Experience proves rural water supply infrastructure is easier to build than maintain. Consequently governments and organizations must expand services and rehabilitate deteriorating systems. As an operation and maintenance model, community management has had mixed results. Therefore a sustainability analysis tool using eight indicators was developed to evaluate community management and inform decision making, strategic planning, and support activities. The tool was applied to sixty-one rural communities in the Dominican Republic. Post construction support to communities was correlated to improved sustainability scores and improving accounting transparency correlated to compliance with tariffs. In turn tariff compliance translated into increased time spent on system maintenance. Participation and the activity level, both of which are strongly linked to sustainability were correlated to improved decision making and younger systems respectively.

Introduction
Characterized by high population densities, urban areas often have better market conditions (commercially viable supply chains, economies of scale benefits, etc) and therefore water supply systems are often managed by private enterprises or state corporations. In contrast, in rural areas of the developing world, where profitability is limited, system management is often the community’s responsibility. After three decades of experience the organizations involved in the expansion of water supply service in rural areas have recognized that the continued functioning of these systems remains problematic (Kleemeier, 2010). Questionable sustainability has been an impetus for investigating alternatives to the community management model, such as self supply and public-private partnerships. These options are promising and should be investigated, however given the scale of the problem and the slow rate of change in development, multiple models must be explored and improved (Balkalian and Wakeman 2009). Harvey and Reed (2006) determined that community management in Africa was more widespread than the conditions for its success. Therefore in order to facilitate the conditions for successful community management and the long term sustainability of services managed through this model; monitoring and evaluation tools must be developed. This research developed a sustainability analysis tool utilizing excepted indicators (Lockwood et al 2003, Fragano et al 2001) building on previous work by WaterAID in Africa (Sugden 2001) and the “TOM” circuit rider program in Honduras (Rivera 2010) and applied the tool to a representative sample of rural water systems in the Dominican Republic. This tool can be used to evaluate and modify training programs as well as post project support roles of government, implementing organizations, etc to ensure optimal sustainability of service. This paper looks at the importance of tariff payments, community participation, and post construction support in community managed rural water supply systems in the Dominican Republic. A second manuscript that contains an in-depth description of the sustainability analysis tool along with the complete results is under review, for more information please contact the lead author.

Dominican Republic Case Study
Lockwood (2002) cited the existence of over 2,500 rural water “projects” in the Dominican Republic (see Table 2). In the Dominican Republic the implementation of simple point source technologies (e.g.-hand pumps and windmills) and rain water harvesting (a self supply technology implemented by individual households) have not included a community management component and as such were excluded from this case study of community management. This research includes all piped systems, gravity fed or mechanically assisted, that provide water for domestic use in rural areas.
Table 2: The approximate breakdown of rural water systems in the Dominican Republic. The breakdown is based upon a 2002 inventory established by USAID consultant Eric Johnson. Source: Schweitzer (2009).

<table>
<thead>
<tr>
<th>Source</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gravity</td>
<td>43%</td>
</tr>
<tr>
<td>Pump</td>
<td></td>
</tr>
<tr>
<td>Electric</td>
<td>31%</td>
</tr>
<tr>
<td>Diesel</td>
<td>5%</td>
</tr>
<tr>
<td>Solar</td>
<td>1%</td>
</tr>
<tr>
<td>Hand pumps</td>
<td>10%</td>
</tr>
<tr>
<td>Mixed (Gravity Pump)</td>
<td>7%</td>
</tr>
<tr>
<td>Windmill</td>
<td>&lt;1%</td>
</tr>
<tr>
<td>Unknown</td>
<td>3%</td>
</tr>
</tbody>
</table>

Focus group meetings, key informant interviews, and household surveys were conducted in sixty-one rural communities with 2,000 or less inhabitants, water committees formally trained by the national water authority or an international development organization, and a piped system that was functioning within the year prior to initiating the research (October 2008). From this cohort a statistically significant geographically stratified random sample of sixty-one communities was chosen (Figure 1).
Results
Values for over 200 variables measured in each community were analyzed to determine correlation and statistical significance (α ≤0.01). Some interesting correlations were observed in the data and are summarized below.

**Tariff Payment**
The research revealed that the amount of time dedicated to maintenance activities (such as cleaning tanks, flushing pipes, etc) and the money spent on wages (for plumbers, operators and tariff collectors) increased when the percent of households paying the monthly tariffs increased (p=0.004 and p<0.001 respectively). This is an important finding as one question that is often raised with respect to the sustainability of physical infrastructure is: “How can you motivate communities to conduct the necessary preventative maintenance activities?” Amongst the communities included in this research, those that reported conducting maintenance activities at least twice a month were three times as likely to report performing activities that were preventative in nature (cleaning/greasing equipment, checking proper function, replacing wearing components, etc) as communities that did not conduct maintenance activities as often.

Therefore the answer to the previous question is: if more people pay their tariff, then you are able to pay plumbers more, and if plumbers are paid more they will likely perform the required maintenance activities. Although this seems intuitive, it is important to note that these findings were not correlated to a higher tariff. In other words, having a lower tariff that everyone was able to pay is better than having a higher tariff that less people pay even if under both scenarios you collect the same amount. One possible explanation for this is the effect of social cohesion if more people are complying with the tariff.

In addition it was found that younger systems had better accounting transparency (p=0.003) and those with increased accounting transparency had higher compliance with tariffs (p<0.001). A possible reason is tied into participation and activity level- as time passes communities reported loosing motivation or enthusiasm, what is referred to in Spanish as *animo*. Individuals in many communities mentioned that the best way to stimulate *animo* would be increased visitation for support institutions.

**Activity Level and Participation**
The decision making processes was more systematic and inclusive with increased attendance at water committee meetings (p<0.001), more frequent elections (p=0.003), and more frequent water committee meetings (p=0.007). The number of “active individuals” (those repeatedly cited in the surveys, interviews, and focus groups as “active,” “important,” or “key”) was higher in younger systems (p=0.005) and those with less shared taps (p=0.002). A possible explanation for these trends is that as a system ages “active” people can become discouraged or disillusioned with providing services with little or no remuneration. This may especially be true if they feel alone in their duties and abandoned by outside organizations. Finally, improved level of service (e.g.- private verses public taps) may also motivate more individuals to take an active role.

**Post Construction Support**
Community participation (measured as the attendance at community meetings and events regarding the water system) was higher in systems that were visited more often by supporting organizations (p=0.005) such as the national ministry, local municipality, or non-governmental organization. Financial durability, measured as the ability of tariff generated income to cover operation and maintenance costs in addition to the presence of significant savings for eventual reactive or “crisis” maintenance activities (as defined by Lockwood (2004) and Castro *et al.* (2009)) also improved along with increased frequency of visits from a supporting institution (p=0.004). Kayser *et al.* (2010) similarly found that communities who received support had higher rates of community payment for water service.
These are critical findings as the nature of visits from the supporting institutions was not specified in this research and therefore each visit reported in the surveys carried equal weight in the statistical analysis, whether it was a regularly scheduled or a special visit/meeting and independent of the duration or “quality” of the visit. Although causation cannot be gleaned from correlation alone, there are significant anecdotal evidence, testimonials, and qualitative data from the research that suggests that in many communities the presence of an individual from an outside organization can stimulate user compliance with rules, regulations, and responsibilities with regard to the water system (i.e...-give animo to the people). This outside presence shows support of the activities of water committee members, operators, or plumbers (many of which are volunteers) and more importantly a commitment to the well being of the community, aiding to the (institution’s) rapport with the community.

Conclusions
This research determined that successful community management is highly correlated with continued institutional support, further evidence of the need to substitute project based approaches to development with service delivery models. This point has been supported by other case studies (Prokopy et al., 2008; Kayser et al., 2010; Rivera 2010). This change will likely have significant implications on the operational budgets of institutions involved in the rural water sector as research has shown the subsidy requirements for financial sustainability of the water services may be higher than previously assumed (Gibson, 2010). The following trends were observed in this case study:

- Improving accounting transparency correlated with tariff compliance
- Tariff compliance also correlated with increased time spent on system maintenance, which in turn translated to more preventative maintenance activities.
- Participation and activity level, both of which are strongly linked to sustainability in community managed systems were correlated to improved decision making and younger systems respectively.

References


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