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Management of Water User's Associations and
Formation of Collaborative Local Society in Rural Africa

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Linking Resource Users' Perceptions and Collective Action in Commons Management

– An Examination of Water Supply Systems in Southern Senegal -

Atsushi Hanatani* and Kana Fuse**

Abstract

Poor maintenance of water supply systems is a critical issue in sub-Saharan Africa. Using survey data on users of motorized piped water supply systems in rural southern Senegal, this paper examines what motivates resource users to contribute financially to the management of water supply system infrastructure by paying their water tariff. Results from logistic regression analysis indicate that users who prefer borehole water and are satisfied with the service provided are more likely than others to pay. In addition, those who trust that other users will pay are more likely themselves to pay than those who do not trust their peers. These findings suggest that assessing the needs of users and providing services tailored to those needs (e.g., quality, convenience) is recommended for future interventions. The incorporation of programs that promote peer trust also should be considered as future interventions to establish or strengthen resource management organization.

Keywords: collective action, community-based resource management, motorized water supply

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Introduction

In sub-Saharan Africa, governments and development partners have been increasing efforts to provide safe water to the populace, especially to those living in rural areas, to meet the United Nations Millennium Development Goals (MDGs). Sub-Saharan Africa remains the largest recipient of donor aid in this sector (OECD 2009). Using these resources, African countries have made modest progress in the water sector, decreasing the percentage of people without access to safe water by 3.7% between 2000 and 2008 (World Bank 2010). Nonetheless, they remain far from reaching the MDG target. This is partly because African nations still are struggling to maintain their water supply systems in a sustainable manner. According to an estimate of 20 African countries, 30%-40% of all hand pumps installed in these countries are non-functioning; in some countries more than 60% of the facilities are out of service (RWSN 2009).

In many sub-Saharan African countries, although governments with support from their development partners still play a central role in providing infrastructure, management responsibility for water supply systems (including operation and maintenance, and sometimes replacement) has been decentralized to users or communities. As applied to natural resource management in "Community-based Natural Resource Management" (CBNRM), the notion of "Community-based Management (CBM)" has shaped institutional arrangements for managing rural water supply infrastructure. Management responsibility has generally been transferred from the government to water user associations (WUAs) composed of user-community members who have become responsible for collecting water tariffs from users and for maintaining infrastructure with the funds collected.

The CBM approach is grounded in the theory of common-pool resources (CPR) and collective action (e.g., Olson 1965; Axelrod 1981; Baland and Platteau 1996; Ostrom 1990, 1992; Ostrom, Gardner and Walker 1994; Wade 1987, 1988). These scholars have challenged other well-established strategies, including state control and privatization of natural resources, and have argued for the common management of resources (Boggs 2000). Since there is enormous interest in understanding how to establish lasting institutions for resource management, scholars have focused on identifying the physical and socio-economic environment/conditions under which sustainable resource management is most or least likely to succeed. They have come up with a list of "design principles" applicable to real-world cases. Some widely-known examples include Ostrom's design principles (1990), Murphree's CAMPFIRE principles (1997) and CBNRM principles developed by Shackleton (2000).

Through these efforts to abstract generalized findings from case studies, it has become evident that collective action for CPR management is a highly complex process. As Stern et al. (2002) point out, the process is "multivariate, path dependent (i.e., historically contingent) and reflexive in nature (i.e., alterable in important ways by the process of studying them)" (pp.446-5). The main complicating factors are the many conditions affecting collective action, the feedback relationships among those conditions, and the adaptive nature of both collective action and its object (e.g., the state of resources) (Meinzen-Dick et al. 2004). Given the complex nature of the collective action process, the influence of different conditions on resource management may vary by physical and socio-economic context and by institutional development process. Thus, crafting a theory for what actually generates collective action for sustainable CPR management remains a challenge for scholars (Agrawal 2002; Meinzen-Dick et al. 2004; Stern et al. 2002).

Very little is known, moreover, about the perceptions of the resource users and what motivates them to engage in collective action for CPR management. While a number of previous studies have tried to interpret the cognitive processes of users by drawing on game theory (e.g., Ostrom 1990, 1994; Baland and Platteau 1996; Wade 1988) or economic theory such as transaction cost economics (e.g., Tang 1993), the true perceptions of the players have remained a black box and have not become part of the causal model. This is despite the fact that game theory payoffs reflect players' perceptions of possible gains and losses incurred through cooperation/non-cooperation, and their resultant strategy reflects their motivations for dealing with collective action situations (e.g., Runge 1986). Aside from some psychological experiments (for a literature review, see Kopelman et al. 2002), only a limited number of studies examine the perceptions of resource users and their real life motivations for participation in collective endeavors. To further the understanding of what motivates users to contribute to resource management, this paper examines the association between motivating factors and collective action using data from community-based rural water supply systems in southern Senegal.

Capturing the factors that motivate resource users will have significant value for development practitioners who are looking for ways to develop sustainable resource management systems by mobilizing cooperation, even in communities where favorable conditions for collective action may not be present.

Senegal was selected for this study as it has implemented major policy reforms – such as the devolution of management responsibilities to users and the introduction of public-private partnerships -- in the rural water supply sector (Sarr 2008). The Tambacounda and Kédougou[1] regions of southern Senegal were selected for a close examination. Southern Senegal is relatively humid compared to other parts of the country and alternative sources of water are available, so villagers are less reliant on water from motorized water supply systems than would otherwise be the case. The southern region is also very ethnically, linguistically and culturally heterogeneous because it borders Gambia, Guinea-Conakry, Guinea- Bissau, Mali and Mauritania). Thus, resource scarcity and homogeneity of resource users, two important conditions identified by previous studies as conducive to successful collective action, are lacking; nonetheless, the actual behavior of the residents diverges among villages.

[1] These two regions formed the Tambacounda Region but were divided during recent restructuring of the government administration. The regions of Kolda and Ziguinchor (south of the Gambia) were excluded from this study due to lingering security issues in the region.

Under these conditions, the present paper will examine which user characteristics and individual level perceptions motivate participation in the management of water supply systems. Insights from this research will provide suggestions for facilitating sustainable CBM of water supply systems in locations with similar conditions.

The outline of this paper is as follows. First is an overview of the characteristics of the resource in question: the motorized piped water supply system in Senegal. Then ASUFOR (Association d'Usagers de Forages), the formal institutional arrangement governing the management of this infrastructure in Senegal, is described. Next is a discussion of the theoretical model of resource user perceptions and collective action for resource management. This is followed by a description of data and methodology used in the study, as well as results from the analysis. The paper closes with discussion of the findings and policy implications.

1. Senegal and its rural water supply system

(1) National background

Senegal is located on the western tip of the African continent and has a population of about 10 million. It has one of the highest urbanization rates in Africa, with some 42% of the population living in urban areas (United Nations 2008). Most of the population – nearly 70% of the total – is concentrated in Dakar, the capital, and surrounding regions. Hence the population density in the remaining areas is only about 30 persons/km^2, well below the national average of 50 persons/km^2 (ANSD 2007a).

The country is in the tropical climate zone and has a dry season running from November to May and a rainy season running from June to October. The rainy season accounts for 80% of the precipitation. Precipitation generally increases as the latitude decreases from north to south. Most areas north of the Gambia River are classified as arid or semiarid.

With low population density and generally dry climate, residents of Senegal's rural areas tap groundwater for domestic use (including water for livestock) in addition to accessing other sources, including streams, standing water and rainfall. It is estimated that the average volume of renewable groundwater in the entire country is 4,747 m^3/person/year, far more than the international benchmark level signaling water shortage: 1,000 m^3/person/year. In general, therefore, Senegal is considered relatively rich in ground water resources, except in the south-eastern part of the country where basement rock platforms extend (CTB 2007).

(2) Regional background

The southern regions of Tambacounda and Kédougou are comprised of three administrative departments. They are divided into 27 and 11 rural communities, respectively, and further sub-divided into 1,972 and 279 villages. As of 2006, there was a population of some 690,000 living within 56,602 km^2 (ANSD 2007b, JICA 2009). The region's population density is 12 persons/km^2, the lowest in Senegal.

The average annual rainfall in Tambacounda and Kédougou over the past 20 years, was 682mm and 1,064mm, respectively (JICA 2009). This is relatively humid by the Senegalese standard. Because geological conditions make it difficult to tap ground water from deep aquifers, villagers use a variety of water sources for their domestic purposes. According to a study conducted by the Senegalese government, 36% of the surveyed households in Tambacounda and Kédougou own shallow wells (ANSD 2007b).

Senegal is a multi-ethnic society composed of more than 20 ethnic groups. Among them, Wolof, Serer, and Fulbe or Haalpulaaren (Pulaar speakers) predominate, comprising more than 80% of the total population (Vilallon 1995). The southern region is even more diverse ethnically due to its geographic proximity to neighboring countries. The main ethnic groups in Tambacounda and Kédougou include Fulbe, Soninke, Mandinka and Bambara; and in Kédougou there also are Bassari.

(3) Rural water supply systems and governance structure

One of the unique characteristics of rural water supply systems in Senegal is that they rely extensively on borehole water supplied by motorized pumps. This is because due to Senegal's hydro-geological characteristics, in most parts of the country exploitable aquifers are located deep underground (i.e., between GL -200m and GL -400m on average). Today there are more than 1,300 motorized systems throughout the country, including those managed by NGOs and privately owned. The pumps are driven by grid electricity, internal combustion engines (diesel), and photovoltaic electricity. These systems serve approximately 4.4 million people (3,400 persons per system on average) in 5,100 villages. Water is delivered through more than 10,800 public standpipes and through more than 67,000 private connections. There is an estimated output of 120,000 m^3/day (DEM 2009). In the southern regions of Tambacounda and Kédougou, there are as many as 130 systems.

At the central government level, the Directorate of Exploitation and Maintenance (DEM) is responsible for the operation and maintenance of water supply systems. Under DEM, there are three regional head offices for maintenance (Sub-division de Maintenance: SM) and 15 regional maintenance centers (Brigade des Puits et Forages: BPF). While the former (SM) conducts major repairs (e.g., submerged pumps, power generators and boreholes), the latter (BPF) is in charge of facilitating and monitoring water user association (WUA) activities as well as providing the associations with technical advisory services.

In 1984, under a structural adjustment policy, the government withdrew from operation and maintenance activities and transferred management responsibilities to the WUAs, now called "Management Committees" (Comités de Gestion: CdG), while retaining infrastructure ownership rights.

(4) Institutional arrangements introduced under the 1996 reform

The Water Sector Reform launched in 1996 further promoted decentralization of management responsibilities by reinforcing the democratic representation of user-villagers in WUAs and also by introducing private sector participation in facility maintenance.[2] As part of the reform, the CdG became ASUFOR. By the end of 2008, of the 1,215 government-registered sites with motorized water supply systems, nearly 700 (57%) had shifted to this new arrangement with support from the government and various development partners. The southern regions of Tambacounda and Kédougou, however, fell behind; only 30% of their sites have been converted to the new arrangement (DEM 2009).

The new institutional arrangement introduced under the 1996 Reform, including the establishment of ASUFOR, can be characterized by the following: i) reassignment of operation and maintenance responsibilities between the government and users; ii) collection of water tariffs according to consumption volume; and iii) transformation of the WUA structure to promote broader and more direct user participation, thus making ASUFOR a true community-based organization. Each of these features is described now in further detail:

Firstly, under this arrangement, there was a reaffirmation that the users bear primary responsibility for operating and maintaining the water supply systems while the government regulates and coordinates technical support services.[3] The users, who are responsible for water tariff collection and management, undertake the daily operation of the system, the routine maintenance and minor repairs, and the replacement of pumps and generators using the tariffs collected. The government, which is the owner of the facilities, is responsible for providing leadership, for technical and managerial skills training to assist with ASUFOR formations, for monitoring the operational and management status of facilities and ASUFORs, for providing technical support in the case of breakdown, and for carrying out major infrastructure repairs and replacements such as boreholes and water reservoir tanks.

[2] The issue of private sector participation – contracting periodic maintenance to private sector service providers – is not covered in this paper, though it is an interesting initiative.

[3] Previously, the division of labor between the government and CdG was not clear. The official understanding was that user-villagers were responsible for operation and maintenance of the facilities, including collection and management of tariffs. However, it was often wrongly thought that the government remained responsible for managing the facilities as had been the case till the end of 1970.

Secondly, water tariffs are collected according to volume consumed as measured by water meters installed at each water point.[4] The unit price is set between 200-400 CFA francs/m^3 depending on the site/location.[5] The price takes into account direct running costs (e.g., fuel or electricity costs, remuneration for pump operators), routine maintenance costs (e.g., lubricant, spares) and major repair/replacement costs (e.g., repair of submersible pumps, generators).[6] Those who have a private connection in their compound are supposed to pay their bill monthly while those who use public standpipes pay for each container each time they fill it. In this latter case, the unit price is set according to container volume (e.g., 10 CFA francs per 20 litter container, an equivalent of 400 CFA francs/m^3).

Finally, upon launching an ASUFOR, all persons who anticipate using the water system are required to register as association members and pay a membership fee (normally 100 CFA francs per member). In principle, only those who pay the membership fee are entitled to fetch water from the facility. The intent is to create a clear boundary of users and tightly control access to the facility.

There are three tiers of organizations within an ASUFOR, namely the General Assembly of users (Assemblée Général: AG), the Committee of Directors (Comité Directeur: CD), and the Secretariat (Bureau Exécutif: BE). The AG is ASUFOR's supreme decision-making body to be attended by all users and held annually unless specially convened. All important matters pertaining to ASUFOR management are discussed in this meeting including adoption/revision of rules and tariff, decisions on major repair/rehabilitation work,

[4] Under the previous CdG arrangement, most committees had implemented a monthly flat rate for water use. Depending on the site, this monthly rate ranged between 100-500 CFA francs for each married woman within a compound called a "carré" (a unit of an extended household comprising two or more nuclear families, unmarried males, migrant workers and occasionally religious disciples who live in the compound and share its meals). According to a study of motorized and handpump sites in the southeastern regions of Senegal, including Tambacounda and Kédougou where the CdG arrangement still prevails, 66% of the respondents were not paying the tariff (JICA 2009).

[5] In this paper, CFA franc converts to 1 US dollars at the rate of 655 francs per dollar (0.0015 dollar per CFA franc), based on the prevailing rate in September 2009.

[6] According to the water supply systems design manual prepared by the Government of Senegal, the standard water tariff includes the cost of operation (22%), replacement (21%), spares and minor repairs (12%), major maintenance (7%), and organizational expenditures necessary to run ASUFOR (37%) (PEPAM 2006).

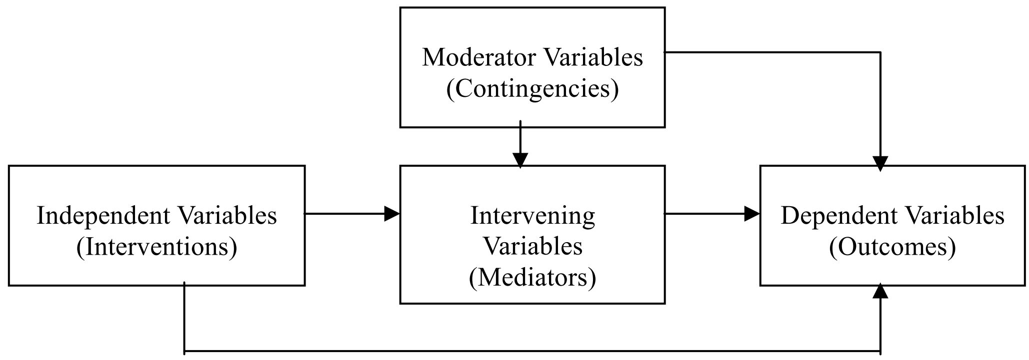
and approval of the year's accounting report. The CD is comprised of members who represent various of the village's social and interest groups (e.g., women's groups, pastoralists, ethnic groups, users of different water points) elected by the users. The BE is selected from among the CD members. BE and CD are expected to meet monthly for discussion and to make minor decisions on issues related to operations, maintenance and accounting. The outcomes of the meetings are to be communicated to the users. All CD and BE members serve two years terms, unless otherwise requested by the users. With these participatory arrangements, downward accountability is enhanced.

Before launching ASUFOR nationally, pilot projects were carried out in a semi-urbanized area of Dakar. This experimentation yielded a remarkably positive outcome in terms of enhanced financial capacity of the WUAs. ASUFOR savings averaged about 10,000 US dollars per site compared to an average savings of 0 to 5,000 US dollars in the rest of the country under the previous arrangement (Direction Nationale de la Planification 2008).

2. Theoretical framework

Numerous case studies and laboratory experiments have been conducted during past decades in conjunction with studies of the commons. Through these efforts, it has become clear that the real world is highly complex and that identifying the causal relationships among key sets of variables is a challenge (Agrawal 2002, Meinzen-Dick et al. 2004, Stern et al. 2002). In a separate article (Hanatani 2010), one of the authors of this paper, reviewed existing literature on the subject and found that the work by Stern et al. (2002) is among the most useful in developing a causal model that explains how certain characteristics of the resource and user groups are linked to resource management outcomes. Their model is notable in that it classifies the factors identified in the commons literature into four types of variables - independent, dependent, moderator, and intervening – in accordance with their functions. This is presented in the following schematic diagram:

Figure 1. Schematic causal model proposed by Stern et al.



Source: Adapted from Stern et al. 2002 with modification by the authors

In this model, *independent variables* are the factors that can be altered by policy interventions. They include institutional arrangement and technology choice. *Dependent variables* are the outcomes of collective actions including institutional durability and resource use efficiency. *Moderator variables* are factors that cannot be altered by short-run policy interventions, such as characteristics of users and resource systems, but which may influence how interventions affect intervening variables and outcomes. Finally, *intervening variables* are those that directly affect dependent variables (outcomes) but are influenced by independent variables (interventions) and moderator variables (contingencies). They cover 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.

According to this model, the independent, moderator and dependent variables are mostly externally observable, but the intervening variables are best described as agents' subjective perceptions/judgments of the situation surrounding resource use and management. By including moderator and intervening variables, the model helps in understanding that the effect of policy interventions (independent variables) or resource and resource users' characteristics (moderator variables) on the outcomes (dependent variables) are not only direct but also indirect in nature.

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. In this paper, we mainly focus on the effect of the latter. Specifically, the paper evaluates how resource user perceptions motivate collective actions for resource management in the context of southern Senegal.

(1) Dependent variable: Water tariff contribution

In the present paper, water tariff contribution is regarded as a result of collective action[7] necessary for successful resource management. The water tariff contribution under ASUFOR arrangements covers both the cost of maintenance and replacement of facilities/equipment and the cost of water supply and extraction.

Besides making payments, ASUFOR members may attend various meetings. But since the vast majority of the associations do not keep meeting attendance records, confirming user participation has proven difficult. In general, the users recognize that their contribution to resource management is embodied in their tariff payment.

We hypothesize that tariff payment, an indicator of collective action, is fostered by user motivation to *use* as well as to cooperate in *managing* the resource. The distinction between *use* and *management* of the resource is critical in this study because two different types of resources are involved: i.e., the water supply system and the groundwater itself. The water supply system is merely the machinery by which groundwater is extracted and supplied. For users, what matters most is the actual water they consume; motivation to cooperate in system management will be generated only when the need to use the water is met. If the water

[7] Length of downtime (service interruption), a measure often considered as a way to measure WUA's performance in system maintenance, was not used in the analysis as it is greatly influenced by other factors, such as the availability of spare parts and repair service by public and private service providers ,which are beyond the scope of the study.

supplied through the system does not meet user needs, therefore, gaining user cooperation in managing the system will be difficult.[8] The nature of the expected benefits from *using* and *managing* also are distinct. The benefits for consumers from *using* water are immediate (short-term) and enjoyed by individuals, while those from *managing* the supply systems are long-term and shared by all users collectively.

(2) Intervening Variables: Motivations to use borehole water *(Water preference and satisfaction*)

We posit here that two factors concerning water use motivate users' water tariff payment: their *preference* in the choice of water and their *satisfaction* from consuming borehole water. Existing studies have pointed to user "resource dependence," or "user demand" for the resource, as one of the conditions affecting successful collective action (Wade 1988; Fujiie et al. 2005; Agrawal 2002). These studies point to a prospective net cooperative benefit for users triggered by a critical resource shortage or resource supply risk as one of the critical factors motivating users to act collectively (e.g., Wade 1988). For this situation to occur, users must have sufficient interest in, or sufficient amount of prospective benefit from, use of the resource. Unlike natural resources that have traditionally been exploited by users (such as forests, wildlife and fishing grounds), resources provided by development interventions are often "new" to users. People will have normally exploited conventional water sources (e.g., shallow wells, surface water, or rainwater) and these will be in competition with the newly provided source.[9] It is important, therefore, to determine whether the users will favor the new resource over the conventional ones. We argue that users will be more inclined to pay a water tariff when their preference/need for water from a borehole is stronger than

[8] The issue of management (conservation) of ground water resource is not covered in this study as it is not part of CdG or ASUFOR responsibility.
[9] This situation aptly describes the conditions of southern Senegalese villages where an alternative water resource is readily available and has been conventionally used especially during the rainy season.

from other sources.

In addition to their preference/need for water from a borehole, user expectations have to be satisfied. Resource user perceptions of the benefits they will receive from using the water may be shaped by whether they are able to obtain the resource in an acceptable manner. This means that users can be expected to pay when they feel satisfied with the amount and quality of the water, the stability of the supply, and the cost associated with its acquisition. If those aspects are not satisfactory, people's sense of obligation to pay their dues may diminish, and/or they may turn to water sources which are normally free of charge. Customer preferences and satisfaction as critical factors influencing the motivation to pay for certain utilities, including piped water, are also emphasized in the "willingness-to-pay" (WTP) theory (e.g., TECHNEAU 2007).

(3) Intervening Variables: Motivation to cooperate for resource management

Intervening variables critical in understanding resource user motivation to cooperate in resource management are threefold: trust among peer resource users,[10] perceived sanctions, and perceived cooperative benefits.

Peer trust

Game theory literature points out that among players the possibility of cooperation for the provision of collective goods exists under two situations (e.g., Taylor 1987; Bardhan 1993). The first is a repeated non-cooperative game situation in which a cooperative equilibrium is sustained by the long-run interests of foresighted, self-interested individuals, if future payoffs are not heavily discounted or the short-run rewards for defecting are not too large (e.g., Axelrod 1968). The second is through an Assurance Game situation in which a self-interested player finds a pattern of payoff distribution that renders cooperation rational when the other cooperates, but defection rational when the other defects (e.g., Runge 1986). In both situations,

[10] In this paper, the word "peer" refers to other users who share the same borehole.

whether one trusts others (i.e., peers) is of crucial importance because of the implications it has for whether collective action will occur. Trust can be defined as "a quality of confidence in a relationship which permits one party to act before knowing that the other will behave as promised" (Wade 1988b, 489). Theoretical models indicate that there are a large number of equilibrium outcomes in a repeated non-cooperative game situation. Therefore, the level of trust held by the players serves a facilitative function in strategizing to reach a cooperative agreement (Bardhan 1993, 635). In order to cooperate in an Assurance Game situation, where the payoff distribution is clearly defined between two possible equilibria ("cooperate-cooperate" and "defect-defect"), players still need to trust other players.

Regardless of which kind of situation is adopted, we can say that user willingness to pay a water tariff is associated with the level of trust in other users. Those who trust that other users will pay are more likely to refrain from free riding and make regular water tariff payments than are those who do not trust.

Perceived sanctions

There is general agreement on the importance of rule/sanction enforcement in sustaining institutions. Agrawal, for instance, indicates that "strong enforcement" is a critical factor for durable institutions (Agrawal 2002). Stern et al. (2002) point out that factors related to rules/sanction enforcement – ease/cost of enforcing rules, user understanding of rules and sanctions, ease/cost of monitoring user behavior – are intervening variables that directly influence resource management systems. They also mention "users' adherence to shared norms" as a critical intervening variable. This highlights the importance of sanctions as perceived by users, themselves (e.g., Coleman 1990).

In addition, according to game theory the payoff from free riding must be suppressed by some form of sanction (e.g., law, guilt, shame, reputation, etc.) to a level lower than the payoff from engagement in the cooperate-cooperate strategy. The incentive to free ride will be reduced only when resource users have confidence that defectors will be sanctioned.

In the case of rural water supply management, sanctions are applied by the WUA executive body (CdG, or BE of ASUFOR) against those who fail to pay the water tariff. Sanctions may take the form of banning defaulters from fetching borehole water, levying fines, and/or exposing violators to public disgrace. It is crucial that water users believe in the effectiveness of these sanctions.

Perceived cooperative benefits

As discussed above, a user's prospective net cooperative benefit from participating in collective action may determine whether he will pay the water tariff or not. Users have to be aware not only of their benefits as individuals from using the resource, but also of the significant decline in benefits likely without their cooperation. Furthermore, if the benefits from cooperation are perceived to be lower than the benefits from some other strategy or combination of strategies, the user's best perceived strategy might be non cooperation (Ostrom et al. 1994, 62).

Cooperative benefits correspond to *long-term* and *communal* benefits accrued from joint management. Those who are aware of the long-term benefits stemming from investment in maintenance activities may be more willing to pay. Communal benefits may be acknowledged by those who value a sense of togetherness among fellow resource users. These individuals can be expected to pay their water tariff since they wish to ensure a fair and adequate water supply for all members of the user community through proper maintenance of the system, including boreholes, water tanks, pipe networks and taps.

(4) Moderator and independent variables: Characteristics of households

There are several household characteristics that may influence payment behavior. They are: i) household economic level, ii) existence of private water connection, and iii) type of WUA to which the household belongs (ASUFOR, CdG, or some other management arrangement). These variables correspond to moderator and independent variables presented in

Figure 1 above.

Household economic level may affect water payment because it may influence both the decision to use the resource and the willingness to pay. Motorized water supply systems in Senegal provide water through standpipes installed in different locations within a village and through private connections that are set up within compounds. Since private connections reduce the labor and time constraints associated with fetching water, they make borehole water more attractive. In this way borehole water not only enhances user preference and satisfaction, but also motivates the required payment.

Finally, ASUFOR is a result of a policy intervention that introduced a distinct system of tariff collection (the volumetric system). We will examine whether the payment behavior of the residents under ASUFOR differs from that in non-ASUFOR areas.

3. Data and methodology

(1) Survey

Data for this paper are from a survey on WUAs collected in the southern region of Senegal from September 2009 to December 2009. This data comes from a larger national study of water supply systems in Senegal carried out by the JICA Research Institute. Interviews were conducted with Chefs de Carré (heads of compound) and water management committee members from randomly selected WUA sites (ASUFOR, CdG, and other management arrangements) equipped with working motorized borehole water supply systems at the time of the survey. For the purposes of this larger survey, the country was divided into three distinct regions (northern, central, and southern).[11] Within each of these three regions, preliminary work was done to compile a list of all WUA sites (518 sites in the north, 977 sites in the center and 266 sites in the south). For each region 10 sites were randomly selected from

[11] For purposes of sample selection, the country was divided into three areas: namely; (northern) Louga, Matam and St. Louis; (central) Thies, Diourbel, Kaffrine, Kaolack and Fatick; (southern) Tambacounda and Kédougou.

the list and a total of 10 compounds were randomly selected from each of those sites. Some WUA sites have satellite villages with water pipe or other connections from the central village. If a selected site did have satellite villages, one of those satellite villages was randomly selected and 10 of its compounds were randomly selected. In addition, 10 compounds from the central village were randomly selected. If the selected site did not include satellite villages (i.e., central village only), 20 compounds were randomly selected. Therefore, a total of 600 compounds consisting of 200 compounds from each geographical region ultimately were selected.

Two types of surveys were administered within each selected site: a management committee survey and a household survey. Members of the water management committee were asked to participate in a survey on the book-keeping, management, maintenance and operation of their water supply system. This survey was completed by a total of 227 members from 30 sites. The management committee questionnaire included questions ranging from basic features of the system used, recent breakdowns and maintenance/repair of equipment and facilities, and structure of the management body, namely BE and CD. The household survey was administered to the heads of compound, who by custom are in charge of paying the water bills. They were encouraged to be accompanied by a married female member who might be knowledgeable about water usage in their particular compound. This questionnaire included questions on water use, contribution to water supply, perceptions of other water users' behavior, evaluation of their water management group, and household background. This survey was completed by a total of 600 heads of compound from 30 sites.

As already noted, the present paper focuses on the social and motivating factors involved in water tariff payment at the household level in southern Senegal. Thus, the analysis here is based on the larger household survey data collected in the 10 sites in southern Senegal (n=200), all samples of which are located in a central village.

Table 1 presents a regional comparison of water management systems and other selected social and geographic variables extracted from the national study. None of the randomly selected sites in the south had satellite villages; all south compounds were found in central villages. This is unsurprising, since satellite villages are rarely found in the southern region. Among the 10 selected sites in the south, 3 are under ASUFOR management. This is relatively fewer than in the northern and central regions because ASUFOR is not as extensively implemented in the south. Geographically, southern Senegal is relatively remote, and due to its low population density, the average number of borehole water users is smaller than in the other two regions. Southern Senegal is also ethnically heterogeneous, diverse in terms of culture, language, and shared norms. Compounds in the region spend less than those in other regions, suggesting lower levels of monetary income. Although only a very small proportion of compounds in southern Senegal are equipped with private water connections, the vast majority have access to alternative water sources. This means that they are less dependent on the water supply resource in question. According to existing studies of resource management (Agrawal 2002), such conditions are identified as unfavorable for successful facilitating/sustaining management. Given these unfavorable conditions, we explore what motivates resource users to contribute to management success (i.e., water tariff payment). This investigation will be particularly meaningful in improving/implementing water management systems in other communities with similar unfavorable conditions.

Table 1. Summary statistics of selected variables by region

	North	Central	South
Number of sites	10	10	10
Number of villages	17	14	10
Number of satellite villages	7	4	0
Number of ASUFOR sites	5	8	3
Mean number of borehole water users per site	306	763	137
Proportion of carreé/households using alternative water source	0.51	0.61	0.94
Proportion of carreé/households with private water connection	0.69	0.13	0.11
Mean monthly expenditure per person (CFA Franc) [1]	8,633	6,350	6,032
Mean distance to nearest city	19.15	11.6	41
Mean ethnic heterogenity within village[2]	0.12	0.19	0.43
Mean proportion of females members of the management group	0.19	0.15	0.19
Mean proportion of management group members who are literate	0.88	0.77	0.66

1 One large outlier (123,000 CFA Franc) was found in the South. Excluding this outlier, the mean was 5445.

2 Ethnic heterogeneity is the probability that any two samples randomly extracted from a group belong to two different sub-groups. Larger values indicate more ethnically heterogeneous populations.

(2) Dependent variable: Water tariff payment

The dependent variable is head of compound payment of the water tariff. In the household questionnaire, respondents were asked to give their best estimate of the percentage of their water bill they usually pay without delay. The response options were 0%, 1%-20%, 21%-40%, 41%-60%, 61%-80%, and 81%-100%. Since responses were not distributed normally and most responses were concentrated in only two of the categories (0% and 81%-100%), this variable was recorded as a binary variable where 0=0%-80% and 1=81%-100%. Thus, this variable distinguishes households that normally pay more than 80% of their water bill and those who usually pay less than that.

(3) Intervening variables: User perceptions

Attitude towards water: Preference for borehole water

Respondents were asked how much they prefer water from the motorized borehole water supply system over other water sources for drinking and cooking. Responses to this question were on a 5 point scale where 5=very much, 4=much, 3=neutral, 2=not really, and 1=not at all.

Attitude towards water: Satisfaction with current water

Respondents indicated their degree of satisfaction with their current level of water supply service. Responses ranged from 5=very satisfied, 4=satisfied, 3=average, 2=not satisfied, 1=not at all satisfied.

Cooperative benefits: Long-term benefit

To assess household willingness to cooperate for long-term benefits, respondents were asked how much they are willing to pay now to prepare for a breakdown of the water supply facility that might occur one year later. Responses were on a scale of 1-5 where 5=very much, 4=much, 3=neutral, 2=not really, and 1=not at all.

Cooperative benefits: Communal benefit

To measure household awareness of cooperating to conjointly benefit their own community, respondents were asked, “Let’s suppose that you do not pay your water fee. Do you think that might negatively affect other users in the community?” Respondents reporting “yes” to this question were coded as 1 while those reporting “no” were coded as 0.

Perceived sanctions: Pressure to pay

Sanctions can come in various forms; also, individual perceptions of what constitutes a “sanction” may vary. Therefore, in this study, we use an indicator that captures individuals’ perceptions of sanctions broadly. We ask a question that measures perceived pressure in the event of non-payment: Specifically “If you do not pay for the water, do you expect people in your community to put much pressure on you to pay?” Responses ranged from 1 to 5, where 1 represents great pressure and 5 represents no pressure at all. Thus, this variable assesses whether people perceive that non-conforming individuals are subject to pressure, both official pressure as part of rule enforcement (which can result in a sanction) and social pressure (which can affect one's self-respect).

Peer trust: Current payment

The household questionnaire includes two questions that capture peer trust. One relates to trust in peers to pay their current water bill. Respondents indicated the degree of their belief that other users of the water system will pay their own water bills. The scale was 5=every user pays fully, 4=many users pay fully, 3=some users pay fully, 2=some users do not pay at all, and 1=no user pays at all. A larger response code indicates a higher degree of peer trust.

Peer trust: Future payment

The second peer trust question relates to trust in peers to pay in the future. Respondents reported their expectations that other users of the water system will pay their bills in the future on a 5 point scale ranging from 5=every user will pay fully, 4=many users will pay fully, 3=some users will pay fully, 2=some users will not pay at all, and 1=no user will pay at all. Again, larger response codes reflect higher degrees of trust in future peer treatment.

(4) Background variables (moderator and independent variables)

Household expenditure per person

It is imperative in this analysis to take into account household income level, since it may influence payment behavior regardless of willingness. However, at the pretest stage of questionnaire development it was found that collecting precise information on monetary income is difficult in these Senegal communities. Since households had a better sense of their monthly expenditure, data on average monthly household expenditure was collected and used. Reported monthly household expenditure was divided by the number of residents in the compound (to account for compound size), yielding a proxy variable for household income.

Private water connection

Whether a compound has a private water connection in the back yard or residents have to commute to a shared borehole may also affect motivation for water bill payment. To control for this effect, a dummy variable distinguishing compounds with a private connection (coded as 1) and those without (coded as 0) is also included in the analysis.

ASUFOR

As described earlier, ASUFOR management has developed a distinct system for tariff collection. Thus, compounds in sites under ASUFOR management may have different expectations for payment than those under other arrangements (i.e. CdG). To account for this, a dummy variable for ASUFOR management is included in the analysis. Compounds in sites under ASUFOR management are codes as 1; others are coded as 0.

(5) Methodology

All results are based on a sample of 184 compounds for which we have data on all of the variables included in the analyses. We first present descriptive statistics of all variables. Then, t-tests, chi-square tests, and logistic regression analyses are performed using the water tariff payment (pays more than 80% or not) as the dependent variable and other aforementioned variables as predictors. We thus examine perceptions and other factors affecting water payment in southern Senegal.

4. Results

Table 2 presents descriptive statistics of all variables included in the study. Approximately 31% of water users report paying their water bills. Overall, there is high level of preference for borehole water use, trust in other users to pay in the future, perceived pressure to pay, and willingness to cooperate for long-term and communal benefit.

Table 2. Descriptive statistics of variables in the study (n=184)

	mean (prop.)	S.D.	min.	max.
Dependent variable				
Water payment	0.31	0.46	0	1
Explanatory Variables				
Water use:				
Preference to use borehole water	4.14	1.13	1	5
Satisfaction with current water	2.46	1.51	1	5
Peer trust:				
Current payment	3.03	1.36	1	5
Future payment	3.92	1.01	1	5
Perceived sanction:				
Pressure to pay	3.55	1.11	1	5
Cooperative benefits:				
Long-term benefit	3.92	1.03	1	5
Communal benefit	0.88	0.33	0	1
Background variables:				
Household expenditure per person (CFA Franc.)	5925.38	10617.22	769.23	123000.00
Private water connection	0.11	0.31	0	1
ASUFOR	0.41	0.49	0	1

Table 3 shows how the explanatory variables are related to water tariff payment at the bivariate level. Significant mean differences reveal that those who prefer borehole water and are satisfied with the current water supply are more likely to pay their water bills than are others. In addition, level of trust that other users pay their bills (currently and in the future), perceived pressure to pay, and willingness to cooperate for long-term and communal benefit all influence water payment in the hypothesized direction. Those who have private water connections are more likely to pay than their counterparts who rely on public standpipes. Contrary to our expectation, there is no statistically significant difference between ASUFOR and non-ASUFOR sites in the percentage of compounds that pay.

Table 3. Means, standard deviations and percentage distributions of variables by payment (n=184)

	Non-payment	Payment
Total (%)	69.02	30.98
Attitude towards water:		
Preference to use borehold water (mean, SD)***	3.89 (1.24)	4.70 (.53)
Satisfaction with current water (mean, SD)***	2.07 (1.33)	3.33 (1.53)
Peer trust:		
Current payment (mean, SD)***	2.66 (1.38)	3.86 (.88)
Future payment (mean, SD)***	3.76 (1.07)	4.26 (.77)
Perceived sanction:		
Pressure to pay (mean, SD)***	3.35 (1.12)	4.00 (.96)
Cooperative benefits:		
Long-term benefit (mean, SD)***	3.76 (1.09)	4.28 (.75)
Communal benefit: ††		
Yes (%)	65.43	34.57
No (%)	95.45	4.55
Background variables:		
Household expenditure per person (mean, SD)	5453.83 (7781.94)	7024.23 (15910.03)
Private water connection: †††		
Yes (%)	30.00	70.00
No (%)	73.78	26.22
ASUFOR:		
Yes (%)	66.67	33.33
No (%)	70.64	29.36

** p<.01, *** p<.001; Significant mean difference between those who pay and don't pay
†† p<.01, ††† p<.001; .Significant overall chi-square for the association between payment and the independent variable

Table 4 gives results from logistic regression analysis that examines the effect of explanatory variables on water tariff payment. Measures of peer trust in future payment, willingness to cooperate, and perceived pressure to pay that are significantly correlated with tariff payment in bivariate analyses are no longer significant when controlled for other predictors in the model. The results indicate that preference for borehole water use and satisfaction with current water supply are strong predictors of water payment net of other factors and that those who trust other users to pay current fees are more likely to pay their own fees. None of the background (independent and moderator) variables are related to water payment when controlled for other variables.

One may be concerned that the household background variables are endogenous to the perception variables (motivational factors) in the model. This potential issue of endogeneity could not be tested due to the unavailability of appropriate instrumental variables for the present survey. However, we ran a supplementary analysis in which we regressed water payment on the perceptional variables only, excluding the background variables. Results from this supplementary analysis showed that removing the background variables does not change the findings of the perception variables at all. Preference to use borehole water, satisfaction with current water, and peer trust (current) were all significant ($p<.01$) in the same direction as in the original model. This suggests that the issue of endogeneity is not a major concern.

Table 4. Logistic regression estimates for determinants of water payment

	β	S.E.	Odds ratio	
Attitude towards water:				
Preference to use borehole water	0.877	0.328	2.403	**
Satisfaction with current water	0.389	0.139	1.476	**
Peer trust:				
Current payment	0.599	0.201	1.820	**
Future payment	0.131	0.290	1.139	
Perceived sanction:				
Pressure to pay	0.213	0.252	1.237	
Cooperative benefits:				
Long-term benefit	0.198	0.260	1.219	
Communal benefit	0.744	1.153	2.104	
Background variables:				
Household expenditure per person (CAF Franc.)	0.000	0.000	1.000	
Private water connection	0.511	0.622	1.668	
ASUFOR	0.358	0.418	1.431	
Constant	-10.805			
-2 log likelihood	-77.878			
χ^2 (d.f.)	72.01(10)			
n	184			

* $p<.05$; ** $p<.01$

5. Discussion and policy implications

(1) Discussion

Our results suggest that users' preferences for borehole water use and their satisfaction with the service provided by their water supply system are important determinants of their payment behavior. The findings indicate that in order to motivate water users to contribute to resource management, water must be provided to them in a preferred and satisfactory way.

On the other hand, contrary to our expectation, in our analysis the relationship between awareness of benefits from cooperation (both long-term benefits and communal benefits) and water tariff payment is not significant. This implies that resource users are more interested in individual and immediate benefits than in collective and long-term ones.

These two findings appear to be in line with Olson (1965) who argues for the importance of "selective incentives" and with Baland and Platteau (1996) who asserts the need for "special economic incentives" to motivate users to participate in collective efforts.

In general, users are willing to use the resource and manage it wisely if the resource is in short supply (relative to the demand). However, it is conceivable that perceived cooperative benefits are not associated with payment behavior in southern Senegal since alternative water sources are relatively abundant in the region. One of the most distinctive qualities of borehole water is its hygienic quality, and it is often assumed that people are constantly and desperately in need of safe water. In reality, fetching "safe" water is not a priority for everyone, especially when there are alternative, more convenient sources. For instance, when considering the burden associated with waiting in a long line to fetch borehole water and/or carrying heavy water containers over a long distance, the benefits of using water from other more convenient sources may outweigh those of using "safe" water from boreholes. In these situations, users may find it difficult to contribute to maintenance of the water supply system out of consideration for long-term and collective benefits.

In southern Senegal, the payment behavior of borehole water users is affected by their perception of other users' current payment behavior. This finding lends some support to past studies of the commons which argue theoretically that peer trust – trust in other player's strategy of action – does influence collective action. Users of borehole water supply systems in southern Senegal appear to behave rationally by responding to others' current behavior when deciding whether or not to cooperate in collective action. An interesting implication is that even in an ethnically heterogeneous society like southern Senegal, trust among users does exist and is a critical element for cooperation among resource users. This means that as long as there is some level of trust within user groups, social homogeneity may not be necessary for users to be cooperative for resource management. Understanding how such trust develops in an ethnically diverse society merits further investigation.

Previous evaluation studies of donor interventions have found that ASUFOR and the use of household water connections have a positive impact on water tariff payment in other parts of the country (CTB 2008; Direction Nationale de la Planification 2008). However, our study does not find that residents in the areas under ASUFOR management differ significantly from those under other types of management. Having private water connections also is not related to payment behavior. This may be due to the fact that only a limited number of ASUFOR sites and households with private water connections ware included in our sample. Further study is needed to assess the impact of those factors on water management in southern Senegal.

In sum, our results indicate that users' *preference* for and *satisfaction* with the water, as well as their *trust* in other users' current payment behavior, are important intervening variables that influence collective action in southern Senegal. Put another way, when users have a high preference level for and satisfaction with the resource, and when they have a high level of trust in their peers, collective action for resource management can be generated even in societies that lack social and physical conditions favorable to resource management. This is encouraging for practitioners trying to establish sustainable resource management systems because, unlike conditions that are beyond their direct control (moderator variables such as resource system characteristics and resource user characteristics), intervening variables can be influenced by appropriate policy interventions (independent variables).

(2) Policy implications

Future development interventions in the area of community-based management of rural water supply systems, particularly those with motorized pumps, can benefit from our results in the following areas.

i) The role of *peer trust* in realizing sustainable resource management merits attention for future development interventions intended to establish or strengthen resource management organizations. Stakeholder participation in familiarization and mobilization processes may enhance interest and preference for using a resource at the individual level, but conventional interventions have done little to improve relationships among users. In order to achieve sustainable resource use and management, future interventions should focus on cultivating peer trust among users by incorporating context-specific programs. It may be particularly important to help promote trust in an ethnically and culturally diverse environment like southern Senegal. Ensuring fairness in the allocation of benefits from the common resource (Baland and Platteau, 1996) might also be emphasized in specific policy interventions designed to generate peer trust. However, how peer trust can be cultivated among the users of a resource remains an unanswered question, to be investigated in future research.[12]

ii) In designing interventions, understanding how users value a resource in

[12] See, for example, the debate on the development of social capital (including generalized trust). A "society-centered" approach emphasizes the influence of social interactions and an "institution-centered" approach views social capital as shaped by governments, public policies and political institutions (Hooghe and Stolle 2003).

comparison to alternatives will give a better understanding of their *preference* for that resource. This is because in order to motivate users to contribute to resource management, the resource must be designed and provided in a way that meets and satisfies their needs. In resource affluent contexts, the resource provided by the intervention may not be more attractive than others; that is, beneficiaries might value the conventional resource (e.g., a shallow well with unsafe water within the compound) over the superior one provided by the intervention (e.g., borehole standpipe with safe water located 100m away). A careful assessment through social surveys and/or focus groups of the lifestyle, values and needs of potential users is necessary to better inform target site selection, facility design and sensitization processes.

iii) Policy interventions aiming at improving the management of water supply systems should also cover infrastructure improvement. Providing improved services through renewed/rehabilitated facilities (i.e., improved hardware) before the devolution of management responsibilities to users will help *satisfy* user needs and generate user interest in contributing to management organizations (i.e., software improvement). Once facilities are handed over to the users in working condition, management bodies like ASUFOR should be strengthened to take proper care of the facilities and to continue providing satisfactory services. Thus, development planners must consider designing and implementing both hardware and software components in an integrated manner. Interventions in hardware should be undertaken cautiously, however. To strengthen trust among users, benefits and burdens must be distributed in a fair and equitable manner within the community without creating or exacerbating social and economic disparities.

In summary, future interventions for sustainable water systems must motivate users by closely assessing their needs and providing improved services/facilities. At the same time, incorporating context-specific programs to promote trust among peer users within community-based schemes is strongly recommended

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Abstract (in Japanese)

要約

　サブサハラアフリカにおいて「安全な水」へのアクセス改善は貧困削減に向けた重要な課題であるが、その実現を阻む一つの要因として給水施設の不適切な維持管理がある。本研究は給水施設の住民管理の可能性と限界に着目し、南部セネガルの村落で実施した質問票調査を元に、動力式村落給水施設利用者の認識と、彼らによる協力的な維持管理行動の関連を検証した。利用者による水価支払い意欲を協力的な維持管理行動とし、ロジスティック回帰分析を行った結果、給水施設から供給される水を好み、利用の満足度が高い利用者ほど水料金を支払う傾向にあることが判明した。また、他の利用者が料金を支払っているという確信を持てない者に比べ、他のユーザーを信頼している者は水料金を支払う傾向にあった。今後有効な援助事業を行うためには、給水施設の利便性や水質等、利用者の多様なニーズを把握し、それらのニーズに見合ったサービスを提供することが重要であるとともに、利用者間の信頼関係強化に着目した住民管理組織形成支援を行っていくことが課題である。

JICA Research Institute

Working Papers from the same research project

“Management of Water User’s Associations and Formation of Collaborative Local Society in Rural Africa”

JICA-RI Working Paper No. 23

Exploring the Causal Mechanism of Collective Action for Sustainable Resource Management: A Comparative Analysis of Rural Water Supply Systems in Senegal

Atsushi Hanatani