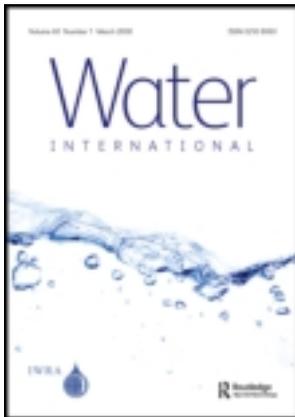


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Attitudes toward post-earthquake water and sanitation management and payment options in Leogane, Haiti

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The Haitian government passed a law in 2009 to decentralize water utility management and improve cost recovery. This study identifies the attitudes of the public towards payment for and management of water and sanitation, several months after the 2010 earthquake, through a survey ($N = 171$) and semi-structured interviews ($N = 19$) in Leogane, Haiti. A majority of survey respondents were willing to pay for water and sanitation, which aligns with the fee-based approach of the 2009 law. Significant differences were found between geographic locations, suggesting that a neighbourhood-level approach to water and sanitation is appropriate.

Keywords: water utility; cost recovery; willingness to pay; disaster recovery; Haiti

Introduction

Until 2009, governmental ownership and operation of water supply systems predominated in Haiti. Two national agencies, both based in the capital of Port-au-Prince, were responsible for water supply. One was known as CAMEP (Centrale Autonome Métropolitaine d'Eau Potable, or Central Metropolitan Drinking Water Authority) and was responsible for water supply in Port-au-Prince, while the second, known as SNEP (Service National d'Eau Potable, or National Drinking Water Service), operated in the other communes. However, in some instances the responsible public entities relied on local community bodies for some aspects of service provision and revenue collection. In lower-income areas of Port-au-Prince, local water committees known as *komité dlo*, created in the 1990s, sold water at public standpipes (Snell, 1998). Revenues were used to (1) reimburse CAMEP for the cost of the service, (2) pay salaries to water-committee members, and (3) reinvest in community projects, with the amount used for each subject to regulation. This system has been referred to as “social privatization” (GRET, 2010a), since the water committees are incentivized to collect revenue by the prospect of retaining a portion of the income, while the balance (after the water supplier has been paid) must be reinvested in projects for the good of the community. From another perspective, the water committees constitute quasi-governmental

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entities themselves, since the committee members are elected and have a responsibility not only to secure economic returns for themselves but also to reinvest revenue in the community. From this perspective, the water committees represent a dramatic decentralization of water supply management in Haiti, with day-to-day operations passing from national entities to a neighbourhood entity. This opens up the possibility of auditing and regulation of the managers of the water supply by higher levels of government and direct local accountability, which may improve responsiveness to local concerns. Decentralization of water and sanitation management is a crucial issue for disaster-prone regions, where centralized infrastructure may be more vulnerable to damage from extreme events such as tropical cyclones, earthquakes and coastal floods.

In March 2009, the *Loi Cadre Portant Organisation du Secteur de l'Eau Potable et de l'Assainissement* (Law on the Organization of the Water and Sanitation Sector) (Haiti, 2009) was passed, which reorganized the Haitian water supply sector to enable both private contract operations and local water-committee involvement in water supply. The law established the *Direction Nationale de l'Eau Potable et de l'Assainissement* (DINEPA, National Drinking Water and Sanitation Directorate) and provided it with regulatory authority for water supply and sanitation. Within DINEPA, a number of regional authorities (OREPAs, for *offices régionaux d'eau potable et d'assainissement* – regional drinking water and sanitation offices] became responsible for water supply, although these regional agencies may use private contractors or local water committees to administer water supplies. The moribund and bankrupt SNEP was supplanted by this new arrangement and ceased operations after a transitional period.

The premise of the new arrangement is that the provision of water and sanitation services can be self-financing on a local level through the levying of user fees that are subject to regulation by higher levels of government. An alternate view would be to provide at least a minimal level of publicly funded access to water, free of charge at the point of use, with the justification being that all human beings have a right for such a basic need to be met, regardless of ability to pay (McCaffrey, 1992; Palaniappan, Gleick, Hunt, & Srinivasan, 2004). Requirements for payment may also be met with resistance if users do not have confidence in water management institutions to use these revenues appropriately (Whittington, Briscoe, Mu, & Baron, 1990).

A large proportion of the Haitian population has little or no ability to pay for public services. Creative rate structures may help to provide services to all, while recovering costs in a sustainable manner. The less affluent may be offered some support, either by explicit subsidies or through a fee structure that charges minimal amounts for a basic water allotment and then increasing amounts for the larger usage volumes that are generally associated with the activities of higher-income users (use of automatic washers, landscape irrigation, etc.) (Whittington et al., 1990).

After the 2010 earthquake, the practice of providing free water and sanitation as a basic service became widespread as an interim measure in the many camps for internally displaced persons in Haiti. Efforts by the organizations running these camps to transition away from directly providing these services were in the planning stage at the time of this research. The Haitian water sector was at a unique transitional moment, as the decentralization of management and cost recovery from user fees envisioned by the 2009 water law was being phased in at the same time that emergency provision of free water and sanitation after the earthquake was instituted by non-governmental organizations. At this complex transitional moment, this study sought to document differing perspectives on the management of and payment for water and sanitation services during May–August 2010 in Leogane, a town located near the epicentre of the earthquake. These perspectives were

elicited through semi-structured interviews and a survey. This analysis provides a snapshot of stakeholder values, though it is recognized that these values and preferences will evolve over time. Documentation of stakeholder perspectives at this critical moment is, however, viewed as practically useful in helping to define where consensus exists and where additional deliberation is needed to arrive at socially acceptable policies. More broadly, the research contributes to the broader growing body of literature regarding the governance of water systems and services in different social contexts.

Study area

The commune of Leogane is situated 30 km to the west of Port-au-Prince and has roughly 300,000 inhabitants, of which roughly one-third live in the City of Leogane and the balance in its surrounding rural areas. Prior to 2008, residents of the City of Leogane and some adjoining towns benefited from a gravity-driven water supply system that delivered water both to homes and to public taps. The system was rendered inoperable during the 2008 hurricane season, when flooding of the Momance River washed out key pipes and other appurtenances. The system had not been rebuilt at the time of the earthquake.

Leogane's piped water system had been owned and operated by SNEP, but control was in the process of being transferred to DINEPA in accordance with the 2009 law. Many inhabitants continued to rely on wells. Water quality was generally considered poor in shallow wells but better in deep wells that tapped an artesian aquifer.

The city had no formal public sanitation system, as is the case throughout Haiti. Though some households had flush toilets connected to septic tanks that were emptied by hand, over half of our study participants relied on some kind of "dry" sanitation, such as a latrine, for sanitation before the earthquake; others practiced open defecation in the fields.

Methods

Data collection

The research team visited the area of Leogane, Haiti, twice, in May–June and July–August of 2010. During the first week-long trip, researchers conducted semi-structured and open-ended interviews, and administered a survey on infrastructure needs and preferences. During the second trip (also a week), the researchers conducted additional interviews and held a participatory stakeholder workshop.

Survey

During the first trip, the researchers trained six Haitian university students, who administered a paper survey in Creole throughout the Leogane region. The survey consisted of 42 questions about pre- and post-earthquake water and sanitation conditions, practices and problems. The survey included the "core questions" used by WHO and UNICEF (2006) for quantifying the percentage of a population that has reasonable access to water and sanitation and those at risk from flooding. Some questions (shown in [Table 1](#)) addressed participants' willingness to pay for water supply and sanitation, as well as their opinions regarding which institutions should be responsible for managing various aspects of water supply and sanitation. As conditions in post-earthquake Leogane did not permit representative sampling, convenience samples consisting of residents from the city, urban-peripheral and outlying areas of Leogane, respectively, were assembled. The use of a convenience

Table 1. Questions asked in the survey.

Question
<i>Payment</i>
Are you willing to pay for a reliable water supply?
Are you willing to pay for safe water?
Are you willing to pay for close access/proximity to water?
Are you willing to pay for a reliable sanitary system?
Are you willing to pay for close access/proximity to sanitary facilities?
<i>Management</i>
In the future, who do you think should be responsible for owning and managing the Leogane water system?
In the future, who do you think should be responsible for owning and managing the Leogane sanitary system?

sample means that the survey results may not be representative of the entire population of Leogane. However, demographic variables were tracked (gender, employment status, area of residence) so that the results could be weighted proportionately to reflect the fraction of the population originating from different groups. Figure 1 shows the locations where the surveys and interviews were administered, and Table 2 describes the areas in greater detail. A total of 171 participants were recruited from a variety of different demographic groups, as indicated in Table 3.

Contingency plots were developed using Microsoft Excel and SPSS 19 (IBM Corporation, Somers, NY), breaking down the results by gender, geographic origin, and employment status. Pearson's chi-squared tests were used to test the statistical significance of different responses by these groupings, with Fischer's exact test used when the expected count in any cell of the contingency table was less than 5.

Semi-structured interviews

Nineteen semi-structured interviews were conducted, with a referral sample beginning with initial contacts of the investigators with leaders of Haitian diaspora organizations. Once in Haiti, interviews of a socio-economically diverse sampling of current residents, returnees from abroad, and representatives of NGOs and government bodies were conducted. While the referral method is also not representative of the general population, this method gave the researchers contact with potential opinion leaders as well as with members of the general public.

Results

The results are presented in three sections. The first section presents results for water supply, and the second for sanitation. Within these two sections, results from the survey are presented in aggregate, with any differences among respondents based on geographic origin, gender, or employment status noted; then, the results from semi-structured interviews are presented. In the third section a summary of stakeholder impressions of different organizations is presented to add perspective to the specific results presented in the previous two sections. Data from the semi-structured interviews are also incorporated throughout, as these interviews further probed questions that were either not included, or not fully elaborated, in the survey.

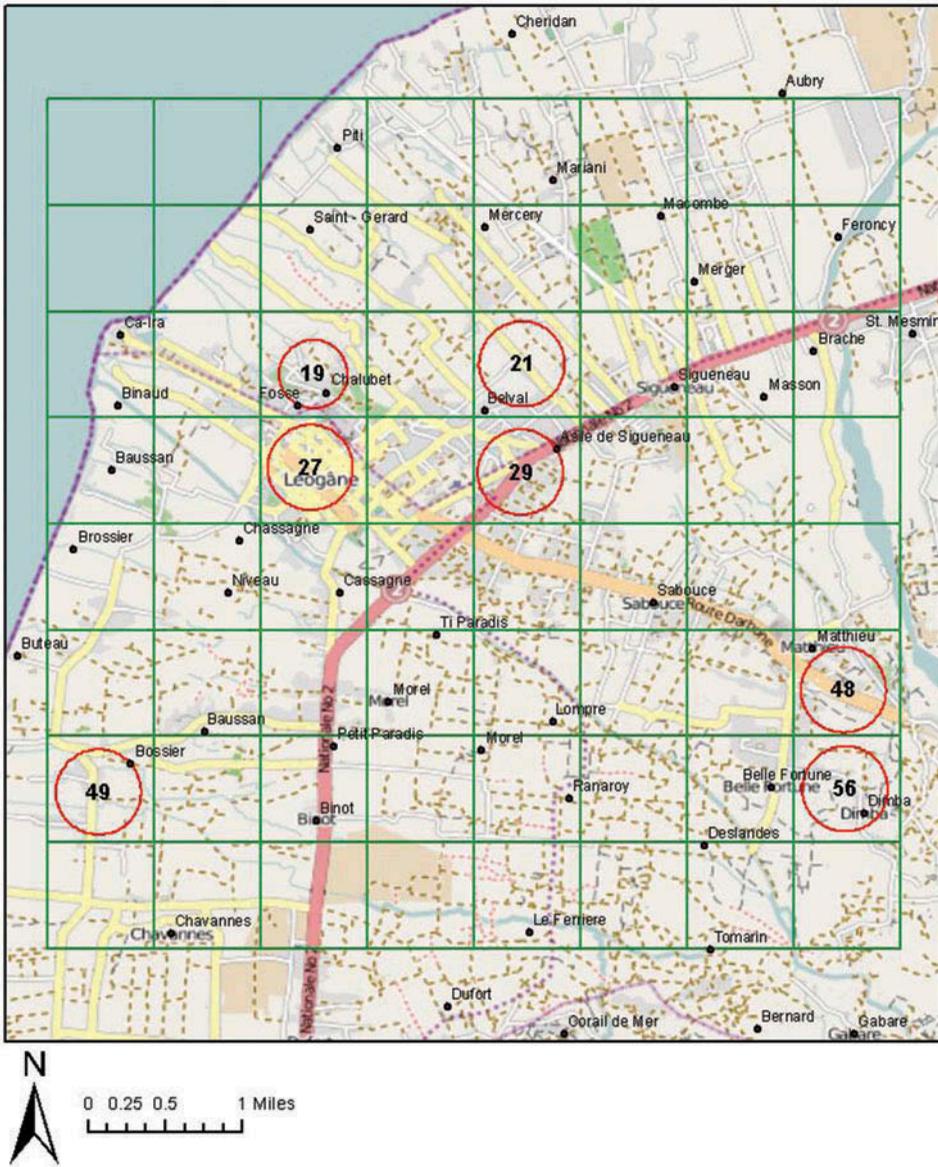


Figure 1. Map of interview and survey locations in the Leogane region of Haiti.

Water supply

The results of the survey’s willingness-to-pay questions, shown in Table 4, are generally supportive of the concept of payment for water supply. Specifically, 66.9% were willing to pay for a reliable water supply, 75.1% for safe water, and 76.2% for close access or proximity to water.

A contingency-table analysis was carried out to test for a significant difference in willingness to pay based on gender, geographic location and employment status. The tests showed a significant difference among geographic groups for willingness to pay for both

Table 2. Locations surveyed.

Location classification	Grid ID	Place/street names surveyed
City core	27	Bas Grand Rue, Georges Kernizan, Grand Rue, Rue Chatelain, Rue Danjous, Rue de la Liberte, Rue des Rampas, Rue La Goix, Rue Lavandye, Rue Lopital, Rue Noir, Rue St Catherine, Rue St Lawrent, Ruelle Pandou
City periphery	19	Fosse, Chalubet
Outlying areas	21	Belval
	29	Chatule
	48	Mathieu
	49	Degay, Beloque
	56	La Colline, Mapou, Mapou Bussonniere

Table 3. Demographics of survey participants.

	Number of respondents	Percentage of respondents
Age group		
18 years and under	3	1.8
19–30 years	54	31.6
31–50 years	54	31.6
51 years and over	46	26.9
Didn't answer	14	8.2
Gender		
Male	90	52.6
Female	81	47.4
Employment		
Employed	53	31
Unemployed	118	69
Location		
City centre	58	33.9
City periphery	17	9.9
Outlying areas	95	55.6
Didn't answer	1	0.6

close access to water and reliable water (Fisher's exact test, $p = 0.007$; Pearson's chi-squared test, $p = 0.044$), with participants in the city periphery more willing to pay for close access to water than participants from the city core or its more distant outlying areas. There were no significant differences among groups in willingness to pay for safe water, although residents of the periphery were slightly more willing to pay (94.1%) than residents of the city core (79.3%) and residents of the outlying areas (69.1%), and these differences approached statistical significance (Fisher's exact test, $p = 0.056$). No significant differences were found between genders or between employed and unemployed participants on any of the three questions on willingness to pay for water supply.

Willingness to pay for water was addressed in 79% of the semi-structured interviews. The proportion of the interviewees supporting payment (roughly two-thirds) was similar to the proportion of survey participants. Specific reasons cited for not supporting payment included a concern that the unemployed would be unable to pay. For example, one interviewee stated, "People would not pay for water . . . they don't have it [money]." Another participant felt that payment should vary by income level: "They need to pay, not much,

Table 4. Percentage of participants willing to pay for water, by location, gender and employment status. All values are percentages.

Question	Respondents who answered yes (% of group)							
	Overall	Location			Gender		Employment	
		City core	City periphery	Outlying area	Male	Female	Employed	Unemployed
Are you willing to pay for reliable water supply?	66.9	63.8	94.1	63.8	71.9	61.3	61.5	69.2
Are you willing to pay for safe water?	75.1	79.3	94.1	69.1	78.9	70.9	79.2	73.3
Are you willing to pay for close proximity to water?	76.2	81.0	100	68.8	76.4	75.9	80.4	74.4

but according to their income. Leogane [should] pay less than Port au Prince.” Another reason for not supporting payment was a lack of confidence in the institutions that would manage the funds and perform system maintenance. As one participant stated, “The idea is that when the problem comes we’ll deal with it.”

Many participants indicated that they already pay for water, for example through purchases of water sold in bottles or sachets (80 ml plastic bags of water that has been treated via reverse osmosis). Participants also stated that they purchase water from kiosks (small privately owned water treatment units that sell water to users with their own containers). Explaining that water was sometimes hauled from the kiosks by motorcycle, one interviewee expressed concern regarding the lack of local water supplies: “Sometimes they have the money for the water but not for the cab fare.” Treated water from the kiosks was reported to cost HTG 25 (USD 0.63, based on August 2010 exchange rates) for five gallons.

Preferences regarding ownership and management of the water supply, as expressed through the survey, are shown in Figure 2. This question was not posed to five subjects due to an error in survey administration. Thus, the sample size for this question is 166. The results indicate that a plurality (29%) of respondents would prefer that the national government own and manage the water supply, followed, in order of preference, by local government (18%), the private sector (12%), regional government (7.6%), and individuals (4.7%). A total of 19% did not provide a response to this question.

The results of the semi-structured interviews appear to differ from those of the structured survey. Ten of the 19 interviewees saw some role for local water committees, a significantly higher proportion than that of the survey participants. Most interviewees who saw a role for committees (7 of the 10 who favoured local committee involvement) envisioned a tiered system consisting of either (1) local government and committees (2 interviewees), or (2) the central government, local government and committees (5 interviewees). Although definitive conclusions cannot be drawn from such a small sample, it may be that the greater time for reflection allowed by the semi-structured interviews resulted in more favourable views of local committees. In addition, the open-ended format allowed more elaborate approaches to be described. Differences between the

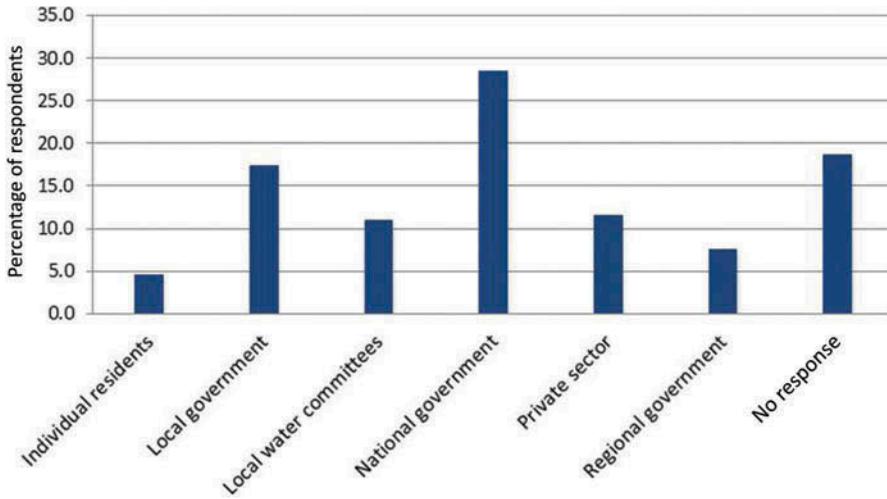


Figure 2. Percentage of participants who would like different groups to own, manage and operate the water supply system ($n = 166$).

semi-structured and interviews may also reflect differences in the sample populations, since the referral-sampling approach applied during the semi-structured interview process favoured the inclusion of individuals active in community organizations.

Sanitation

Over half of the participants were willing to pay for both reliable and nearby sanitation facilities. These values are lower than the percentages willing to pay for water. In contrast to their views on water supply, which reflected more willingness to pay for good access than for reliable water, the survey participants were more willing to pay for a reliable sanitary system than for close access to a sanitary facility.

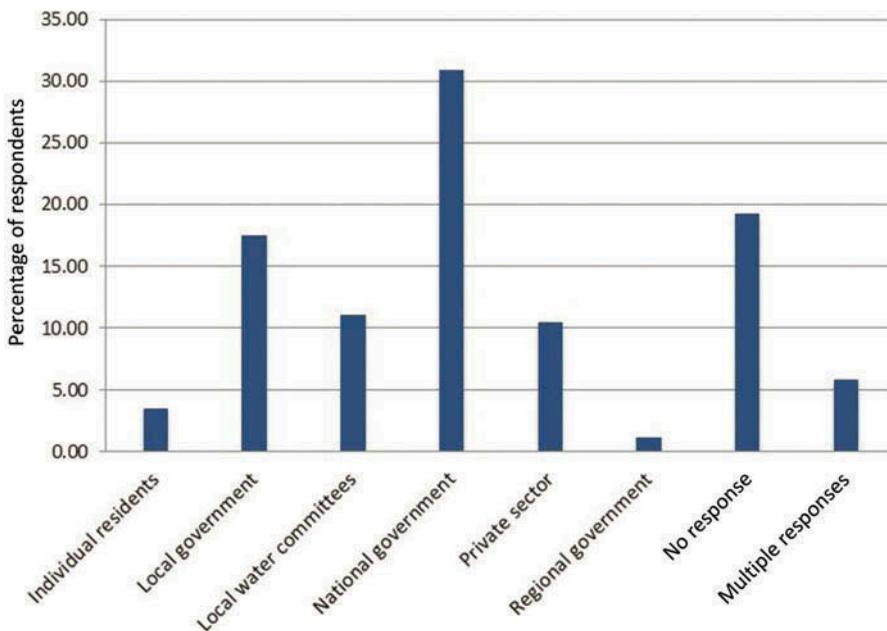
A chi-squared contingency analysis was used to test for differences in willingness to pay for close access to sanitation facilities between participants of different gender, geographic origin and employment status (Table 5). The test showed a significant difference among geographic groups (Pearson's chi-squared, $p = 0.002$), with participants in the city periphery (94.1%) more willing to pay for close access to a sanitation facility than participants from the city core (45.8%) or from outlying areas (50.5%). More men (61.4%) than women (44.3%) were also willing to pay for close access (Pearson's chi-squared, $p = 0.027$). No significance differences were found between the employed and the unemployed. When a similar test was performed on willingness to pay for reliable sanitation facilities, no significant differences were found among any of the different groupings (gender, employment status, or geographic location).

The topic of payment for sanitation systems was raised in only eight of the semi-structured interviews. While results from such a small sample cannot be considered representative, these interviewees were less likely to support payment for sanitation (3 out of 8) than for water (10 out of 15). Those supporting payment looked forward to a central toilet facility and showers at the market. Some of those not supporting payment for sanitation suggested that payment for sanitation might be included in payment for water, since they believed people would be likely more willing to pay for water.

Table 5. Percentage of participants willing to pay for sanitation, by location, gender and employment status. All values are percentages.

Question	Respondents who answered yes (% of group)							
	Overall	Location			Gender		Employment	
		City Core	City Periphery	Outlying Area	Male	Female	Employed	Unemployed
Are you willing to pay for close access/proximity to sanitary facilities?	53.3	45.8	94.1	50.5	61.4	44.3	57.7	51.3
Are you willing to pay for a reliable sanitary system?	65.3	66.1	82.4	61.5	70.5	59.5	67.3	64.3

The survey also addressed management of sanitation services. The question was not posed to five participants due to an error in survey administration, which resulted in a sample size of 166. Figure 3 shows participants' preferences regarding ownership and management of the sanitation system. As with water supply, a plurality (31%) prefer that the national government own and manage the sanitary system. The local government is

Figure 3. Percentage of respondents who would like different groups to own, manage and operate the sanitation system ($n = 166$).

second (18%), followed by local water committees (11%), the private sector (11%), individuals (3.5%), and regional government (1.1%). Some 5.9% of respondents identified multiple preferred options, and 19% did not provide any response to this question.

The management of sanitation systems was not raised in most of the interviews (11 of 19). In cases where it was raised, responses were scattered among the central government (favoured by two respondents), the local government (favoured by two), local committees (favoured by two), NGOs (favoured by one) and individual households (favoured by one).

General attitudes toward different organizations

As part of the semi-structured interviews, general attitudes were assessed towards the national government, local government, foreign non-governmental organizations (NGOs), and local organizations and committees. These results are summarized in Figure 4. Attitudes toward the national government were generally either unfavourable or neutral (47% each), with only 5% favourable. For example, one participant stated, “Six months after the earthquake, the central government has been incapable even of clearing the National Palace, let alone anything else.” Local government engendered a much higher percentage of favourable responses (16%), although unfavourable attitudes (37%) were somewhat more frequent than neutral attitudes (32%). No opinion of local government was expressed by 16% of interviewees.

Attitudes toward foreign non-governmental organizations were categorized as 26% favourable, 53% neutral, and 16% unfavourable, with 5% not addressing the issue. Favourable views of non-governmental organizations derived from gratitude for foreign assistance. Unfavourable views originated with a concern that qualified Haitians were not allowed to fill the more senior positions at these organizations; with the belief that the organizations themselves had collected large amounts of money from international donors for reconstruction, yet had not brought a commensurate level of assistance to the people of Haiti; and with a perception that their personnel were out of touch, driving around in sport utility vehicles and spending time at the beach, rather than dedicating themselves to their mission.

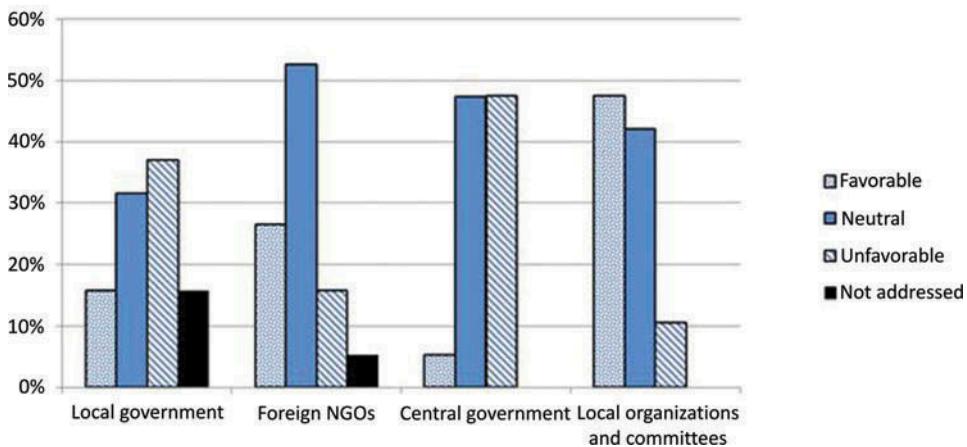


Figure 4. Attitudes towards institutions among semi-structured interview participants.

Attitudes toward local organizations and committees were generally favourable (47%) to neutral (42%), with only 11% unfavourable. One respondent mentioned that committees had been active in managing local water resources but that they had become inactive over time. Of the 11 respondents who addressed the issue of whether committee members should be paid for their time, 8 favoured payments, while 2 felt committee service should be done as a voluntary service.

Discussion

The results of any cross-sectional study have to be interpreted cautiously, and this is certainly true for the results of this study. Given the many transitions in progress at the time of the study, the knowledge and attitudes expressed here are expected to evolve with time. Nevertheless, the results characterize the study participants' baseline attitudes towards different water and sanitation infrastructure options at this point in time, i.e. before any major reconstruction efforts had taken place.

In some respects, the attitudes observed in this study were compatible with the governmental policies being pursued under the 2009 reorganization of the water sector. For example, the 2009 water law envisions water supply as being largely fee-based, and a majority of the study participants expressed a willingness to pay for both water supply and sanitation. The 2009 law also decentralizes water supply, a policy that could receive wide support, given that only 5% of semi-structured interview respondents had a favourable view of the central government. The law also envisions a greater role for water committees, a view shared by a majority of semi-structured interview participants.

However, some attitudes expressed during the study do not bode well for the 2009 law. For example, while the new law stipulates that administration of contracts and supervision of local committees are managed at regional offices, few study participants favoured any role for regional government in either water supply or sanitation. Instead, respondents to the survey preferred that the central government own and manage both water supply and sanitation infrastructure. This attitude was unexpected, given that the national government had failed in its administration of the water system in Leogane (i.e. the system had not been operational since 2008), and also because many semi-structured interview participants viewed the central government negatively.

These contrasting attitudes may be due to a reluctance of the study participants to criticize the government. In one semi-structured interview, for example, a participant stated outright that he was not comfortable talking critically about the central government. A different interview subject stressed the general authority and responsibility of the central government in Haiti. These observations suggest that the study may have picked up participants' normative assessments rather than their pragmatic considerations regarding the actual effectiveness of different institutions.

It is also worth noting that while a majority of participants expressed a willingness to pay for water and sanitation, a substantial minority did not. An effective planning process could not ignore this substantial sector of the population. On the one hand, if the overall economic situation in Haiti improves, concerns over ability to pay could diminish on their own. On the other hand, concerns about the potential misappropriation of funds might be mitigated by a concerted effort to enhance the transparency and accountability of the different governmental and non-governmental agencies and committees.

Another means of addressing the concerns of those residents who do not support payment for water and sanitation services is by sponsoring an exhaustive study of water costs in Haiti. Given that many individuals currently purchase water from private vendors, it would

be useful to compare the cost and efficiency of public provision of water to current private-vendor costs. For example, in Port-au-Prince, neighbourhood water committees sold water from the piped distribution system for HTG 0.2 (USD 0.005) per gallon (GRET, 2010a), which is far below the HTG 5 (USD 0.13) per gallon (see Results section) reported by for the private water kiosks in Leogane. (The committees actually purchased the water from the utility at HTG 0.05 per gallon, and the mark-up both covered the committees' operating costs and provided a small profit that was reinvested in the community following the "social privatization" model (GRET, 2010b).) Similarly, in 2009 DINEPA implemented payment for a piped water supply service in the city of St. Marc at a cost of HTG 0.24 per gallon (personal communication, Nouvellon, DINEPA, 1 June 2010). This price is comparable to that charged by the Port-au-Prince water committees and dramatically lower than the price for water from kiosks in Leogane. (Fees in St. Marc also include a connection fee of HTG 104 per month over three years. Ideally, such fees would be shared among groups of lower-income users. Even if they cannot be shared, the piped supply cost would remain substantially lower than the kiosk water for any reasonable household water consumption rate.)

Indeed, the diversity in opinions revealed by the study suggests that some form of public engagement will be necessary for the reorganization envisioned by the 2009 law, or some variation of it, to be successful. It is noteworthy that few study participants were even aware of the ongoing water-sector reorganization or of the recently established OREPAs.

At a minimum, an outreach campaign would explain to the public the central government's motivation for instituting the regionalization strategy, namely to more efficiently meet its obligation to provide needed infrastructure. While the public largely supports payment for infrastructure services, public-engagement efforts should be extended to elicit stakeholder input regarding how to ensure transparency in financial management and how to provide affordable service for those with limited ability to pay.

The convenience samples used in this study mean that the specific percentages are not necessarily representative of the entire population of Leogane. To make the findings more robust, the results would need to be re-weighted to reflect the population of each geographic region; but no such census data is currently available. It is notable, however, that majorities favoured payment for water supply and for reliable sanitation in each of the three geographic regions surveyed. The finding that a majority of study participants were willing to pay for close access to sanitation might not be robust with sample re-weighting, because it had only a small majority (53%) and was not favoured by residents of the city core. However, the statistically significant geographic differences in response to this basic question are one of many potential neighbourhood-scale differences in attitudes toward cost-recovery efforts that should be expected by government planners. The diversity in surveyed opinions suggests that a fine-grained approach to building support is necessary in which the attitudes and the socio-economic backgrounds of the residents of different neighbourhoods are addressed in the design of management and payment programs.

Local and community-level decision-making processes may suffer from weaknesses, such as (1) lack of technical expertise, (2) lack of incentives for individuals to participate in group processes, and (3) divergent interests among local stakeholders. However, there are some encouraging features in the decentralization approach being undertaken in Haiti. Technical support for the water committees in Port-au-Prince has been provided to local committees in the past by GRET, a non-governmental organization. The 2009 water law established regional offices of DINEPA (the OREPAs referred to above) that will provide technical support to local water supply entities, including a regulatory review of rates

(personal communication, Nouvellon, DINEPA, 1 June 2010). The 2009 water law also addresses the incentives issue (item 2 above) to some extent, as the rate structures allow for remuneration of individuals directly involved in water provision; and it is encouraging that payment for these services is supported by a large majority of the admittedly small number of interviewees in this study (see Results section). Some valuable lessons regarding this issue might be transferable from other projects in Haiti, such as Sustainable Organic Integrated Livelihoods (SOIL). Co-founder Sasha Kramer described the evolution of their approach to bringing “ecosan” biocomposting toilets to Haiti:

“When we first started, we were really interested in reaching the largest number of people possible,” Kramer says. “And we thought that the best way to do that was to build public toilets that were maintained by the community, and that everyone could have access to. . . . If you build something that is accessible to everyone, but that no one is paid to maintain, then it won’t be maintained. I think that this lesson could be carried into other sectors as well . . .” For SOIL, the lesson learned was that, ultimately, sustainable livelihoods are the most pressing need for people, and the key to lasting change. “That’s why we’ve moved away from public toilets, and into setting up a household sanitation system where people pay a small monthly fee to have their toilet waste collected,” Kramer says. (Wang, 2013)

This is indicative that small payments can help integrate such systems into livelihood creation, which leads to longer-term maintenance.

The concerns over divergent stakeholder interests (item 3 above) may perhaps be the greatest challenge, particularly regarding the locations selected for any common distribution points and the extent to which private connection fees or surcharges for high quantities may be used to subsidize rates for basic services. Identifying and evaluating stakeholder engagement and negotiation processes for their ability to successfully resolve such challenges is a key research challenge.

Haiti has both physical vulnerabilities (including hurricane and seismic risk) and the social vulnerability associated with widespread poverty. Resiliency is generally associated with redundancy of capabilities throughout a system; the lack of redundancy in Leogane’s centralized water supply led to its failure in 2008, when the only pipes across the Momance River were washed out by a hurricane. However, there are opportunities to build in redundancies. The empowerment of local water committees provides redundancy by providing a large number of potentially autonomous agents who could act in the event of a failure of centralized resources. Despite the upheavals of the earthquake (and perhaps because of the destruction of the earlier centralized piped-water system by a hurricane), there is a constituency of people at the local level who would be willing to participate in the conceptualization, implementation and potential operation and maintenance of future water and sanitation systems in Leogane. Moreover, the local constituency demonstrated a deep understanding of the complex nature of the water and sanitation challenges in Leogane and had specific ideas about how to tailor solutions to address unique, local conditions. Solutions that include local participation within a national legal framework, and that build in a certain amount of redundancy (including both centralized and decentralized systems tailored to particular areas and populations), are more likely to be resilient in the face of future disruptions. Local participation in post-disaster engineering projects can provide better and more comprehensive solutions to complex problems – solutions that cut across human and natural systems, that can help to build local capacity, and that ultimately can shore up the sustainability of the entire infrastructure system, thereby reducing social vulnerability when the next disaster comes along.

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