft by public standpipe caretakers. Sanctioning of defaulters or thieving caretakers was not possible at that time because, according to him, "there was no means of confirming the exact amount that should have been collected". Nonetheless, money that was collected was properly accounted for and the committee was able to save some extra each month.

After the departure of the first president from the village in 2005, one of the CdG members was appointed as the second president. No village-wide meeting (*Assemblée Général*: AG) was held to select the new president or to report the financial position of the committee. Soon after his appointment, the second president, without consulting other committee members, began withdrawing money from the bank for his own personal use. This occurred several times between 2006 and 2007 unnoticed by anyone. It was only in the period May-July 2007, when the water supply was interrupted for three weeks due to lack of fuel that villagers detected irregularities in the president's behavior. The villagers appealed repeatedly to the president to explain the committee's financial position to the CdG, but without success. The CdG's only recourse for restarting the water supply was to borrow fuel

from the banana cooperatives as villagers' water tariff payment dwindled.

In the midst of this crisis, with the help of government, a new management arrangement, ASUFOR, was introduced. A series of meetings was held in October 2007 to familiarize villagers with the new arrangements. In the AG, the second president was dismissed with the unanimous agreement of the villagers and replaced by a housewife known for her prominent role in a women's group. This idea of choosing a woman for president came from the villagers and received strong support. According to one of the informants;

> *Having woman in a leadership position is against our traditional norm. But water belongs to women's domain and should therefore be managed by a woman. There was no choice then as the former president had failed to deliver*[9].

An arrangement allowing any interested party to check the bank statement was also proposed and adopted.

In an effort to remedy the fraudulent management of the previous president, the new management started using water meters to collect water tariffs with rigor and austerity. Three families who were threatened with suspension of their access to borehole water when they refused to pay their dues despite repeated warnings, eventually agreed, apologized and paid in full. In 2008 even the private water supply of the former chief of village was cut when he fell three months behind in his dues. Three standpipe caretakers who were suspected of cheating by under-reporting their collection amounts against the meter readings were replaced by the president and her team.

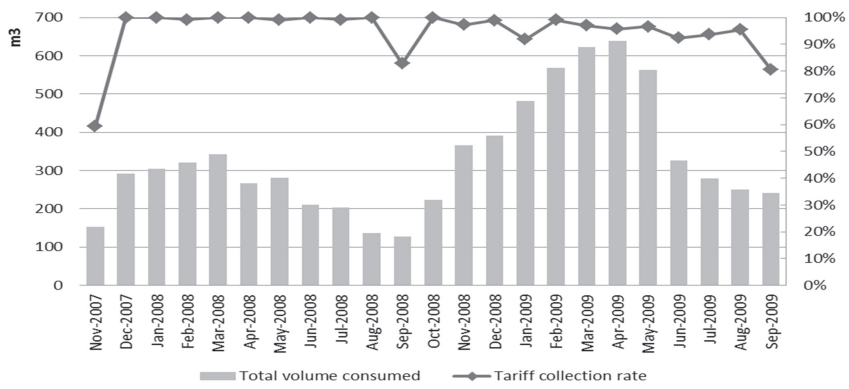
Finally, in October 2008, in response to strong requests from the villagers, the current ASUFOR — with some support from the government — installed an additional public standpipe in a previously underserved area as well as private connections for 50 village compounds.

3.7. Outcomes

Figure 2 below shows effective water volumes (volume of supplied water as recorded by meters) and water tariff collection rates in Koar between the period immediately following the establishment of ASUFOR and the time of survey. The water tariff collection rate in November 2007 hovered around 60%, then improved considerably, reaching nearly 100% after December 2007. The rate has remained high since that time averaging 95% through 2008 to 2009, though showing some decline in the latter half of 2009.

The bank balance also shows a steady increase after November 2007, from the lowest figure of 139,000 CFA francs, to 750,000 CFA francs recorded as of July 2009. With this strengthened financial capacity, in May 2009 ASUFOR was able to employ a technician from Tambacounda to repair the alternator of the generator at a cost of 100,000 CFA francs.

Figure 2 Effective Water Volume and Water Tariff Collection Rate (Koar)



Source: prepared by the author

Answering the question on one's perception of own payment behavior and others (n=11), all the respondents answered that he/she is paying water tariff regularly and about two thirds of respondents believed that other people are also behaving in the same manner. When asked about the purpose of payment, 73% answered that the money is to enable daily operation of pumps (purchase of fuels, remuneration for pump operator) and the remainder answered it is out of sense of duty. People generally give high opinion on the performance of ASUFOR (4.25 on five point scale on average), with an exception of information sharing to users (3.40 on average).

3.8. Assessment

In Koar, even before ASUFOR was introduced, people were paying their water tariffs at least to the level that enabled continued water provision, but after introduction of ASUFOR, people began to pay their dues at a significantly higher rate.

In terms of motivation to use the borehole water, there has been a moderately high level of preference given to borehole water in this village, which later showed further increase. They gave high value to the quality of water and regarded it as a main reason for their choice. Against this background, the motorized system continued to supply water for nearly seven years with limited period of suspension. Hence it is reasonable to assume that people's level of satisfaction remained high, which is illustrated by the high level of evaluation given to ASUFOR performance in terms of stable and sufficient supply of water.

As to the motivation to manage the infrastructure, there seems to be moderate level of trust among users as far as tariff payment is concerned, as nearly two-thirds of respondents believe that other users are paying tariffs regularly. In terms of sanctions application, in the pre-ASUFOR period, sanctioning defaulters and caretakers were difficult because there was no means to calculate exact amount of consumption. However, this situation changed after the introduction of ASUFOR, when sanctions

on defaulters/thieves began to be seriously pursued. Recognition of long-term benefits was difficult to observe behind the act of tariff payment as majority of respondents answered that the purpose of payment is to cater for daily operational needs rather than to prepare for future maintenance/renovation. However, strong manifestation of communal benefits, in the form of unanimous agreement to dismiss the president and to elect a new one (who was a woman), was observed when faced with suspension of water supply.

As to contextual conditions, tariff payment may be a financial burden to Koar villagers, as no one rated the current tariff appropriate. However, the fact that the tariff collection ratio drastically increased after the introduction of ASUFOR accompanied by new (and higher) tariff rate suggests that there is more than just affordability that determines users' payment behavior. Existence of private connection certainly increased the utility of water supply infrastructure as the consumption volume increased after the installation of private connection; however, whether it positively affected users' motivation to pay is unclear, as tariff collection rate rather dwindled, though slightly, after its introduction. Finally, as to the effect of different management system on motivation to pay, it did coincide with the change of payment behavior as far as this case is concerned.

4. Case Study 2: Dialakoto Village

4.1. General Background

Established by two families of the Socé ethnic group during the latter half of the 17th century, the village of Dialakoto is located 80km away from the regional capital of Tambacounda. It extends 2.5km in east-west along the national highway and 1.0–1.5km in north-south. The village currently has a population of approximately 3,600 people, 54% male and 46% female, and 277 compounds.

There are nine quarters in the village, each of which is occupied predominantly by one of the three main ethnic groups: Socé (43%), Diahanké (40%) and Fulbé (7%), with a small number of Wolof and Serèr also living in the village. The village is administered by the village chief, a hereditary position held by one of the original Socé settler families, who is assisted by chiefs of the quarters designated from among the elders in each area.

The main economic activities of the villagers include agriculture (both food crop and cash crop production), livestock husbandry, commercial activity and emigrant labor. Crop production is basically done by family labor with limited practice of labor exchange between kinship groups in times of plowing and harvest. All villagers are Muslim. Average amount of monthly expenditure per compound used as proxy for personal income level is 65,000 CFA francs, which is equivalent of 168 CFA francs per person per day.[10]

BPF responsible for the village is located in the city of Tambacounda. In principle, monitoring of ASUFOR activities is exercised on an as-need-arises basis.

4.2. Resource User Characteristics

It appears that people belonging to different ethnic groups find it more comfortable to live separately in this village. Three of the nine quarters are predominantly occupied by Socé, four by Diahanké and two by Fulbé. Separation among different quarters is such that there are now nine mosques (*Jaka*) where daily prayers are conducted separately, except for Friday prayers (*Juma*) when all the villagers assemble in the largest mosque. The practice of labor exchange for agricultural production beyond compound members is a limited phenomenon in this village, though some cooperate within their circle of clan members. A taboo is observed on intermarriage between Diahanké and Fulbé on one side and Socé on the other. The latter is regarded by the former as late converts to Islam, lacking seriousness in learning the Koran, which deters the parents of the former from marrying their daughters into Socé families.

4.3. Resource System Characteristics

Average annual precipitation in this region ranges from 700 to 1000mm, which reflects a relatively humid climate. Traditionally, villagers have depended on water from shallow wells owned by them, available throughout the year, for domestic consumption for both drinking and cooking. Around 61% of all compounds have private wells within their compound (168 out of 277 households) in addition to 19 shallow wells available for public use. A 2009 survey of 20 households conducted by the author showed that people prefer to have private shallow wells within their compound due to ease of collecting water (27%); no time restriction of use (24%); no conflict with other users (17%); social prestige associated with having one (21%); and good taste (11%).

A motorized borehole water supply system was first constructed in this village in 1980 with donor support. In 1999, this was expanded by the same donor, creating a dual water supply network with two reservoirs, each with $50m^3$ capacity. Public standpipes are located at 13 different points around the village and there are a few private connections, each with a water meter. The supply network, however, covers only five quarters of the village, leaving four without standpipe access.

4.4. Resource Unit Characteristics

People use jerry cans and water basins to collect water from public standpipes or shallow wells. At the time of the field survey, all villagers were using water from shallow wells, as there was no running service from the motorized system. According to a survey conducted in 2007 (n=30) when there was still running service of motorized system, 61% of villagers were using shallow wells as main source of water for drinking and cooking (JICA and DEM, 2007b), and 90% of respondents found no problem with the quality of water from shallow wells.

Findings from the 2009 survey by the author (n=20) reveal that villagers use approximately 24.7 liters of (shallow well) water per person per day, and 75% of respondents found no problem with quality

of shallow well water, and 35% even found the taste to be "sweet".

This is despite the fact that there were 375 cases of diarrhea and 55 cases of dysentery reported at local health post in 2008 (104 cases and 15 cases per 1000 people). People have been sensitized to apply some form of treatment to such water, but the relationship between quality of water and waterborne disease is not adequately recognized by the villagers, despite repeated sensitization programs.

4.5. Governance System

The first generation ASUFOR was established in November 2004, and lasted for slightly more than three years. At the time of its introduction, a membership fee amounting to 100 CFA francs per person was collected from each registered user. A volumetric water tariff of 400 CFA francs per m^3 was agreed,[11] but the actual rate offered at public standpipes remained unchanged at 10 CFA francs per 10–liter container and 15 CFA francs per 20 and 25–liter basin. According to the survey conducted in 2007, 99.7% of respondents found this amount acceptable and payable (JICA & DEM, 2007b). CD and BE were formed according to the standard regulations, and a bank account opened to save extra money for future repairs.

The second generation ASUFOR assumed position in February 2008 with renewed CD and BE membership under the leadership of a new president. The water tariff structure was maintained, and again all official positions were filled by elections among villagers representing the different constituent groups.

In both ASUFORs, one-third of the BE membership has been female, meeting government requirements. The presidency, however, has always (since 1981) been held by a male villager.

4.6. Process of Interactions

During the tenure of the first ASUFOR president, water tariff collection at a fixed rate per container was applied at each public standpipe, but volumetric water tariff collection by water meter was not strictly practiced. Furthermore, aggregation of water tariffs collected by individual tap caretakers was done by the president himself, without the involvement of the treasurer or any other member of BE or CD, and no accounting records were kept.

Despite these problems, no action was taken to hold the president accountable for the financial position of ASUFOR. It was only in February 2008, at the time of a GA, that some villagers voiced complaints about the irregular supply of water and the lack of transparency in management. Those who suspected misconduct by the president suggested that the matter be taken to court, but this idea was abandoned due to a lack of hard evidence to substantiate wrongdoing, and because the BPF advised that the matter be sorted out in an unofficial manner.

Eventually, however, these complications led to the resignation of the first president from his

position. At the time of reelection, the possibility of a female president was mooted by one of the villagers, but the idea was denied by one of the elders who said:

> *ASUFOR is not like income generation groups which are meant for limited number of people interested. ASUFOR is for all the villagers. Such an important position should be held by a man not a woman*[12].

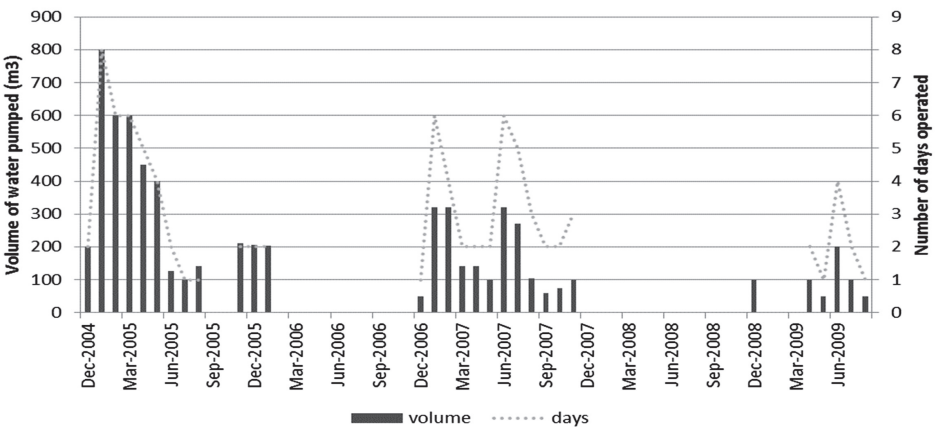
But the second generation ASUFOR was installed with no funds to work with, and matters were soon made worse by a mishap. The submerged pump broke down and it took 11 months for a new one to be installed, paid for by a donor. Hence throughout 2008 virtually no water was supplied. During this period, villagers in non-served quarters requested the new president to lay water pipes to their areas only to be turned down.

Furthermore, after the pump was restored in December 2008, there were still no funds to buy fuel. An appeal from the BE for another round of membership fees contribution was made, but rejected by villagers because this had already been done when the first generation ASUFOR was established. So in the first half of 2009 again there were insufficient funds to run the system.

The only exception was one short period in the middle of 2009 when the pump was operated by a construction company that bore the fuel costs. At that time water was provided to a limited number of users living near the construction site, but again the revenue was accounted for by the president personally and no written records were kept. During this period CD members held only two meetings, both to discuss how to raise funds to buy fuel, with neither resulting in any action.

Figure 3 below indicates the number of days the pump was operated and the volume of pumped water over the past several years. The average volume of water pumped per month was 300 m^3 in 2005 (water supplied for 10 months), 25 m^3 in 2005 (2 months), 127 m^3 in 2006 (2 months) and 170 m^3

Figure 3 Number of Operation Days and Pumped Volume (Dialakoto)



Source: prepared by the author

in 2007 (12 months). In 2008, the pump was out of order for much of the time and in 2009 there was only a limited supply of water due to a lack of funds.

4.7. Outcomes

The water tariff collection rate is hard to capture as there were no records in this village[13]. Sporadic information regarding the balance of the amount collected is the only indicator allowing any estimation of villagers' tariff payment behavior and ASUFOR performance. In November 2004, first generation ASUFOR received nothing from the previous administration, and the amount saved as of August 2005, stood at only 65,000 CFA francs. Calculating from the total amount of water lifted during this period (3,725 m^3 for eight months) and the amount saved, the estimated ratio of tariff collection stands at around 7%.[14] Three years later, the balance handed over to the second generation ASUFOR in February 2008 was only 2,000 CFA francs. This figure stood unchanged at 2,000 CFA francs until at least October 2009, meaning there was hardly any water tariff collection during this period including the time when limited supply of water was realized in 2009.

Reflecting this poor state of management, the survey undertaken in 2007 reveals that 63.3% of respondents had no confidence in ASUFOR and 16.7% showed no interest in ASUFOR. According to the key informant interview in 2009 (n=14), this situation was partly due to the president's mismanagement of funds collected, and partly to failure of individual users to pay the fixed water tariff. Numerous reasons were given for non-payment (multiple answers), including lack of trust in ASUFOR officials (36%), higher preference attached to private shallow wells (36%), lack of private connections (43%), lack of convenient public standpipes (39%), and failure of migratory pastoralists visiting the village to pay the water tariff (21%). About a third of respondents (29%) answered that they were not interested in ASUFOR management at all.

4.8. Assessment

In Dialakoto, despite early introduction of ASUFOR, the payment level remained low from the beginning, which, combined with poor management, led to irregular supply of water and culminated into further reluctance of users to contribute.

Majority of villagers owned private shallow wells within their compounds, and people gave preference to them over the public standpipes. Even when there was still supply of borehole water, people chose shallow wells as main source of water. Their positive evaluation of water quality remained high throughout the period under investigation. The preference given to borehole water was extremely low from the very beginning.

Lack of interest in borehole water allowed successive presidents to take advantage of their positions to squander whatever little funds collected, which led to short of fund to buy fuel and irregular supply of water. In addition, some people were not happy with the fairness in water distribution network

as their quarters were not covered. Faced with poor water supply and lack of fairness, Dialakoto villagers' dissatisfaction with the service is clear in their responses to questions asking reasons for non-payment.

In a village where different ethnic groups live separately from each other, within which social and economic activities are mostly confined, and where some of the ethnic groups antagonize each other along ethnic and religious lines, it is hard to imagine that trust can emerge across different groups of the people as there was no such relationship that binds villagers together. Free-riding of non-ASUFOR members (pastoralists) was never sanctioned, which further made villagers reluctant to contribute. With this social division and lack of trust, recognition of collective benefits was extremely difficult. The request for extension of pipes to non-covered quarters was not seriously considered.

People in Dialakoto found the tariff rate acceptable and payable; hence the financial cost does not appear to be a major constraint. There were only a limited number of private connections, and its impact on payment behavior should be negligible. Finally, throughout the period under investigation, Dialakoto was under the ASUFOR management. Instituting ASUFOR itself has no direct bearing on users' motivation: what matters here is actual functioning of the organization.

5. Discussions and Conclusion

From the assessments presented above, it was possible to confirm in Koar that there were a certain level of preference and satisfaction with the borehole water as well as trust among users behind the moderate level of water tariff payment from the very beginning. On the other hand, in Dialakoto, all of the motivating factors were rated extremely low or absent throughout the period under investigation. While it is difficult to disaggregate the effect of various factors on the outcomes, the result of key informant interview underlines the importance of the same three factors.

From the synthesis of the two cases, it is possible to conclude that the motivating factors posited to influence users' water tariff payment — preference, satisfaction and trust — are useful in understanding the real-world cases; which is in line with the conclusions of the previous paper of the author. Sanctions were rarely applied and collective benefits were difficult to be perceived most of the time in both cases. However, the sudden increase of tariff payment observed after the introduction of ASUFOR in Koar prompts one to examine other motivating factors as well.

Notable events observed around this time include the sudden increase of sanctions application to defaulters/thieves, and collective decision to introduce a new management system and a new institutional arrangement meant for ensuring transparency. The former was aided by the introduction of volumetric water tariff system using water meters which apparently reduced the cost of sanctions application. With this technological device, comparison of quantity of water "sold" and the amount of dues to be collected was made easier, which prompted treasurers of WUA to pressurize standpipe

caretakers to collect, and private connection users to pay the exact amount.

The latter was triggered by the suspension of supply of water to which people attached certain level of preference. When the benefit they enjoyed was put at risk, they began to appreciate the importance of the borehole water, leading them to reform institutions (including having a female leader). As Wade (1988: 192) once noted, collective action becomes more readily acceptable when the existing interests of resource users are threatened because their net collective benefits is enhanced by the threat. These facts suggest that sanctions and cooperative benefits also need to be counted as motivating factors under certain circumstances.

As to the contextual conditions that aided/hindered emergence of motivating factors in both cases, one comes to note the diverse nature of conditions related to motivating factors. In Koar, some of the conditions that aided the emergence of three motivating factors include; existence of fair number of immigrants from the more urbanized western part of the country (related to preference); absence of major breakdown of the infrastructure and equitable access to public standpipes (related to satisfaction); and existence of channel of communication and information sharing through the membership to banana cooperatives (related to trust). These conditions stand out as facilitators in a context which is otherwise not favorable to the emergence of collective action, e.g., existence of alternative resource and heterogeneous composition of user groups, as was observed in Dialakoto.

The cross-case examination of the contextual conditions also point to the fact that borehole water is not always at the top of the list for everybody, even if people find it affordable. The analysis has demonstrated that people find different kinds of benefit expected from water: "a health expenditure-saving benefit" and "a labor and time-saving benefit". While the people in Koar valued the former, those in Dialakoto did otherwise. This should be attributable partly to the different level of hygienic awareness held by users in two villages and partly to the difference in accessibility to the resource in question.

This implies that users must have sufficient amount of interest in using the resource before they are motivated to manage the resource. Unlike natural resources that have traditionally been exploited by users (such as forests, wildlife and fishing grounds), borehole water is "new" to users. People have normally exploited conventional water sources and these are in competition with the newly provided resource. Only after reasonably satisfied from using their preferred water, there is a chance for users to be motivated to participate in management.

In terms of contextual conditions, it appears that private connection is the most preferred form of water supply. Moreover, it appears to be an ideal form of provision from the viewpoint of soliciting collective action since it addresses both types of benefit thus contributing to the increase of user preference, and it opens up the possibility of applying sanctions as well. However, its effect on payment behavior was not confirmed in this study as well as in the previous work of the author. Hence, the linkage between private connection and payment behavior deserves further examination.

Finally, the present analysis has demonstrated that collective action is not a one-off event; it is rather a dynamic process which can change over time. Collective benefits were strongly perceived by Koar villagers only when they faced the crisis — suspension of their preferred water. The very dynamism suggests that cooperation can be weakened or lost over time unless it becomes institutionalized through, for instance, shared norms or customs and/or enforcement of monitoring from the external agency such as government.

The present study confirms the importance of focusing on motivating factors to arrive at a better understanding of incentive mechanisms surrounding water utility users. These findings underline the usefulness of causal models proposed by e.g., Stern et al. (2002) and Agrawal (2001, 2002), both of which emphasize the indirect nature of causality in understanding incentive mechanisms surrounding resource users for successful CPR management. They are also in line with one of the arguments proposed by Poteete et al. (2010) who emphasized the importance of studying "microsituation" which directly impinge upon individuals' behavior within the broader contextual context.

Analysis of actual cases using a CPR perspective may be useful as a step for exploring incentive mechanisms for water users' ongoing motivation for infrastructure management. These efforts may be of value to development policymakers and intervention practitioners when they face field operation tasks of designing institutions and interventions, since they can do little actually to change the characteristics of resources and resource users.

Notes

1 These two regions formed the Tambacounda Region but were divided during the restructuring of the government administration in 2009.

2 Female members of the compound are included in the interview as they are more knowledgeable about how much water is collected from where and how it is used for different purposes.

3 This work was built upon the game structure called "Assurance Problem (AP)" which was proposed by Runge (1984; 1986), and was supported by McCarthy (2004).

4 SES builds on the long-standing analytical framework called Institutional Analysis and Development (IAD) which was developed by Ostrom (e.g., Ostrom et al., 1994).

5 Those who chose "close distance" as a reason for selecting borehole accounted for 15% of respondents.

6 CdG is a form of water users associations commonly practiced in Senegal prior to the introduction of ASUFOR. It is normally composed of president, vice-president, treasurer(s), secretariat(s), who are selected from the user villagers.

7 ASUFOR is an institutional mechanism for water users associations promoted under the water sector reform started in 1996; and can be characterized by i) management body having an independent legal status; ii) use of water meters to enable volumetric water tariff system; and iii) increased private sector involvement in management (UNDP, 2013; Sarr, 2008).

8 For example, African Development Bank sets its water tariff affordability threshold at 5% of household monthly disposal income, but it is said to reach 7.5% of the same sometimes (Hutton, 2012).

9 A statement made by vice-president of ASUFOR, interviewed by the author on October 6, 2009.

10 655 CFA Francs=US$1.00 (September 2009).

11 According to the government manual, the unit price is set between 200–400 CFA francs/m^3 depending on decisions of users in specific locations. Price includes direct running costs (e.g., fuel or electricity costs, remuneration for pump operators), routine maintenance costs (e.g., lubricants, spares) and major repair/replacement costs (e.g., repair of pumps, generators) (PEPAM, 2006).

12 A statement made by one of the heads of compound, interviewed by the author on October 30, 2009.

13 Due to limited data availability in Dialakoto, the same kind of graph showing tariff collection rate as used for Koar (as presented in Figure 2) could not be produced for Dialakoto.

14 Against the total amount of water lifted during this period, assuming that all tariffs are collected, the total amount to be collected should be 1,490,000 CFA francs. Leaving aside operational costs of 22% of the unit price, and 30,000 CFA francs for pump operator remuneration, 922,200 CFA francs could have been saved from eight months of operation.

References

Agrawal, A. 2001. Common Property Institutions and Sustainable Governance of Resources. *World development*, Vol. 29, No. 10, pp. 1649–1672.

Agrawal, A., 2002. Common resources and institutional stability, in: Ostrom, E., Dietz, T., Dolsak, N., Stern, P. C., Stonich, S., Weber, E. U. (Eds), *The drama of the commons.* National Academy Press, Washington, DC, pp. 41–86.

Andersson, K., 2006. Understanding decentralized forest governance: an application of the institutional analysis and development framework. *Sustainability: Science, Practice, & Policy* 2 (1), 25–35.

Baland, J. M., Platteau, J. P., 1996. *Halting degradation of natural resources: is there a role for rural communities?* FAO, Rome.

Hanatani, A. & Fuse, K. 2012. Linking resource users' perceptions and collective action in commons management — an examination of water supply systems in Southern Senegal. *Water Policy*. 14 (1) 127–147.

Harvey, P. A., Reed, R. A., 2004. *Rural water supply in Africa: building blocks for handpump sustainability*. WEDC, Loughborough University, Leicestershire, UK.

Harvey, P. A., Reed, R. A., 2007. Community-managed water supplies in Africa: sustainable or indispensable? *Community Development Journal*. 42 (3), 365–378.

Hutton, G. 2012. Monitoring 'affordability' of water and sanitation services after 2015: review of global indicator options. http://www.wssinfo.org/fileadmin/user_upload/resources/END-WASH-Affordability-Review.pdf, downloaded on 15 November, 2015.

Japan International Cooperation Agency (JICA) and Direction de l'Exploitation et de la Maintenance (DEM). 2007a. *Rapport etude de base: Koar*. Projet eau potable pour tous et appui aux activités communautaires.

Japan International Cooperation Agency (JICA) and Direction de l'Exploitation et de la Maintenance (DEM). 2007b. *Rapport etude de base: Dialakoto*. Projet eau potable pour tous et appui aux activités communautaires.

Madrigal, R., Alpízar, F., Schlüter A., 2011. Determinants of performance of community-based drinking water organizations. *World Development*. 39 (9), 1663–1675.

McCarthy, N. 2004. Local level public goods and collective action. *Collective action and property rights for sustainable development*, ed. R. S. Meinzen-Dick, and M. Di Gregorio. International Food Policy Research Institute.

Meinzen-Dick, R., Di Gregorio, M., McCarthy, N., 2004. Methods for studying collective action in rural development. *CAPRi Working Paper 33*. International Food Policy Research Institute. Washington, DC.

Naiga, R., & Penker, M. 2014. Determinants of users' willingness to contribute to safe water provision in rural Uganda. *Lex Localis-Journal of Local Self-Government*, *12*(3), 695–714.

Norgaard, R. B. 1994. *Development betrayed-the end of progress and a co-evolutionary revisioning of the future*. New York. Routeledge.

Ostrom, E. 1990. *Governing the commons: the evolution of institutions for collective action*. Cambridge University Press, Cambridge, UK.

Ostrom, E., Roy Gardner, and James Walker. 1994. *Rules, Games, and Common-Pool Resources*, The University of Michigan Press. Michigan.

Ostrom, E. 2007. A diagnostic approach for going beyond panaceas. PNAS (Proceedings of the National Academy of Sciences of the United States of America), 104 (39), 15181–15187.

Ostrom, E. 2009. A general framework for analyzing sustainability of social-ecological systems. Science 325: 419–422.

Poteete, A. R., Janssen M. A., Ostrom E., 2010. Working together: collective action, the commons, and multiple methods in practice. Princeton University Press, Princeton, NJ.

Programme d'Eau Potable et d'Assainissement du Millenaire (PEPAM), 2006. *Manuel des Projets Eau, Ministère de l'Agriculture et de l'Hydraulique et de la Sécurite Alimentaire*, Ministère de la Prévention, de l'Hygiene Publique, de l'Assainissement et de l'Hydraulique Urbaine, République du Sénégal.

Runge, C. F., 1984. Institutions and the free rider: the assurance problem in collective action. *Southern Political Science Association* 46 (1), 154–81.

Runge, C. F., 1986. Common property and collective action in economic development. *World Development* 44 (5), 623–635.

RWSN (Rural Water Supply Network). *Hand pump data, selected countries in sub-Saharan Africa.* http://www.rwsn.ch/prarticle.2005–10–25.9856177177/prarticle.2005–10–26.9228452953/prarticle.2009–03–09.1365462467 (downloaded on 28 August, 2009).

Sara, J., Katz, T., 1997. *Making rural water supply sustainable: report on the impact of project rules*. Water and Sanitation Program, UNDP-World Bank.

Sarr, B. 2008. *Public-private partnerships in the management of rural boreholes in Senegal*. The paper presented at the international conference on Financing Water for Growth in Africa organized by the Infrastructure Consortium for Africa (ICA), Dakar, Senagal.

Soniya, C., & Howard, W. (1997). *Combining the quantitative and qualitative approaches to poverty measurement and analysis: the practice and the potential* (Vol. 23). World Bank Publications.

Stern, P. C., Diets, T., Dolsak, N., Ostrom, E., Stonich, S., 2002. Knowledge and questions after 15 years of research, Ostrom, E., Dietz, T., Dolsak, N., Stern, P. C., Stonich, S., Weber, E. U. (Eds), *The drama of the commons*. Washington, DC: National Academy Press.

Subramanian, A. N., Jagannathan, V., Meinzen-Dick R., 1997. *User organizations for sustainable water services*. World Bank technical paper, No. 354. Washington DC.

United Nations Development Programme (UNDP). 2013. *Commercializing communities: transitions in water management in rural Senegal*. New York.

Villalon, L. A. 1995. *Islamic society and state power in Senegal*. Cambridge University Press. Cambridge. UK.

Wade, R. 1987. The management of common property resources: Collective action as an alternative to privatization or state regulation. *Cambridge Journal of Economics*. 11, 95–106.

Wade, R. 1988. *The village republics*. Cambridge, UK: Cambridge University Press.

Water and Sanitation Program (WSP). 2010. *A review of progress in seven African countries: public-private partnerships for small piped water schemes*. WSP field notes.