GOVERNANCE MODLES FOR COMMUNITY WATER SYSTEMS: THE CASE OF AGUACLARA

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ABSTRACT

Over a billion people do not have access to safe, regular, and sufficient water. This takes a toll on health, and the economy. Community-based management is the most widespread form of water delivery and many scholars consider it the approach to be used to address the global water shortfall. Yet the history of such an approach is full of failures. Scholars attribute such failures to poor technological design, lack of access to sufficient funding for operations and repairs, poor management, and lack of external support, among others. Poor governance in general is pointed to as one of the most significant reasons for water system failure.

In this report I use the insights from the literature on community-based natural resource management to create a framework through which to analyze the strength of water governance models. The framework I develop rests on two principal concepts. First, is the importance of six kinds of capital—natural, physical, financial, social, human, and political—that are necessary for sustained success in water treatment and delivery. Second, is the concept of nested governance, where the governance arrangement which exists at a local level is complemented by a hierarchy of other institutions at different levels (especially the state), which may provide certain forms of capital lacking at lower levels. I apply this framework to the case of AguaClara, a program with roots at Cornell University which has helped eight Honduran communities build water treatment plants and set up functioning systems of governance.

My analysis, based on program documents and interviews with key project personnel, indicates AguaClara's governance model is strong; its various layers of governance have the capacity to steward, develop and marshal the requisite capital needed for sustainable water delivery. AguaClara's physical capital appears particularly robust, especially in terms of

sustainable, low cost, limited energy use designs, which suggests it may be able to compensate for weakness in other areas such as financial and human capital. AguaClara's social capital is also substantial, especially in the areas of trust and community participation. Some weaker areas include financial capital, especially that necessary for major capital investments in construction or repair, and human capital, since a great part of its accumulated learning is found in a few individuals. Political capital, in the form of regular and effective ongoing support, is also of concern—one which AguaClara is actively addressing. The report concludes with suggestions to strengthen different aspects of capital necessary to reach AguaClara's values of equity and sustainability, and to achieve program expansion.

BIOGRAPHICAL SKETCH

Karim Beers was born in Tuskegee, Alabama, was raised in Ecuador, before settling with his family in Ithaca, New York. He has since lived, studied and worked in a dozen countries in Latin America, Africa, Europe and Asia. He is interested in building capacity for social change, and his work in education and planning is informed by a Baha'i-inspired vision: that the purpose of social and economic development is to cultivate the limitless potentialities latent in human consciousness. He currently resides in Ithaca with his wife and children, where he cherishes being immersed in extended family, a warm circle of friends, and a larger community actively moving towards a human-centered, equitable and environmentally sound society.

I choose to dedicate what may well be my one 'dedicatable' project
to my wife, Alba, and to our two precious sons, Noé and Ali.
All three are a gift to me.

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Introduction

Local governance capacity is essential for sustaining community-based water systems. While technological choice and financial capacity are also necessary for creating systems that provide sufficient, safe and regular drinking water, the governance of a water project--the “capacity … to coherently organise the sustainable development of water resources” (Peña and Solanes, 2003: 3)--is often neglected at great cost to the impact and sustainability of the project. To cite one figure, between 30-40% of built water systems are dysfunctional at any given time (Lockwood and Smits, 2011), suggesting that the maintenance of the systems is just as important as the building itself.

AguaClara is a network of organizations based at Cornell University that aspires to develop and implement innovative pro-poor water treatment technology. Working in Honduras over the last six years with local NGOs and communities, AguaClara has built seven water treatment plants, with a few more currently underway or in the pipeline. AguaClara strives for plants which provide sufficient drinking water that meets national standards for quality at an affordable rate. As the program seeks to ramp up diffusion of the technology, it is timely to inquire into not only the infrastructure and financial capacity of the program, but also into the fuzzier social dimensions of water provision.

With this report I intend to assess the strength of AguaClara's model of governance. More specifically, I will look at whether AguaClara's governance successfully stewards, develops, and marshals the necessary natural, physical, financial, social, human and political capital to sustain and expand the benefits of its water projects. To do this I will compare AguaClara's experience thus far to the challenges and issues of governance raised in (mostly) academic

literature. I specifically focus on community-based management literature, as this is the approach AguaClara has taken for service delivery. Community-based management is also the most ubiquitous form of water delivery (Lockwood and Smits, 2011); hence the insights from this field of study are applicable to most water systems around the world. According to one group of water experts, "there is little doubt that community management will be the predominant model for those striving to reach the goal of bringing sustainable water supply to hundreds of millions of rural people in the next ten years" (Scaling Up Rural Water Supply [SURWS], 2005: 3).

It may come as a surprise that community management is so widespread, especially with the recent buzz on privatization. It is ubiquitous in part because most water systems are small, in small towns and cities where there generally isn't the profitability necessary to entice private investment. In large cities delivery is generally public, followed by private provision.

Before continuing with a literature review, methodology, analysis and suggestions, I will provide some context in order to begin to grasp the potential contribution AguaClara could make to an entrenched global problem. To do so, I will sketch a picture of the importance of water provision, and how the world and Honduras in particular are doing in terms of ensuring this basic human need.

According to the World Health Organization (WHO)/UNICEF Joint Monitoring Program (JMP) for Water Supply and Sanitation, some 900 million people—roughly one out of eight human beings—do not have access to what they call "improved water" (JMP, 2010). This is different from 'potable' (safe to drink) water. An improved source includes household connections, public standpipes, protected wells (JMP website, 1/23/12) but doesn't imply necessarily that the source is potable. For example, from my own experience around the world I know that tap

water does not mean it is safe to drink. Thus the figure for those without sufficient, safe, and regular drinking water is certainly much higher than a billion. Virtually all of these people are poor, are in so called 'developing' countries, and most are living in rural or peri-urban areas. So even though we are on track to meet the United Nation's Millennium Development Goal (MDG) to halve the number of people without access to improved water (UN, 2011: 53), progress is slow, and the improvements may not be that substantial.

The lack of progress is disconcerting--especially because the impact of poor water is so substantial: "[A]t any one time, close to half of the urban population in Africa, Asia and Latin America is suffering from one or more of the main diseases associated with inadequate provision of water and sanitation. These diseases account for a high proportion of infant and child deaths" (Hardoy et al., 2001: 39). One of the diseases, diarrhea, "is the second leading contributor to global burden of disease—ahead of heart disease and … [HIV/AIDS]. Two and a half billion cases of diarrhea occur in children under five years of age every year, and an estimated 1.5 million children die from it annually" (UN-GLAAS, 2010: ii). It is because of this that some authors have concluded that the "greatest environmental threat" to poor people in developing nations is their homes--as poor infrastructure and location make these places hotbeds of disease and injury (Hardoy et al., 2001: 39).

Poor water service not only affects health. It takes an economic toll as well. Where there is no public provision, poor households pay private companies higher rates than those with public supply (Hardoy et al., 2001: 48). For example, in Tegucigalpa, the capital of Honduras, water vendors have charged up to 34 times the public utilities' rate (ibid.). Fetching water from rivers or streams or public standpipes usually entails long waits in queues, and this task usually falls to women and children (often girls), who have to get up early, miss school, etc.

Having access to good water, in contrast, could provide an economic boon to developing countries. A report commissioned for the WHO estimated that improving water and sanitation around the world would provide a $5-28 return on each dollar invested, depending on the region, reflecting the benefits from reduced morbidity and loss of work time, and the time saved from not collecting water (Hutton et al, 2007).

Honduras presents its own particular problems. It is still recovering from the blow dealt to it in 1998 by Hurricane Mitch, which caused $2 billion in damage (CIA factbook, n.d.). Honduras is the second poorest country in Latin America with about 65% of its population living in poverty (ibid.). In terms of water provision, Honduras doesn't appear to be doing that poorly. Eighty-six percent of the population has access to "improved" water sources (JMP, 2010: 43), and one recent study found that it was on track to reach the MDG targets for rural water supply (Lockwood and Smits, 2011). This, however, does not take into account infrastructure failure rates, and, as noted before, it doesn't mean that most people are receiving water that is safe for drinking. A 2004 Zamorano University study of 43 rural potable water systems in Honduras found that in 88% of the systems the water wasn't being treated and 70% had excessive coliform counts (Zamorano, 2004). Eighty-three of the 86% of improved sources are listed as 'piped on premises' (JMP, 2010: 43), and it would not be too bold to assume that many of these have similar problems as those in the study.

It is in this challenging context, and with such high stakes, that AguaClara is situated.

In the following sections I engage literature on community-based governance in order to come up with a framework for analyzing the strength of AguaClara's model. I describe this framework more extensively in a section on research methods, and then hold up AguaClara's experience to the framework to gain insights into the strengths and weaknesses of the

program's governance model. After engaging in this analysis I offer some recommendations to enhance the governance of the program and suggestions for future research.

Literature Review

This section describes a sampling of the literature on governance issues for community resource management, of which water services management is a subset. The literature, much of which is based on case-study analyses, addresses in some way the following conundrum:

> Governments' inability (largely because of lack of resources) to maintain water and sanitation infrastructure has been the major factor leading to community-based approaches. And yet, communities rarely have the sustainable capacity to manage their own infrastructure, in complete independence of government or non-governmental institutions. (Carter et al, 1999: 295).

Necessarily, the theorists both try to explain the common pitfalls of local governance and why community-managed systems frequently fail, and to offer insights into building capacity for sustainable local natural resource management. These insights include broad principles for effective governance, and strategies for strengthening local capacity. Here we find readings on training programs and the skills they seek to build, and on the importance of collaboration and partnerships. Within this latter discussion, there is a large volume of literature debating the relative virtues of public vs. private management of utilities, which I'll touch on only briefly. Another set of readings emphasizes the significance of the political and economic environment in which communities are embedded--external factors, if you will. Finally, I include some authors' perspectives on how to evaluate the success of a water project, especially as it relates to pro-poor development.

Why So Many (often small, community-based) Water Projects Fail

While community provision of water is the most ubiquitous form of water delivery, it may fail early on especially if issues of governance and appropriate technology are not adequately addressed. While more nuanced explanations of the challenges of community-based

management will be found alongside the authors' contributions below, I include here a summary table to introduce the breadth and complexity of the problems.

Table 1. Why (Community-Managed) Water Systems Fail

Problems	Reason
Technological	Inappropriate technology (Zamorano, 2004); Distribution system (pipes) unattended (Lee and Schwab, 2005); Poor design (Scaling Up Rural Water Supply [SURWS], 2005), leading to Water quality so poor that customers don't want to pay for O&M costs (Weber-Shirk, personal communication, 2/12/2012).
Financial	Lack of access to funds for capital infrastructure costs (Hardoy et al., 2001; Nickson et al., 1997; Peña and Solanes, 2003); Costs of service are unacceptable and/or unaffordable (Carter et al., 1999; Nickson et al., 1997)
Social	Poor management (Zamorano, 2004, Hardoy et al., 2001, Lockwood and Smits, 2011, SURWS, 2005); Corruption (Budds and McGranahan, 2003); Financial mismanagement (Fabricius and Collins, 2007); Lack of maintenance and monitoring (Georgia Kayser, interview; Nickson et al., 1997; Zamorano, 2004; Hardoy et al., 2001); Lack of capacity to manage assets (Lockwood and Smits, 2011). Lack of community ownership, motivation and participation (Carter et al., 1999): Community is unconvinced of the new system's desirability; Lack of ownership and low payment rates (Zamorano, 2004); Low motivation because benefits are intangible or lack of incentives for workers, administrators and volunteers (Fabricius and Collins, 2007); Lack of involvement of women, the poorest, and marginalized (Spronk et al., 2012); Wealthy and powerful influence provision away from needs of poorest (Cleaver and Toner, 2006) Poor planning: low tariffs and bad service (Peña and Solanes, 2003); Unprepared for severe weather (Rizak and Hrudey, 2008); Lack of preventative maintenance (SURWS, 2005)
Human resources	High turnover of leadership (Fabricius and Collins, 2007); Lack skills for repairs and maintenance and low administrative capacity (Peña and Solanes, 2003; SURWS, 2005; Gasteyer and Taylor, 2004)
External factors	Government bureaucracy clogs channels for communities receiving support (Carter et al., 1999) Lack of ongoing support: from local, regional, national government (Fabricius and Collins, 2007; Lockwood and Smits, 2011; Gasteyer, 2011; SURWS, 2005) Lack of national legal, regulatory, and policy frameworks (Allen et al., 2006; Lockwood and Smits, 2011); No land tenure for homes so utilities can't legally service them (Budds and McGranahan, 2003) Political and economic instability (SURWS, 2005); Top-down development efforts from outside disempower community (Fabricius and Collins, 2007; Ostrom, 1994); Political interference in planning and resource allocation (SURWS, 2005)

Broad Principles for Good Governance; Community Capitals

Governance can be the key factor in making a community water system sustainable. While there are many documented instances of community-based management failure, successful examples illustrate the importance of governance. For example, local corruption and mismanagement of a water system in a village in Cameroon, was turned around by improving participation in governance, and increasing local accountability (Tayong and Poubom, 1999).

Ostrom is an early and prominent voice in the field who studied hundreds of traditional, local governance institutions and practices that successfully managed community-level natural resources, including irrigation systems and forests. She pointed out that it isn't a specific set of governance policies or structures that are crucial for successful long-term management of common-pool resources (CPR); rather she argued it is the *match* of these diverse laws and institutions "to the physical, biological, and cultural environments in which they are located that will enable institutions (and the resources to which they relate) to survive into the twenty-first century" (Ostrom, 1994: 1-2).

Ostrom identified eight broad 'design principles' that characterized the most robust of these governance institutions:

1. Clearly defined boundaries (effective exclusion of external unentitled parties);
2. Rules regarding the appropriation and provision of common resources are adapted to local conditions;
3. Collective-choice arrangements allow most resource appropriators to participate in the decision-making process;
4. Effective monitoring by monitors who are part of or accountable to the appropriators;
5. There is a scale of graduated sanctions for resource appropriators who violate community rules;
6. Mechanisms of conflict resolution are cheap and of easy access;
7. The self-determination of the community is recognized by higher-level authorities;
8. In the case of larger common-pool resources: organization in the form of multiple layers of nested enterprises, with small local CPR at the base level (Ostrom, 1990: 10).

Ostrom (1994) considered these rules, structures, relationships, and mechanisms to be part of a community's social capital, which she defined as "the shared knowledge, understanding, and patterns of interaction that a group of individuals brings to any productive activity" (Ostrom, 1994: 20). Social capital is created "when individuals learn to trust one another so that they are able to make credible commitments and rely on generalized forms of reciprocity rather than on narrow sequences of specific quid pro quo relationships" (ibid.). Well-meaning governments and NGOs can damage this capital by bypassing longstanding traditions and relationships that have helped a community manage its natural resources for centuries or even millennia. (This top-down development is elsewhere categorized as 'disempowering'.)

Ostrom underscored the importance of social capital (and human) at a time when much attention was being given to technical aspects of development. "[A] major lesson we need to take forward into the next century is that it is a mistake to design irrigation and other development projects on the presumption that physical capital is the most important input factor in development" (Ostrom, 1994: 21). She sees human capital and social capital as "necessary complementary inputs" in order for the physical capital--the built infrastructure--to have a lasting impact (ibid.: 20). All three forms of capital require time and effort to build up; however, social capital is quite different from its physical counterpart. First, it does not wear out from use, and may even improve over use and time. Second, it may be used in distinct contexts from where it was created. And third, "if unused, social capital deteriorates at a relatively rapid rate" (ibid.: 21).

Ostrom has also looked into the question of what leads people to cooperate as opposed to free-loading which leads to sub-optimal outcomes (Ostrom, 2010). She constructs a model using a combination of external structural variables and "inner core individual variables"

(Ostrom, 2010: 163). The external variables that have been shown to encourage cooperation are the number of participants involved (generally, the smaller the number, the higher the chances of cooperation), the nature of the goods being shared (whether they are public goods, or 'subtractive', that is, that their use by one affects the amount available to another), the heterogeneity of participants (the more homogeneous the group, the more likely cooperative strategies are chosen), and face-to-face cooperation. These are significant even when there is a single interaction. When interactions are repeated, then information about past actions (an individual's reputation), the linkages among the individuals, and the opportunity to enter and exit also influence the choice of cooperation. Ostrom suggests that "the links between the trust that one participant … has in the others … involved in a collective-action situation, the investment others make in trustworthy reputations, and the probability of all participants using reciprocity norms" (Ostrom, 2010: 162) are also key to understanding successful (and unsuccessful) collective action. These individual characteristics of trust and reciprocity, which come from individual heuristics and values, can be positively reinforcing, leading to greater levels of cooperation.

Other authors have followed Ostrom and looked at a community's capacity to manage its water resources in terms of its different types of capital, and have further elaborated on a capital framework.

Cornelia Flora (2004) identified six forms of capital that communities need for sustainable development: natural, cultural, human, social, political, and financial/built (Flora, 2004). Natural capital is the community's environment and natural resources. Cultural capital includes "ways of knowing …, language, ways of acting and defining what is problematic" (Flora, 2004: 8). It "determines how we see the world, what we take for granted …, what we

value …, and what things we think possible to change" (ibid.). "Human capital is the native intelligence, skills, abilities, education, and health of individuals within a community" (ibid.). Flora says that these three forms of capital constitute the base of any community. Social capital includes "mutual trust, reciprocity, collective identity, cooperation, and a sense of a shared future" (ibid.). This includes "bonding" and "bridging" components. Bonding social capital encompasses the trust, connections, and interaction among the community. While this kind of capital can lead to cliques, "bridging" social capital helps overcome strong divisions and enables work with outsiders. These forms of capital are likely formed over decades or centuries from prior interactions. Political capital is "the ability of a community to influence the distribution of resources and to determine which resources are made available" (ibid.: 10), and includes political connections to access resources. Finally, financial/built capital includes both sources of funding (debt, investment, savings, taxes, etc.) and the physical infrastructure that the funds are designed to construct.

Flora links community participation with the development of all the capitals, and finds that the more elements of participation employed--e.g. in building a collective vision, deciding on rates, expansion and repairs, monitoring and evaluation--"the higher the impact on a greater number of capitals" (Flora, 2004: 10). Like Ostrom, she sees the benefits accruing from such participation to be applicable to contexts beyond water: "community participation has an impact not only on the [water] system's sustainability but on community sustainability as well" (ibid.: 11). Although technicians or water operators may not be skilled in facilitating such participation, "the extra collaborative effort necessary to involve those with skills in the planning and implementation process has long-term positive pay-offs" (ibid.: 12). And the burden of community participation is not necessarily a responsibility of the individual

technician. “The supporting agency--whether for profit, not-for-profit, or governmental--must support and encourage such action through its reward structure” (ibid.).

Gasteyer and Taylor (2009) slightly modify Flora’s framework, separating financial and built capital into distinct categories, and dividing social capital into ‘bridging’ and ‘bonding’ social capital. They end up with eight forms of capital:

> 1) human capital: improved knowledge of water system issues and needs at the individual board member level; 2) political capital: improved connections to the local community governance structure; 3) bonding social capital: increased interactions between the water operator(s), the water board or committee, and the community council and mayor; 4) [bridging] social capital: improved communication with regulators, funders, and technical assistance providers; 5) cultural capital: the development of the understanding at the community level that the water system is a community asset that needs attention; 6) natural capital: better understanding of the water source and what will be needed to protect it; 7) built capital: improved water management, distribution and treatment infrastructure; 8) financial capital: a better financial management plan (Gasteyer and Taylor, 2009: 5).

The authors suggest the framework can be used to assess the strength and resilience of a community’s governance structure for its water system.

In a personal interview with professor Gasteyer (10/17/2011), he underscored the importance of different forms of capital: “Don’t think that just because you have a good technology it will be sustainable. Think about the extent to which that capacity is needed locally and inter-locally--regionally. What kinds of political and social capital are going to be needed beyond human capital, and of course the technology itself.” In particular, he laid emphasis on political capital for water system sustainability: An effective local governance system is not enough. “I really think that the ability of either networked communities or institutions that serve those communities to advocate politically for resources is critical for ongoing sustainability of a rural water system.” He noted that this ability to leverage external resources has been “critical” for rural water systems in the US. Why? Because there isn’t enough internal capital to finance

significant repairs and replacements--even if the communities are setting the rates appropriately.

Gasteyer suggested that all such capitals need not be present at the local level. He suggested using the concept of 'nested governance', looking at the network of institutions at community, intercommunity, regional and national levels, and how they can support and complement each other's work. He suggested that the ability to pull in resources may be found at higher, regional or national, levels.

Hardoy et al. (2001) similarly acknowledge the importance of political capital: "[T]he capacity of low-income groups to build, to work collectively in addressing common problems and to negotiate effectively with local, city and (often) national government will continue to have the greatest influence on the quality of their living environment" (Hardoy et al., 2001: 10). They cite the challenges of provision stemming from a lack of investment capacity for installing or expanding basic infrastructure and inadequacy of basic capital equipment, but even when capital investment is there, the community's capacity to manage and maintain the infrastructure is very limited.

Fabricius and Collins (2007) also use the lens of community capitals to examine failures of what they call "community-based natural resource management" (CBNRM). Drawing on work by Carney (1998) and others, they cite five categories of capital in people's livelihoods: natural capital, i.e. "ecosystem goods and services"; social capital, "social and kinship networks and reciprocity, and social institutions"; human capital, "skills, knowledge and labor"; physical capital, "infrastructure and services"; and financial capital, "money or other financial assets" (Fabricius & Collins, 2007: 84). This is known as the 'sustainable livelihoods framework'. The authors suggest that while local communities may count with plentiful natural and social

capital, the short supply of human, physical and financial capital make CBNRM initiatives extremely vulnerable.

This framework uses a broader definition of social capital than Flora's, one which resembles Ostrom's. It might consider political capital--the connections to governing institutions and resources--as part of social capital.

The authors cite seven 'classic surprises', any of which can be enough of a shock to disrupt or destroy a CBNRM initiative: conflict, including competition that arises at the time of success, tension between traditional authorities and elected leaders, and between entrepreneurs and collective action; financial mismanagement, from both corruption and poor accounting skills; mismanagement of natural resources; high turnover of leadership; political and economic change at higher levels, including civil conflict; changes in markets; and top-down developments, such as large-scale infrastructure development, which may end up disempowering local community governance efforts (Fabricius & Collins, 2007: 85-6).

They also point to a set of 'obstinate implementation challenges' that result from weak governance and further threaten CBNRM initiatives, especially at the early and most delicate stages of implementation. These include, a slow pace of development, from poor estimates of time and lack of planning; weak participation by local, national and provincial governments; and poor coordination.

According to the authors, the five types of capital act as buffers that can absorb shocks and surprises and buttress CBNRM initiatives. They suggest focused efforts on strengthening the "harder" types of capital--human, financial, and physical--which as noted earlier, they consider to be in short supply, without neglecting the social and natural capital already present, and

which are less mutable over time. The process of building up the various forms of capital, they suggest, takes about a decade or more. “In the short term”, they argue, “while the financial, physical and human capital base is being developed, strong and resilient governance systems are essential to buffer CBNRM against change and unexpected events” (Fabricius & Collins, 2007: 93).

The authors use a broad definition of governance in CBNRM, which includes both the formal decision-making structures and more informal social networks and the relationships of trust that sustain them. Governance is about rules and compliance, and about resolving conflict. Governance institutions also systematize experience, learning from it. According to this definition, governance would encompass aspects of social and political capital, and would be responsible for caring for, building and marshaling all the other forms of capital.

The authors emphasize aspects of governance that need be strengthened in the early stages of projects to overcome the challenges to CBNRM noted earlier and be resilient when unexpected changes occur. These are: ‘knowledge networks’ made up of diverse and experienced actors; decision-making structures with formalized membership and procedures, and which are recognized as legitimate by the community and government officials; conflict-resolution practices; formal commitments to responsibilities for main actors, and incentives to help these individuals meet these commitments; and “professional facilitation to promote communication between participants in the knowledge network document the lessons learnt on an on-going basis, keep champions motivated and on board, manage conflicts before they have escalated, and remind key individuals of their commitments and responsibilities” (Fabricius & Collins, 2007: 94).

Finally, the authors specifically suggest that governance structures engage in a "trialogue", a form of "cooperative governance" where scientists, government and local communities "share information and develop innovative solutions" (ibid.). In this framework each of the three actors plays a key role. Local communities are abreast of conditions in the grassroots and can respond to changing circumstances by creating appropriate rules for natural resource use on a local level. The role of scientists is to collect and share information that might not be apparent to local communities and to government officials, and to facilitate two-way communication between communities and policy makers. Also, scientists have access to advanced technology such as GIS and computer models which can help with such tasks as planning and monitoring. Government's role is to ensure long-term stewardship of the natural resources. While this three-player model may be considered distinct from one of 'nested governance', since there is no hierarchy here, it highlights the importance of external support to local governance.

Other literature also underscores the capacity to engage in learning as important to long-term project success (e.g. Uphoff 1998). In the context of scaling-up--expanding the scale of successful projects—another scholar comments that this "… inevitably requires project staff and management to learn and adapt their approaches and activities to local needs and conditions" (Garrett, 2004: 49).

There have been a number of recent publications from the non-profit sector, generally written by academics, that distill this sector's experience in promoting water access in developing countries. *Scaling Up Rural Water Supply* (SURWS, 2005) is a publication by experts from the non-profit sector which attempts to compile lessons for sustainable rural water supply. The document "Provides policy makers with a set of principles that set out the basis for assessing,

understanding and creating the necessary enabling environment to take community management to scale" (SURWS, 2005: 3).

The authors believe "there is little doubt that community management will be the predominant model for those striving to reach the goal of bringing sustainable water supply to hundreds of millions of rural people in the next ten years" (ibid.). They recognize, however, that "the majority of communities are not able to manage their water supply systems without external assistance. Even when the management capacity of communities is strengthened, it is simply not realistic to expect rural communities to be completely self-sufficient throughout the whole cycle of water service management: deciding on service levels and design, operating, maintaining, extending, upgrading, adapting and replacing the system" (ibid.: 10).

They identify three sets of challenges for CBM water systems: First, there are limitations within the community. These include tension within community groups, mismanagement, and lack of capacity to maintain the water technology. Second, there are constraints that are internal to the sector but external to the community, such as poor design and poor implementation, or political interference in construction or financing, "and, very importantly, failure to support communities who are attempting to deal with major repairs, conflicts and other problems with extension and upgrading" (ibid.: 10). Finally, there are constraints that are external to the water sector, such as poor economic conditions which can frustrate community efforts. Natural disasters and armed conflict also fall in this category.

In the face of such obstacles, according to the authors, "most communities require some form of institutional support to sustain service provision" (ibid.), and add a word of caution: "Those seeking to take community management models to scale must ensure that institutional support mechanisms are also established and maintained over the long-term" (ibid.).

In order to expand the benefits of well-functioning water systems, the authors believe successful models must be 'scaled up'. "Scaling up" is a broad term:

> Scaling up seeks to achieve sustainable universal coverage through community management. It relates to all aspects of sustainable rural water supply: political conditions, funding, cooperation between stakeholders, participatory planning, the role of women and empowerment of communities. Scaling up is a process of learning and doing, building on the experiences of stakeholders, and jointly applying the lessons for coordination, harmonisation and joint planning. This approach requires guidance and facilitation and takes time to become fully established within various spheres of government (SURWS, 2005: 9).

They find (a whopping) 26 principles to be relevant and necessary for the scaling up process which they categorize under Universal, Enabling Environment, Institutional, Social Equity, Monitoring and Evaluation, and Technical. 'Universal principles' frame a water system that offers universal service, is indefinitely sustainable, contributes to poverty reduction, and is managed at a local level. One of these principles introduces the concept of the 'water service delivery model', which sees "planning, implementation, operation and maintenance, and eventual upgrading or replacement of water supplies as part of a single continuous management cycle" (ibid.: 13).

The second set of principles relate to an 'enabling environment'. These call for decentralization, good governance, accountability and transparency at all levels, government leadership and support, and sector policy and legislation that defines, establishes and supports the vision, goals, norms and models for water provision in the country. Next are 'institutional principles' that outline the need for strong and competent institutions at all levels, with clearly defined functions, roles and responsibilities, all of which receive institutional support, and are regulated according in line with the public interest. 'Financial principles' call for comprehensive financial planning which take into account all costs--planning, capital, recurrent and support--, balancing service levels with financial resources available. Sources of

revenues must be identified, along with cost-sharing mechanisms, and if subsidies are considered they should be prioritized to "ensure access by the poorest to a minimum acceptable service level" (ibid.: 17).

'Social equity principles' highlight the need for universal participation, with special attention given to including the poorest and women and (other) marginalized groups in decision-making. This may require processes of empowerment and capacity building. Two 'environmental principles' listed require using integrated water services management--giving thought to the whole water cycle, including disposal--and, if relevant, ensuring community representation on higher-level bodies in charge of water allocation. 'Monitoring and learning principles' entail controlling quality through continuous monitoring, evaluating the impact of the project through a comprehensive evaluation, and a learning environment where lessons are shared in order to improve future work. Finally, there is one 'technology principle', espousing the need for a range of technologies that are suited for varied physical and socio-economic conditions. This will help diverse demand for varying levels of water service.

In a 2011 study of 13 countries for an IRC-sponsored global learning initiative called "Sustainable Services at Scale" (shortened as "Triple-S"), Lockwood and Smits extract lessons on sustainable water delivery--many of which mirror those described above. They document a continuum of approaches from the more traditional capital-intensive focus on construction of plants and distribution systems to a more holistic and long-term approaches focused on the whole life-cycle of the water system--what they and the 'Scaling Up' report call a "Service Delivery Approach" (Lockwood & Smits, 2011: 19) . This combines infrastructure with long-term post-construction support. While they understand that countries with low coverage tend to choose the former strategy, they suggest the Service Delivery Approach is more sustainable.

A “Service Delivery Model” then is one that uses this approach, and can be implemented by CBM, public, or private sectors.

Perhaps having learned that 26 principles was unwieldy (Lockwood was among the few dozen experts in the SUWRS Task Force mentioned earlier), they condense their insights into nine “building blocks” for more sustainable service delivery:

1. *Professionalisation of community management:* Community management must be properly embedded in, and supported by, policy, legal and regulatory frameworks and support services, both at national and local levels; in order to become more effective community-based management entities must be legally recognized.
2. *Increased recognition and promotion of alternative service provider options*; There is a range of different management options beyond community-based management--including local private operators--that can better support different service levels, technology and types of settlements; these should be described and set out in clear Service Delivery Models which are well disseminated.
3. *Sustainability indicators and targets*: Monitoring and target indicators should move beyond systems built and ‘beneficiaries’ served and include benchmarking against the services delivered and the performance of service providers.
4. *Post-construction support to service providers*: Most community-based management and local private operators cannot manage on their own; there is a need for structures systems of support that are properly funded to back-up and monitor these services providers; in many cases it is local government that will take on this responsibility.
5. *Capacity support to decentralised government (to the service authorities):* Many local governments will require help and support if they are going to fulfill their role in guaranteeing services; ongoing capacity support programmes covering key functions in the life-cycle of rural water supply services, including management, procurement and contracting are needed and must be paid for.
6. *Learning and sharing of experience*: Learning and knowledge management is an important element of any mature sector; this should not rely on *ad hoc* support, but become an integral part of sector capacity and be properly funded both at national and decentralised levels.
7. *Planning for asset management*: One of the main weaknesses of rural water provision has been the lack of proper asset management; systematic planning, inventory updates and financial forecasting should be introduced; ownership of assets must be better defined so as to allow for delegated contracting, where appropriate.
8. *Financial planning frameworks to cover all life-cycle costs*: Sector financial frameworks must be expanded beyond the basics of capital investments and minor operation and maintenance costs; all life-cycle costs must be accounted for, especially major capital maintenance expenditure, and direct and indirect support costs.
9. *Regulation of rural services and service providers*: Service provision--and the performance of service providers of all types--should eventually be regulated, even where this is done with a ‘light touch’ system. Any attempts to establish regulation should apply appropriate performance criteria and not be overly punitive for fledgling rural operators (Lockwood & Smits, 2011: 2).

They also provide a framework for evaluating service, consisting of five levels from “no service” to “high service: people access a minimum of 60 liters per capita per day of high quality water on demand” (ibid.: 23).

The authors give shape to the idea of nested governance, by separating out three levels of governance--national, intermediate, and service delivery--and spelling out their respective functions. The national level is responsible for policy and normative functions, that is, creating the “overall enabling environment where sector policy, norms and regulatory frameworks are set, service levels defined, and macro-level financial planning and development partner coordination takes place” (ibid.: 20). They note that it “can also be the level at which learning, piloting and innovation is funded and promoted” and where capacity-building is coordinated (ibid.) The intermediate level refers to local government that is in between national and the service provider, a level which could be municipal, district or some other government, depending on the country. This is where “service authority functions … such as planning, coordination, regulation and oversight, and technical assistance, take place” (ibid.: 21). Finally there is the local level, the level at which the service provider functions, whose role is the day-to-day functioning of the water system. The authors argue that it is “the interplay between these three levels” that makes for a quality and sustainable water system (ibid.): “[c]ommunity management must be properly embedded in, and supported by, policy, legal and regulatory frameworks and support services, both at national and local levels” (Lockwood & Smits, 2011: 2).

There seems to be a growing literature recognizing the importance of factors that are external to the community, for effective community resource management. Flora (2004), for example, underscored the importance of a nation’s economic and political climate, including the presence or absence of relevant policy, legal and regulatory frameworks, in determining

whether or not communities have regular and sufficient access to safe water. Budds and McGranahan (2003) note one particular legal problem is the lack of land tenure for the poor (often in slums). In such cases, public and private companies are often legally prohibited from serving them. The importance of national legislation frameworks for water provision is highlighted in the discussion on the conception of water as a good or a right. Allen et al. (2006) question the conception of water as a good to be distributed by market forces. They suggest that by looking at water as a right--not just a good--governments can and have figured out policies to make service provision happen. Legal and policy frameworks thus impact the success of water distribution efforts, by aligning government funding with laws and policy priorities.

Capacity Building

Given the broad appreciation for local governance capacity presented above--including the importance of management and technical capacity--, it should come as no surprise that the literature places significant emphasis on building local capacity. As Fabricius and Collins (2007) put it:

> CBNRM [Community-based natural resource management] focuses on the collective management of ecosystems to promote human well-being and aims to devolve authority for ecosystem management to the local (community) level. CBNRM therefore requires strong investments in capacity development of local institutions and governance structures (Fabricius & Collins, 2007: 83).

Gasteyer and Taylor (2009) consider local management capacity to be at the center of a community's ability to take care of its water systems. Small communities are in particular need of this capacity. Eighty-three percent of "community water systems in the United States serve fewer than 3,300 customers" (Gasteyer & Taylor, 2009: 10), and these systems have "a disproportionately large number of health-based violations and often lack experienced

municipal and board members to implement the kinds of policies and procedures to correct these issues over time" (ibid.: 10-11). Another problem that besets small systems is the lack of resources to hire experienced management staff, balance budgets, and communicate effectively.

The authors note that in the U.S. significant effort has gone in to building this capacity through small community water board and management training, which they abbreviate as BMT. While assessing the effectiveness of BMT in five states, they noted that "[t]here is remarkable similarity in the basic curricula taught around community water system board and management training. All attempt to address aspects of technical, managerial and financial issues" (Gasteyer & Taylor, 2009: 51-2). One example of a typical training program (from Kansas) includes content on:

- Managerial capacity: roles and responsibilities of board/council members; conducting meetings; customer service policies; emergency water supply plans; personnel policies; benefits and legal issues.

- Financial capacity: understanding your audit; budgets; record retention; capital improvement plans; rate reviews.

- Technical capacity: water rights/water conservation/drought planning; operator certification; monitoring, reporting and record keeping; O&M plans, rules/regulations; Safe Drinking Water Act regulations; Reducing unaccounted for water loss.

While such training is ubiquitous it is more difficult to ascertain how effective the training is. The authors above were unable to determine the impact of the trainings on the water system,

concluding that “more research is needed to really understand the impacts of BMT” (Gasteyer & Taylor, 2009: 60).

More literature that provides detailed guidance for sound board management can be found in the non-profit domain. One non-governmental organization, *Governance Matters*, prepared a manual called the “Good Governance Guide” (Governance Matters website, accessed 1/24/12) to help grant makers and board members assess the strength, and build the capacity of community governance boards. The guide lists nine principles of good governance, each one accompanied by relevant indicators, questions to gauge progress towards these goals, and examples of board practices that meet the criteria in the indicators. The nine principles are: Board Effectiveness; Board Operations; Strategic Planning; Program Effectiveness; Funding Stability; Financial Oversight; Constituent Voice; External Relations; and Organizational Evaluation.

Partnerships and Nested Governance

Building local capacity is one way to deal with weak community capacity and capitals. Another way is by accessing them through other individuals and organizations. Such support can come from within the organization itself but from a higher level than the local--say from the national office of an NGO. It can also be external, from donor agencies, universities, and different levels of government. When there are different levels of decision-making and management working on the same project or process, each receiving support and orientation from the level above, this is referred to as ‘nested governance’.

Gasteyer conveyed the importance of looking at community assets within a nested governance framework (interview 10/17/11). He mentioned that all the forms of capital need not be

present on a community level for the system to be successful in the long-run. If the community organization is nested within what he called ‘intercommunity’ or regional structures, and within national organizations, the different forms of capital--such as political--may be found on different levels of this multiple-layered governance framework.

Uphoff et al. (1998) too insist on the importance for local communities to be connected to a larger scheme: "Small organizations by themselves may be beautiful, but their impact will be limited if they are not joined in some larger enterprise" (67).

Others have suggested partnerships as a way to supplement lack of local capacity in water systems. Carter et al. (1999), for example, argue for the role of partnerships for effective community water and sanitation provision, noting that neither governments nor NGOs have the capacity to sustainably manage water systems in developing countries.

First the authors state the following reasons for why improvements in water provision and sanitation are not sustained: Communities or households may never have been convinced of the desirability of new facilities; the financial costs which communities are expected to raise as a contribution to capital or recurrent expenses may be unacceptable, unaffordable, or impracticable; communities may never have felt ownership of the new infrastructure, and under-resourced governments have been unable to carry our repairs and maintenance; benefits which have been promised at the outset of projects (e.g. dramatically improved health) have failed to materialize; community education (e.g. hygiene education) and the attitudinal and behavioral change expected to be achieved by it, take a long time to produce results, and yet it often ceases prematurely; even where full community participation or management has been planned from the start, community-level committees and caretakers

have lost interest or trained individuals have moved away. This can be a particular risk if community-level organization is on a voluntary basis.

To overcome these shortcomings the authors suggest the need to strengthen four interrelated elements: motivation, maintenance, cost recovery and continuing support. Motivation is needed to maintain use of a new facility. This may be challenging especially if the safer water tastes different, or if it entails a higher cost to the user.

Carter et al. then highlight the importance of proper maintenance for sustainability.

> Regardless of the type of technology, a clearly structured, resourced, and trained maintenance organization is necessary … Community caretaker(s) or committees may have an important role in maintenance (for which they need training), but in almost all circumstances they will need back-stopping by some district, regional, or national level organization. This government agency or NGO will also need resourcing and training (Carter et al., 1999: 294).

Parts and tools, as well as appropriate transportation, also need to be available. Whether right or wrong, the recurrent costs of water and sanitation service are placed on the community as a practical measure, since dependence on outside funding is fickle. “The level of payment, including any subsidies, the basis of payment (by volume, or flat rate per household), and the means of administering and accounting for water charges, have to be decided--preferably by the community” (Carter et al., 1999: 295). Empirical evidence suggests community enthusiasm necessary for sustaining local committees and water boards can wane within two or three years of construction. Thus it is essential for communities to receive outside support from government or NGOs. “This is a long-term function, with a need to continue until there is such a ‘critical mass’ of good practice within a district, that there is no going back” (ibid.).

Aside from motivation, maintenance, cost recovery and continuing external support, the authors note that there must be significant community participation in the whole enterprise to

make it sustainable. According to the authors, "this is a pragmatic recognition of governments' inability to deliver services" (Carter et al., 1999: 295). Effective community participation, however, requires capacity building:

> Education in health and hygiene, training in maintenance and the handling of cash, and involvement of women in community institutions and decision-making, are key activities which are needed to create local capacity to manage (ibid.).

Since the success of a project depends so heavily on the sustained participation of the community, one major challenge facing water projects is the total reliance on the "strength of community spirit" (295), since modernizing forces assail this spirit--including increased mobility, materialism, and individualism. Government bureaucracy constitutes another significant threat to a sustainable water project, especially when the public sector is the support agency behind the community project.

Regardless of whether communities receive support from government or NGOs, or other places, they need help. Many governments have devolved responsibility to communities, mostly due to lack of resources, but communities have been largely unable to sustain improvements in water and sanitation. "[W]ithout support, few community-based water and sanitation systems will achieve anything approaching permanence" (Carter et al., 1999: 295). The authors then argue for "[n]ew models of community participation, and specifically institutional, legal, and contractual links between communities, governments and NGOs, need to be developed" (ibid.).

Communities may also need external support to ensure equity in service delivery, as local elites may influence policy to preclude offering service to the poor (Cleaver and Toner, 2006).

Evaluation

Carter et al. (1999) also place special attention on criteria for evaluating community water projects. They provide a framework for evaluating community water supply and sanitation programs in developing countries, using the two frames of "impact" and "sustainability". They believe the framework can be used in the design, monitoring and evaluation of water and sanitation projects in developing countries, with the aim of improving the limited impacts of these projects. The table below shows the criteria by which a water supply project should be deemed of impact and sustainable (criteria on sanitation has been omitted since it is not directly relevant to this study). The costs have been updated to reflect inflation.

Table 2. Impact and Sustainability Evaluation Criteria

Objectives in relation to "Impact"	**Objectives in relation to "Sustainability"**
a. Achieve a daily consumption of at least 20 liters/household	a. Caretakers should be in post and fulfilling their assigned job descriptions
b. Reduce the time spent in water-carrying to a maximum of one person-hour per day	b. Committees should be meeting regularly, keeping minutes, and functioning in a manner which is acceptable to the community
c. Bring about significant improvements in water-carrying technology	c. Revenue collection should be taking place in the manner agreed at the construction phase, or in some other effective way
d. Achieve a water-quality target of 10 faecal coliforms/100 ml at the point of use	d. The backstopping agency (government or NGO) should be in regular and effective contact with the community
e. Achieve equity in all aspects of service provision	e. The use of water supply … should be continuing at high levels
f. Supply these services [water and sanitation] at a per capita capital cost of no more than $42	f. Physical infrastructure should be fully functional
g. Supply these services at a per capita recurrent cost of no more than $4.2/annum	

Source: Carter et al., 1999. Original figures updated to 2012 dollars.

Others have outlined the impact of community participation: "Participation determines whether local stakeholders continue with a project, how much effort and how many resources

they dedicate to it, and how long the project continues to function after the instigating agency leaves, affecting effectiveness and stability (Lefevre and Garcia, 1997).

Younger (2007) uses public participation as a criterion for evaluating pro-poor infrastructure technology. He states that such technology should have three characteristics: they can be used by small communities and enterprises as well as larger ones; they require only modest capital investments and are not dependent on costly external inputs, and they are relatively simple to use (Younger, 2007: 828). Furthermore, the best examples of pro-poor water engineering develop with little external finance and build on self-help principles (e.g. communities contribute labor and land). Having studied a partnership of a Bolivian NGO with local communities on water provision and found that after eight years 95% of water wells were still working, he concludes: “Although it is deeply rooted in the local cultural value system, the insistence on community commitment coupled with the provision of strategic technical assistance is in line with best practice worldwide” (ibid.: 832).

Younger contends that the highly technocratic nature of water projects by imposing technology and processes in a top-down manner actually damages local community: “the uncritical export of northern attitudes and hardware to the South does violence to both the value systems and realities of many Southern countries” (ibid.: 829).

It isn’t easy though to get everyone to the table. Wealthy and powerful community members may be able to control projects on local scale (Cleaver and Toner, 2006). The poor and marginalized groups need special attention, as do women (Hardoy et al., 2001). Cleaver and Toner suggest that facilitating equality of access at the local level requires concerted action from both ‘above’ and ‘below’. These actions include ensuring an adequate legal/policy

framework guaranteeing access to water and a real commitment on the part of the implementing agencies to targeting the poor.

Ongoing External Support

There seems to be a growing consensus that community-management in the absence of outside support is unsustainable. Lockwood and Smit (2011) sum it up thus: "Most community-based management and local private operators cannot manage on their own; there is a need for structured systems of support that are properly funded to back-up and monitor these service providers" (2).

One longstanding model of ongoing support that has received some attention in the literature is referred to as the Circuit-Rider model, and is concerned primarily with technical support. Here is a description from Georgia Kayser, postdoctoral scholar at the University of North Carolina's Water Institute:

> The Circuit Rider model, founded by the National Rural Water Association in the United States in the 1970's, is designed to provide on-going technical assistance so that the Village Water Committees (VWCs), and their water system operators have the capacity to prepare for and overcome technical, financial and operational obstacles. The Circuit Rider model is operating in El Salvador, Guatemala, Honduras, and the United States. The Circuit Rider model, in all four countries, offers access to a trained technician. These technicians are engineers, have years of experience as a water systems operator, or are trained by other Circuit Riders, water engineers, and water operators prior to gaining Circuit Rider status. Circuit riders, once trained, make monthly visits to a specific set of rural communities to address operation and maintenance problems, and train VWCs and their operators in water quality and disinfection, water source protection, and accounting and budgeting. Circuit Riders also hold workshops every few months for operators and VWCs. These workshops address common operation problems in rural water systems and in managing rural water systems. These workshops include: pump maintenance, water treatment, treatment technology options, microbiological water quality testing, and residual chlorine testing, calculating household water fees, and relay any new standards or laws. In El Salvador, the Circuit Riders also stress the importance of meters, installed in households to reduce water waste. To receive assistance from the Circuit Riders in El Salvador, Guatemala and Honduras, VWCs solicit support, or Circuit Riders who work in one community will offer their assistance to adjacent communities. Funding for the Programs outside of the USA, comes from the International Rural Water Association, an arm of the Rural Water Association (Kayser, personal correspondence, 10/31/11).

The Circuit-Rider model is part of the 'post-construction' support. One recent study of the model in El Salvador linked the model with improved water quality and better payment rates (Kayser, 2011). One problem Kayser pointed out with this model is that funding for the support is unstable, often coming from external NGOs, posing a challenge to its sustainability (interview 11/2/11). One option is for government to be involved.

Partnerships are another way support can be found. Many voices on the importance of partnerships are found within the debate on public versus private provision of water and other services, a debate that is separate from community-based management. While Ostrom and those in CBRNM were writing about governance systems that are neither public nor private, others take sides on whether these should be under public control or run like a business. Those who favor private control refer to public mismanagement, bloated and inefficient bureaucracies, and claim that the introduction of market competition will lead to water delivery that is more efficient and less expensive (Nickson 1997, e.g.). Those who argue for public control show that market forces don't operate well with water (tends to a monopoly), and cite examples of the same problems that plagued the public sector, like corruption, in private hands. While in the 90s there was much support, especially from the World Bank and its ilk, for the privatization of public water management, more recently there has been substantive opposition from academic, activist and public sectors (see, for example, TNI 2010). Twenty years later, most water systems are still under public control, although the debate is not over. One meta-study (Bel and Warner, 2008), however, found no link between cost reduction and water privatization.

However, insofar as provision to the poor is concerned, the public-private debate may miss the point entirely, as neither sector has done a good job in facilitating regular and affordable

access to safe water to those with few financial resources at their disposal and both private and public have done well when attending to wealthier populations (Budds and McGranahan, 2003). Hardoy et al. (2001) agree. Since no one is providing services, they suggest "[t]here is tremendous potential in new partnerships between local governments, local community organizations and local NGOs. ... What is needed is a series of pragmatic alternatives with a potential to expand so all those in need can be reached" (242).

Community-based organizations (CBOs) can often show how cheap and feasible alternative solutions are without government funding, after which governments or NGOs can step in to ramp up efforts and channel funds through local organizations. Hardoy et al. (2001) cite the example of Orangi Pilot Project, an NGO working in a slum in Karachi, Pakistan helping groups of 10-15 houses to organize to raise funds for a sewer system, which the community then builds and manages at one-sixth the cost of the official system. However, the authors find that the scope and effectiveness of CBO efforts increase substantially if these are aided by government. Similarly, they argue that donor organizations can get a bigger bang for their buck if financing is channeled through grassroots organizations that can set priorities and administer the funds.

Discussion

The above readings on community capitals, capacity building, nested governance and external support have helped me develop a lens through which to view and analyze AguaClara's experience. Following Gasteyer and Taylor (2009) I employ the frame of community capitals as a way to organize the various themes in the literature. My framework is slightly different from those presented in the literature. Ostrom (1994), for example, shows a sagacious appreciation for the nuances of social capital, but does not seem to give value to enabling policies and

regulatory environments, and external support—i.e. what I'm calling political capital. The sustainable livelihoods framework which Fabricius and Collins (2007) use for their analysis contains the same weakness. The authors' claim that social capital is usually robust in local communities also suggests that they are using a less comprehensive definition of this capital. My framework resembles those used by Flora (2004) and Gasteyer and Taylor (2009), both of which contain references to political capital. I include what they call cultural capital into my category of social capital, which I consider to include traditions, shared understanding, and patterns of interaction. Gasteyer and Taylor formalized Flora's (2004) division of social capital into bonding and bridging types. In my framework, the relationships with outsiders (regulators, funders) and the capacity to build these, fall into three (or four) separate categories. On the one hand, connections to funders and sources of funding can be seen as financial capital; if financing comes through government, then it may be considered part of political capital. The relationships that a community has with outsiders may also be considered part of its social capital. One could further complicate things by noting that the capacity to build outside connections may be found only in a few individuals within the community; then it would make sense to say this was part of the community's human capital.

The capitals I ended up with are six—natural, physical (or built), financial, social, human and political. These categories, as can be gleaned from the discussion above, contain significant overlap and have divisions that are at times arbitrary. The following diagram shows this interconnected nature for the capitals I have chosen for my analysis, an analysis that primarily focuses on social, human and political capital. Note that there is not necessarily more interconnection between abutting capitals.

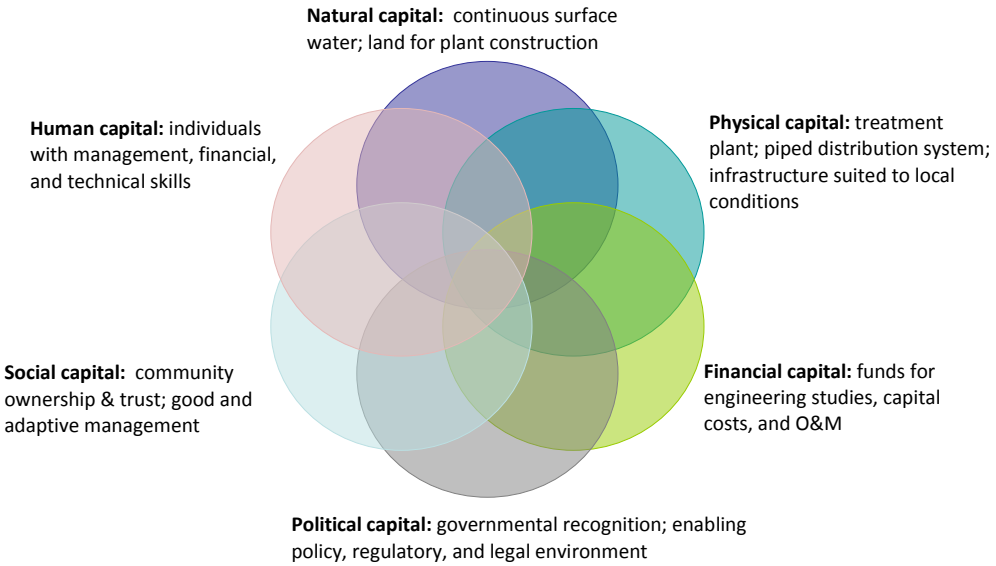

Figure 1. Framework for Analysis Based on Six Intersecting Components of Capital

Methodology

The aim of this report is to assess the strengths and weaknesses of AguaClara's governance model. By governance I mean the "capacity … to coherently organise the sustainable development of water resources" (Peña and Solanes, 2003: 3), and by sustainable I mean such that it can be maintained over time. In order to do this assessment, I conducted mostly qualitative research in the form of a multiple case study analysis, looking at AguaClara's experience with six plants in the light of insights on community-based water governance found in academic and development practitioner literature. I also interviewed a few prominent practitioners. For my analysis I created a framework based on my reading of the literature, a framework that outlined the major topics to consider and questions to answer. And I compiled information on AguaClara using primary documents and several key informant interviews.

I conducted a literature review on community-based management, in general, and water system governance in particular. I conducted most of this research using electronic Cornell library and Internet searches, including *Google Scholar* and the *Google* search engine. My literature review was further enhanced by two key interviews with scholars in the field of water system management, Stephen Gasteyer, Assistant Professor from Michigan State University, and Georgia Kayser, a Postdoctoral Research Associate at the Department of Public Policy and The Water Institute at the University of North Carolina at Chapel Hill. Professor Gasteyer has experience working with small community-based water systems in the U.S., and Dr. Kayser is an expert on the Circuit-Rider model of post-construction technical support for water systems. Both provided me with valuable insights, and suggested relevant literature to further inform my research.

As noted in the previous section, based on the insights from these interviews and from the literature, I created a framework for analysis around the concept of a series of capitals that a community may or may not possess. Using this framework I first identified the issues raised in the literature that most directly related to each one of the six capitals, and came up with sets of broad and more specific questions whose answers would address each of the identified issues. This is the framework with which I approached AguaClara's experience, which can be seen in the table below:

Table 3. Framework for Analysis

Capital	Issue	Bigger Question	Little Questions
Natural	Community needs to have a reliable and nearby river source above it The community needs to have control over the source Needs to have land for building the plant	Does the community have access to a river that can meet its needs for water supply?	-Where is the source located in relation to the homes? -What pollutant problems does it have? -Does the community control it?
Physical	A community needs a functioning water treatment plant, and distribution system. These need to be suited to local conditions: built with locally available materials; run and repairable with locally available materials and talent	Is the plant and distribution system suited to local condition?	-Is the plant and distribution system built, run and maintained with locally-available materials and talent?
Financial	System should aim for total cost recovery for O&M (Carter et al., 1999) Need access to financing for engineering studies and capital costs, including construction and major repairs and/or expansion	Do system have, or have access to, funds to cover engineering costs, capital expenses, and O & M?	--Can handle future capital costs, e.g. repairs? -How is payment rate? What is WTP? -Capacity to fund expansion of service? Subsidize poor?
Social	1. *Community ownership and trust:* Communities need to feel like the water system belongs to them. This is related to the concept of empowerment. -Space for broad community participation in decision-making (Ostrom, 1994; Bakker, 2008, Flora, 2004), especially for women. -Members are motivated to participate in system that belongs to them (Gasteyer, 2011; Flora, 2004; Carter et al., 1999; Younger, 2007) -There is trust between users, board and operators (Ostrom, 2004), and an ethic of reciprocity -Structural variables (Ostrom 2010) that affect collective action: small communities, homogeneity, face-to-face communication, and repetition	Do communities feel like the systems belong to them? Is there trust in the community?	-Is there space for participation? -Who is participating (women? poor?)? -Structural variables that affect collective action present? -Are there indicators of trust? -Is the trust born from the project or did it exist beforehand? -Does the AguaClara project contribute to or detract from this social asset? -What elements of the project motivate community members to participate?

Social	*2. Good management:* The water system (structures, policies, procedures) needs to be transparent, efficient and fair: -Needs rules and boundaries to determine who can participate and how (Ostrom, 1994; Carter et al., 1999) -Meet regularly, keep minutes (Carter et al.,1999) -Monitoring of participation (Ostrom, 2004; Fabricius and Collins, 2007) -A system of graduated sanctions for misappropriation (Ostrom, 2004) -System of conflict-resolution (Ostrom, 2004; Fabricius and Collins, 2007) -Constitution for board, and rules for membership and procedures, including ridding of misbehaving members (Fabricius and Collins, 2007) -Formal contracts and commitments for employees, and incentives, especially for volunteers (Flora, 2004; Fabricius and Collins, 2007) -Professional facilitation to promote communication between varied participants (Fabricius and Collins, 2007; Flora, 2004) -Maintenance and asset management plans (Carter et al., 1999; Lockwood and Smits, 2011), including plans for sudden events (Rizak and Hrudey, 2008) -Financial planning for all life-cycle costs (Lockwood and Smits, 2011)	Is the system managed well?	-Have constitutions? -Written contracts? -Monitoring system? -Conflict-resolution and graduated sanctions? -Incentives for fulfilling obligations? -Maintenance and asset management plans? -Water boards meet regularly? Have minutes and funds in order?
Social	*3. Learning or 'adaptive management':* Water systems need to continually learn and incorporate new insights into operations (Lockwood and Smits, 2011; Fabricius and Collins, 2007) -There is regular space and time for evaluation -Reflections and learning are systematized and shared -Ongoing training and capacity building (Carter et al., 1999) -Iterative process that allows for positive feedback of trust and reciprocity (Ostrom, 2011) -Knowledge networks to draw on broad expertise to share learning (Fabricius and Collins, 2007)	Is AguaClara able to learn from its experience?	-Spaces for reflection and evaluation on different levels? -Capacity to systematize learning -How learning shared? -Ongoing training and capacity building? -Is there an iterative process to allow for positive feedback of trust? -Experts to facilitate exchange of information between groups?
Human	1. Communities need individuals with *management skills/capacities:* -Facilitation of Dialogue and conducting meetings -Maintain motivation--both for paid and especially unpaid staff (board members) -Manage conflict and Customer service -Planning both contingency (e.g. drought, emergency water supply) and expansion or strategic planning	Do Board members have management skills?	How is motivation among board members and workers kept up? Are there venues for resolving conflicts? Are customers happy with their service? How is the board chosen? Does it rotate members? Do retiring members train the next set? Is there a tradition of board members serving the

			community or using this position to extract personal gain? What is the culture around board behavior in general?
	2. Technical skills -Maintenance of infrastructure -monitoring, reporting and record keeping -Reducing unaccounted for water loss	Are operators able to run and maintain the infrastructure?	-How often are plants functioning? -Incidences of breakdowns and successful repairs?
	3. Financial skills -Budgeting, capital improvement plans and grant-writing -Understanding audits and oversight -Record retention	Do Board members (and others) have capacity to manage funds, and solicit more?	Do people have the numeracy skills required? Are Village Water Boards (VWBs) saving money? Have VWBs been able to solicit more money?
Political	*Ongoing support:* Community-based water systems need continuous and ongoing support to maintain infrastructure, motivation, build skills, learn, and access funds (Hardoy et al., 2001; Flora, 2004; Gasteyer, 2011; Fabricius and Collins, 2007; Carter et al., 1999; Lockwood and Smits, 2011) -Governmental recognition (Fabricius and Collins, 2007; Ostrom, 2004; Lockwood and Smits, 2011) and support essential for long-term sustainability of system -Support for training and refreshing for developing other HR skills -Support in order to maintain motivation (Carter et al., 1999) -Support for technical problems -Support to access funds -Nested governance, each level receiving support from one above (Ostrom, 2004; Lockwood and Smits, 2011; Gasteyer, 2011)	Do AguaClara communities receive sufficient ongoing external support?	-Support for funding, technical assistance, and other governance issues -Political support locally? regionally? nationally? -Connection to NGOs/CBOs? -Connection to private sector? -Connection to universities? -Connection to government funding? -At least avoid government interference? -Other outside funding sources?
	2. *Enabling Environment* 1. Policy, Legal and Regulatory Framework for Water sector: rules and responsibilities are clear (Allen et al., 2006; Lockwood and Smits, 2011) 2. Recognition of CBM or local administration 3. Political system and champions locally and nationally that fight for sustainable water supply (service delivery approach) not just construction of infrastructure, or are indifferent to needs whatsoever	Is there a national enabling environment for water service provision?	-A legal and policy framework for water sector? -Is there regulation of service? -Is water considered a right? -Are there support institutions? -Are there other national or regional networks in which communities can exchange information, and receive support?

The first category of capital I'm considering is natural, which refers to the natural resources available in the community. The most relevant concerns here relate to the presence of perennial surface water, a water source for which the plants are designed, and sufficient land

on which to build the plant. These are mostly givens, as AguaClara only enters in communities with such resources, but I include the relevant questions here for completeness and as a reminder of a capital which may easily be overlooked.

The second category of capital is physical, which refers to the built aspects of the water system. For my research this capital is the treatment plant and the distribution system. My questions have to do with the presence of such infrastructure, and, perhaps more importantly, with its suitability to the context. That is, I look at the extent to which the design of the plants and piped system fits in with the other capitals—e.g. the physical environment, or the level of human capital. Looking at the appropriateness of technology helped highlight some of AguaClara's strengths in the treatment plant design, while including the distribution system in the questions provides a reminder that the plant is dependent on the presence of other functioning infrastructure.

Third is financial capital, which recognizes the reality of the importance of funding to get something built, and then to maintain it over time. My questions probed for financial capital either present in the community or AguaClara institutions or access to it for three areas: initial engineering studies, the building of the plant itself, operation and maintenance (O&M), including large scale repairs or expansions.

Fourth is social capital, a category so complex I decided to separate it into three: community ownership and trust, good management, and learning. The first of these includes the issues on which Ostrom's work (1994, 2010) focuses. I wanted to know if and how AguaClara was working in places that had the factors that contributed to successful community management, and in what way did AguaClara's technology and governance structure contribute to the trust and empowerment that are so crucial to such a management model. Some of the questions

got at the frequency and nature of spaces for community participation, as one main element that contributes to both trust and community ownership.

Good management was the second category I used within social capital. Here I looked at more standard measures of management—clear rules and boundaries to limit and shape participation in the form of written constitutions and policies; sanctions for misappropriation; incentives for fulfilling responsibilities, plans for maintenance and management; and administrative competence as shown by the regular use of minutes and well-kept financial records.

The third category dealt with the specific ability of AguaClara to learn from its experience and adapt to changing circumstances. I looked for evidence of this in the presence of specific spaces for reflection and learning, in the ongoing training offered, in the iterative process that allows feedback, in the presence of people who act as facilitators to share learning among the varied participants in the projects.

Human capital is the fifth category of capital, which I divided into management skills, technical, and financial. This category had plenty of overlap with others—the presence of management skills was also probed for when asking about management capacity under social capital; the financial skills of keeping books and soliciting funds can also be induced from management capacity, and from the presence of financial capital. Technical skills, however, refer to those needed to build, maintain and operate the treatment plants, and is inferred from the amount of time the plants are properly running, and AguaClara's ability to deal with breakdowns.

The final category of capital is political capital, which I divided into two sections: the presence of ongoing external support, and an enabling policy, legal, and regulatory environment. For the

former I looked at the connections AguaClara communities have with external agencies—NGOs, universities, different levels of government, and the private sector—and the examples of received technical and financial support, as well as support for other governance issues. I also looked at the support the different AguaClara actors (communities, NGO, Cornell researchers) had, in the context of a nested governance model. For the latter I asked questions mostly about the presence of legal and regulatory frameworks on a national level, regulatory bodies, and fertile national and regional networks for the exchange of information and support.

With these questions in mind I set out to gather information on AguaClara. I used several sources. These included archival records--project documents, reports, presentations, and training materials--which I gathered from people involved with AguaClara projects and from AguaClara's website. I also conducted a series of key informant interviews. The most important of these was with Antonio Elvir, who has had the most direct and complete contact with the communities where AguaClara plants have been built over the last six years. I interviewed him twice during his weeklong visit to Cornell at the end of October 2011. I also conducted interviews with Chuck Brown, a former AguaClara intern who helped train AguaClara staff in grant writing, and Daniel Smith, an AguaClara engineer who has worked in Honduras for the last several years, one year as a Fulbright fellow.

I also benefited from information from Michael Adelman and Matthew Fisher-Post, two members of the AguaClara research team with whom I frequently met to share updates on our respective research and pass along useful documents. I also spoke to Monroe Weber-Shirk, Lecturer/Research Associate in the College of Civil and Environmental Engineering, and

director of the AguaClara program at Cornell, informally on a number of occasions and exchanged some emails.

Having the stories of six plants enabled me to compare their experiences in the light of the literature, and try to draw out relevant insights. This is referred to as a multiple case study analysis (Yin, 1994).

As I began to write up my research, and answer some of my questions, I would often realize that I needed additional clarification from the academic literature, and I would set off on a fresh search. More frequently, I would realize that I could not yet answer my questions with the information I had, or another new question would emerge. I compiled these questions in a document and sent them to relevant people as follow-ups to my interviews. For this follow-up research, I also benefited from a group of Cornell students who visited Honduras in January 2012, among them Michael Adelman, as part of a Student Multidisciplinary Applied Research Team (SMART) program out of Cornell's International Institute for Food, Agriculture and Development.

Since governance is a concept that is defined very differently throughout the literature a few words on how I use it are in order. I have used the capitals framework as a proxy for assessing governance capacity. The relationship between governance and the various forms of community capital is varied. While in particular I will look at AguaClara's governance capacity in terms of its human and social capital assets, I will also consider the organization's ability to access, protect, marshal, and develop the natural, physical and financial capital of their communities as an indication of governance strength.

Also, I have used the concept of nested governance for my analysis. That is, for the overall AguaClara model to be governance to be strong, it need not have all the types of capital at each level of governance--in each water board, at the local NGO, at Cornell. Each capacity and type of capital is important, but may be sufficient if found at a certain level. Indeed, requiring all forms of capital at all levels may be too much to ask, especially at lower levels where some forms are in short supply (e.g. financial). That would be imposing what is sometimes referred to as a governance burden.

My research contains a number of limitations. First of all, it relies heavily on interviews. While I have tried to triangulate in order to verify information, much of the details of the stories of each of the community come from the perspective of a single person. Having limited access to the Village Water Boards, their documentation, or records from the operation of the plants, circumscribed my research mostly to qualitative inferences. Second, most of the communities have had plants for less than three years, which makes it hard to judge what will happen over a longer period. Some scholars note that many of the problems that assail community-based managed systems only emerge two or three years after the system is built (Carter et al. 1999); a study in a few more years may provide much greater insight into my research question. A related issue is that I'm using a relatively small sample size. Six plants provide some diversity of experience, but a larger sample would provide for richer comparisons and contrasts.

Notwithstanding these limitations, since this is a project report intended to inform the practice of the AguaClara program, I think there is value in having identified salient issues that merit the program's attention. As their experience matures, AguaClara staff may be able to bring into better focus the root challenges, and identify solutions to improve their interventions.

Analysis

In this section I apply the analysis framework developed through my background research to the AguaClara model. By going through the major questions relevant to each category of capital, I hope to gauge the strength of the AguaClara governance model. Before proceeding with this analysis, however, I will provide a little background of the AguaClara story, and of the Honduran context in which its first projects have emerged.

AguaClara Background

The AguaClara program began in 2005 as a collaboration between Cornell University and Agua Para el Pueblo (APP), a Honduran NGO focused on providing piped water to poor communities across the country. AguaClara was started by Monroe Weber-Shirk, senior lecturer at Cornell's School of Civil and Environmental Engineering, who is the director of the program. Since its founding, seven AguaClara plants have been built in small rural communities around Honduras.

The story of AguaClara is shaped by the story of Monroe. Monroe was raised on a small farm in Fleetwood, Pennsylvania in the Mennonite tradition, with the community's commitment to issues of peace and social justice (Weber-Shirk, CEE website). Monroe volunteered in the early 1980s in Salvadoran refugee camps in western Honduras sponsored by the Mennonite Central Committee, where he worked as a technical assistant. It was there where he saw first-hand the impact of poor water and sanitation on people who had the 'misfortune' of being born poor. After taking a degree in Physics at a small Mennonite college in Indiana, he finished his M.S. in Agricultural Engineering at Cornell, conducting research on slow sand filtration, a water treatment technology that he thought might be relevant to communities in Honduras. Monroe

then spent another year working with the Mennonite Central Committee in Honduras, before returning to Cornell to continue his research on slow sand filtration for his Ph.D. Receiving his doctorate in 1992, Monroe has continued his research in technologies for water treatment.

Monroe lost contact with colleagues in Honduras until 2004 when he reconnected with Jacobo Nuñez, the director of APP. The idea for AguaClara came to Monroe during one of his visits there, when Nuñez asked Monroe, "What can we do to treat the dirty water that we are providing to rural communities?" AguaClara was thus born out of a concern for other people, who happen to have been born with fewer financial resources. Monroe's continued commitment to social justice can be seen in the amount of pro-bono work he has put in, the hours worked, the time spent in Honduras, and the sincerity and quality of his relationships with people of different cultures and backgrounds.

Communities and Plants

Eight plants have been built in the last six years in seven communities (one has two parallel plants). Four communities are located in the Francisco Morazán department, where Tegucigalpa is, and two in contiguous departments, La Paz and El Paraíso (see map and table below for summary). A ninth plant is under construction in the department of Santa Barbara. While all have followed a similar sequence of steps of design, build, operate, train and transfer, new practices have evolved over the years, which illustrate well issues of governance, and indicate AguaClara's capacity to learn from its experience.

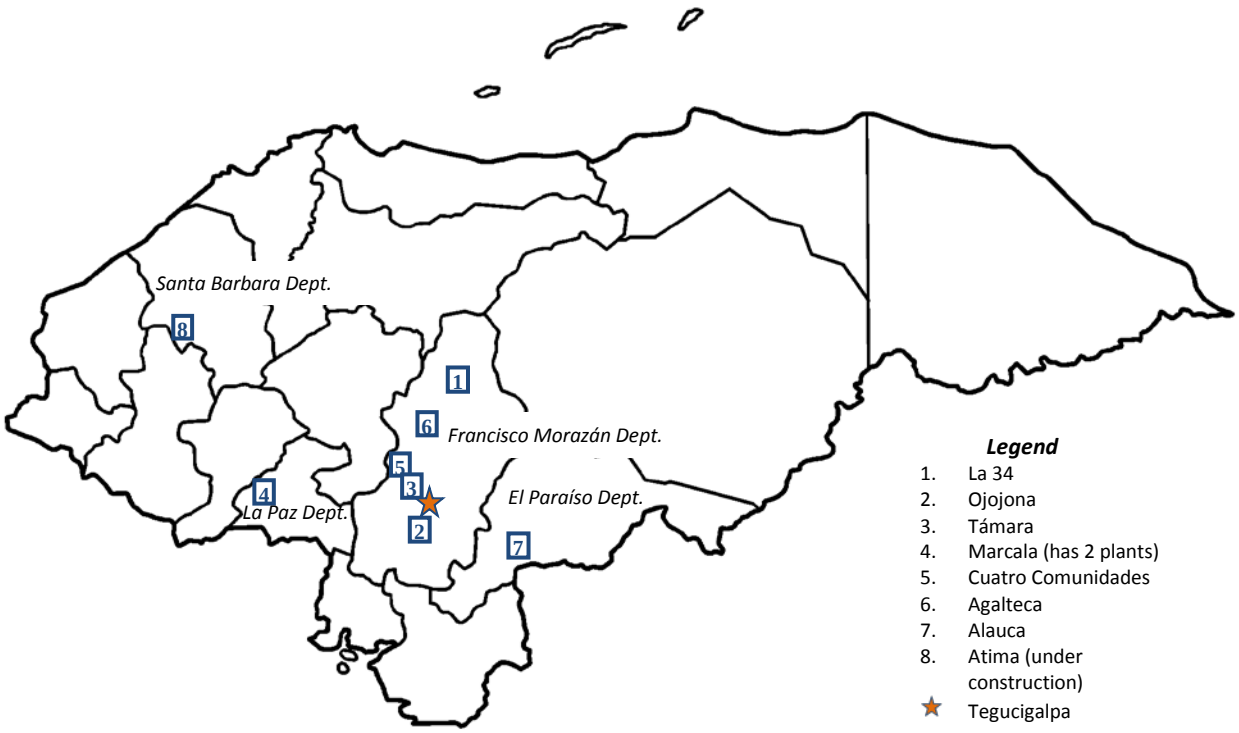

Figure 2. AguaClara Plants in Honduras.
Sources: http://mapsof.net/map/honduras-departments-blank; AguaClara website (n.d.)

The first small-scale gravity powered flocculation/sedimentation plant was built starting in the fall of 2004 for a town built on a former United Fruit Company banana plantation and known as "La 34" (interview Antonio, 10/24/11). It is located in the municipality of Cedros, in the Francisco Morazán department. This was not technically an AguaClara plant, as the program had not yet started. I include it here because it was the prototype for the AguaClara technology, designed by a team led by Monroe at Cornell, and it illustrates well what happens when capitals aside from the physical are neglected. It was a proof of concept that gravity powered water treatment could work for small communities. The plant was funded by IRWA (under the direction of Fred Stottlemyer, a friend and mentor of Monroe's) and did not involve much community involvement in the construction. APP was not involved at this stage, and there was no pre construction community agreement on raising the tariff as is currently done. According to Antonio, while the plant works well, it is not used much, being run only when

someone from AguaClara pays the community a visit. This said, the community has elected to develop a new higher quality water source and no longer uses the water treatment plant.

Table 4. AguaClara Plants in Honduras

Community	Year Built	Financed by	Implem. Partner	Pop. served	Capital Cost	Tariff (HH/mo.)	Other
"La 34"	2004	IRWA	IRWA	n/a	n/a	n/a	Pilot; not used by community; mining town owned by Standard Fruit Company. Predates AguaClara; directed by IRWA.
Ojojona	2006-7	Fundacion San Juan, VWB, Cornell, ESW, and municipality	APP, IRWA, ESW	2,100	$68,028	$2.83	VWB members don't change; some problems with corruption
Támara	2008	Rotary Int'l, Cornell, VWB	APP	3,500	$61,594	$2.65	VWB approached APP and requested plant. APP took lead role and high degree of community participation
Marcala	2008	IRWA, municipality	IRWA, ADEC, APP	9,000	$64,000	$3.18	IRWA supervised construction; APP's role was limited; municipal government manages plant; ADEC provides ongoing technical assistance
Cuatro Comunidades	2009	CESAL, Alliance for Water Progress, private donors, VWBs	APP	1,500	$49,063	$3.18	Single plant serving four small villages, each with a water board. VWB made up of members from all four community boards.
Agalteca	2010	Italian mining co., municipality, others	APP	2,160	$58,279	$2.65	1st plant built using the AguaClara Online design tool
Marcala Expansion ("El Chifladór")	2011	ACRA (Italian NGO)	APP	6,000	$83,382	$3.18	Enabled town to abandon a second untreated source of water.
Alauca	2011	CARE Int'l, COSUDE (Swiss Agency for Dev.)	APP	3,000	$82,375	$2.88	Built as part of a CARE project in the community.
Atima	under const. (2012)	Rotary Int'l	APP	3,300	$76,530 (includes AguaClara staff cost)	$2.62-$10.48	Cross-subsidized tariff scheme not approved yet.

Sources: Antonio Elvir, personal interview (10/24/11) and personal communication (2/8/12); AguaClara website (n.d.); Michael Adelman presentation (n.d.); Smith, 2010; Presupuesto "El Chifladór", 8/31/10; Presupuesto Atima, excel (n.d.).

The first plant under the auspices of AguaClara was built in 2006 in the municipality of Ojojona. This is a small town of 2,100 in the department of Francisco Morazán, some 22 miles from the capital city of Tegucigalpa. While maintaining its connections to its agricultural roots, a significant percentage of people, many of whom are indigenous, make handcrafts which are sold in markets in the capital (Ojojona, 2007). The plant took over a year to build, and was financed primarily by third-party funding. The community did provide wood, stone and about one-fifth of the unskilled labor. AguaClara was building the very first small scale plant with vertical flow flocculation and vertical flow sedimentation tanks and did not want to place the cost of the experiment on communities (A. Elvir, personal interview, 10/24/11). The plant's capital cost was approximately $68,000, and it could treat 6.3 liters of water per second. Funding was from IRWA and the Sanjuan Foundation. The plant lacks a roof, making it an unpleasant place to work when it is raining. Ojojona has two different water supply sources and the plant only treats one of the sources. This has been one of the complicating factors and has made setting appropriate tariffs in Ojojona more difficult.

The next plant was built in Támara in 2008, a town of about 3,000, located 15 miles to the northwest of Tegucigalpa in the Francisco Morazán department. The process changed significantly under APP's direction, and included substantial community involvement before construction began. According to Antonio, it was the Village Water Board (VWB) itself which approached APP to request a plant be built. The educational, promotional work was carried out primarily by Antonio Elvir, an APP technician with a background in community education and organizing. He explained the AguaClara technology at community-wide water user meetings. APP also approached local health centers to learn

more about water-borne diseases in the town, and shared this information at the meetings. Water samples of untreated and treated water were displayed to show the difference between them, and the results of laboratory tests with information on fecal coliform counts and other contaminants were shared. After these meetings the water users were asked whether they wanted such a plant and if they were willing to pay an increased tariff (about double the previous one), which APP had calculated beforehand. A majority (at least "fifty percent plus one" according to Antonio) agreed. They also agreed to contributing 30-40% of the construction cost by providing materials (such as sand and bricks) and unskilled volunteer labor. Every water user had to volunteer for one or two days in order to receive treated water later. This was all formally detailed in a contract signed by the water users and APP.

Once the contract with the water users and the VWB was signed, construction and training began in parallel. Construction took some five months, and was supervised by an APP-designated engineer, who hired master builders (the community provided a steady stream of unskilled labor throughout the five months of construction). The Támara plant cost around $62,000 (not including in-kind and labor contributions), was financed by Rotary International, and has a treatment capacity of 12 liters per second.

The Marcala plant was completed in 2008 in the department of La Paz, and is the largest one thus far, with a capacity of 30 liters per second. The six to nine thousand people it servers are indigenous, and many cultivate coffee (A. Elvir, personal communication, 5/2/12). Similar to "La 34", this plant was built under the supervision of IRWA, who also provided over half of the $64,000 needed for construction (Smith, personal

communication, 3/22/12). The rest was provided by the municipality. IRWA also provided training for the operators, though APP assisted in the training. Agua y Desarrollo Comunitario (ADEC), another organization founded by Fred Stottlemyer, has provided technical assistance to the municipality and its workers.

The next plant built is referred to as “Cuatro Comunidades”, as it serves four small, rural villages in the Francisco Morazán department. APP had been working there previously to improve their water distribution system and had a relationship with the people and water boards in the villages. The plant is small with a capacity of 6.3 liters per second and serves around 1500 people and was completed in spring of 2009. The VWB is comprised of representatives of each of the four communities. It cost around $49,000, most of which was given by CESAL and *Alianza por el Agua*, two Spanish development NGOs, along with some private donations. (The communities themselves contributed as well--an estimated $9,000 in materials and labor.)

The following four plants have mostly followed the format described above, and the procedure has been further systematized by APP, who by this time had become the only implementation partner on the ground in Honduras. The next plant built was in Agalteca, a small municipality about 37 miles to the north of the country’s capital. This plant was financed by friends of AguaClara, an Italian mining company (Five Star Mining), and the municipality, and others. The capital cost was around $58,000, and the capacity is 6 liters per second, and serves 380 households. It was completed in June of 2010.

The next two plants were completed in 2011. One was an expansion to the plant at Marcala. This was a second plant that provided an extra 22 liters per second of treated

water. This enabled Marcala to abandon their second water source that had served a significant fraction of the town. The decision to expand the capacity of the first water source was based on the concept that it would be more economical to have plant operators running parallel treatment trains at a single site rather than requiring a whole new set of plant operators to run a second facility at a different location. It was financed by ACRA, an Italian NGO, and completed in May of 2011.

The Alauca plant was built as part of a CARE international project, who had been working in the municipality, with financing from the Swiss government (through its development agency, COSUDE). The plant has a design flow of 12 liters per second and is intended to serve a population of some 3,000 people.

A ninth plant, in the municipality of Atima in the Santa Barbara department, is currently under construction, and slated to be completed in 2012. Many of the 3,300 people it will serve are connected to coffee cultivation. Estimated costs are $76,530. This is being funded by Rotary International, and for the first time includes in its budget the time APP staff are dedicating to it. There is also a cross-subsidized tariff scheme proposed for the town, which has not yet been approved by the Assembly of Water Users.

In general, the process from design to transfer takes about a year: one month for community research and education, five months for construction and training, and another three to six months for follow-up.

AguaClara has seven more sites pending for plants, including San Nicolas in Santa Barbara, San Vicente in Santa Barbara, La Libertad, Santa Rita in Copan (AguaClara Website,

"Project Sites", n.d.), with another half a dozen identified as potential sites, with requisite water source, turbidity problems, population size and capacity to pay an adequate tariff to cover operation and maintenance costs.

Organizational Scheme

While the general division of labor is that Cornell handles the development of the technology and APP the implementation, and the Village Water Boards (VWBs) the day to day operations, this arrangement has evolved over the years and has grown in complexity.

AguaClara's governance model--which encompasses how decisions and policy are made, and how they are implemented--may be looked at on three levels, international, national, and local. The international level is comprised of what is called the AguaClara Research, Invent, Design, and Empower (RIDE) Group, at Cornell University, and of Donor Organizations. The RIDE Group, which is made up of undergraduate and graduate students, and led by Dr. Weber-Shirk, with the support of other professors, is dedicated to advancing the design of the treatment plants and developing the sustainable processes that they employ. They do operational research working in teams focused on answering a variety of technical questions. Small teams of students work all semester on the project, and one question may require various semesters to address. Students can and do take the class several semesters in a row. Some students become experts, and guide the work of other teams, and organize the class itself. Groups of 15-20 students have been visiting Honduras every year since 2004. In the last few years about 50 students have been enrolled in the course at any given time.

Although the RIDE Group operates within the university framework, some additional funding is required here. The RIDE Group typically has two to three paid research assistants, who are

MS/PhD students in the School of Civil and Environmental Engineering advised by Monroe and Dr. Len Lion. These students are sometimes supported by departmental teaching assistantships, but the AguaClara RIDE Group must sometimes pay them with funds from supporting foundations or research grants. In addition to the graduate students, the major expenses for the RIDE Group come from purchasing equipment and supplies such as pumps, tubing, analytical instruments, laboratory reagents, etc.

Once a new treatment process or a technical improvement has been developed in the lab, it is taken to the field. Students again participate in this. Technical innovations are often field-tested at AguaClara plants during the annual student trip, and students from the RIDE Group may spend additional time in the field as new technologies are brought to scale. The AguaClara engineers in Honduras play an important role in the sharing of information among the RIDE Group, the APP staff, and the plant operators. Technical insights from the lab work are added to plant operating procedures and training materials in the field. Similarly, feedback from the APP civil engineer and social technician and from the plant operators helps inform future research priorities for the RIDE Group.

The innovations are all considered 'open-source engineering', and are shared freely. The RIDE Group disseminates its technical insights and treatment process on its own website and through academic conferences and publications. This way, the knowledge is available to the public and not 'hidden' through patents or copyrights. The students in the course have also put together an automated design tool (AguaClara, "Automated Design Tool", n.d.), to help communities come up with technical drawings for a treatment plant according to their specifications and needs. AguaClara offers this design service for free, and it greatly simplifies the process of producing detailed designs of each new plant.

The other component of the international level of governance is the donor organizations--though these can be considered in some sense as external agencies to AguaClara. These have contributed the funds needed for the capital costs of constructing the plants. CARE International, International Rural Water Association (IRWA), Rotary International and the Cooperazione Rurale in Africa e America Latina (ACRA)--an Italian NGO--, Spanish cooperation, and Swiss cooperation (COSUDE), are among the donors. In the early years Monroe helped raise this funding for capital costs. It is now the focus of AguaClara Engineers working for APP along with the APP grant writer. There is some evidence of small towns beginning to take a more active role in obtaining funding. Aside from providing financing, some of these international organizations have also provided technical assistance and training (IRWA, e.g.), or helped connect AguaClara to communities and done some of the preliminary legwork.

The second level of governance is found on a national level, and is currently represented by Agua Para el Pueblo (APP), a Honduran NGO founded in 1984 with decades of experience in the water treatment sector. APP is considered "the implementation partner" and is in charge of the relationship with the local communities where the plants are built, overseeing construction of the plant, training the water boards and operators, and doing follow-up support. APP is a small NGO of 11 staff, five of whom work exclusively on AguaClara projects, including Cornell engineering graduates. APP has a long track record of working with communities on water projects, and has contacts with national water service organizations, and national level water networks, such as the Red de Agua y Saneamiento de Honduras (RAS-HON), a network comprised of public sector officials, NGOs, and international donors, which receives the support of CARE, IRC, and the European Union, among others (RAS-HON website, undated). APP is dependent on external funding, and has in the past received support from USAID, and European development agencies. Antonio mentioned that in the last few years it

has struggled to find donors for its projects, and is just struggling to survive (personal communication, 2/7/12).

For the last few years, there have been a few Cornell engineering students who after graduating have gone to work for APP full-time. They have acted as links between the RIDE Group and APP, the implementation partner, and helped in a number of roles, including grant-writing, technical support, and plant monitoring.

The local governance functions primarily reside in the Juntas Administradoras de Agua, usually translated as "Village Water Boards" (Kayser, 2011) and abbreviated VWBs. They coordinate various parts of the construction, oversee operations and maintenance of the plant after construction, hire and pay operators, set and collect tariffs, and resolve conflicts and problems at the local level. These are nationally-mandated bodies, and according to national legislation, are elected every two years by all water users of that community (interview Antonio, 10/24/11). Generally, the VWB have a president, vice-president, secretary, treasurer, 'fiscal', and two other voting members all of whom work on a voluntary basis (APP, "Estructura JAA y sus Estatutos", n.d.). They are supposed to serve a maximum of two two-year terms, although this isn't always practiced or enforced. The deputy mayor is also a member, with voice but not voting powers. In one of the AguaClara plants local operations are under municipal control, which has its own organizational scheme and hierarchy.

This governance model is illustrated in Figure3.

The local level has several layers itself. The general assembly, made up of all water users elects the VWB (which in Figure 3 is erroneously is referred to as the Municipal Water Board) and makes big decisions about whether to build or not, to raise tariffs, etc. The VWB is the non-

profit that owns and manages the water and sanitation systems. Under the VWB may be a few committees--construction and O&M, micro-watershed management, and primary health. Antonio mentioned that these committees do function, especially during the construction phase; after construction is over they cease meeting (Antonio Elvir, personal communication, 1/4/12).

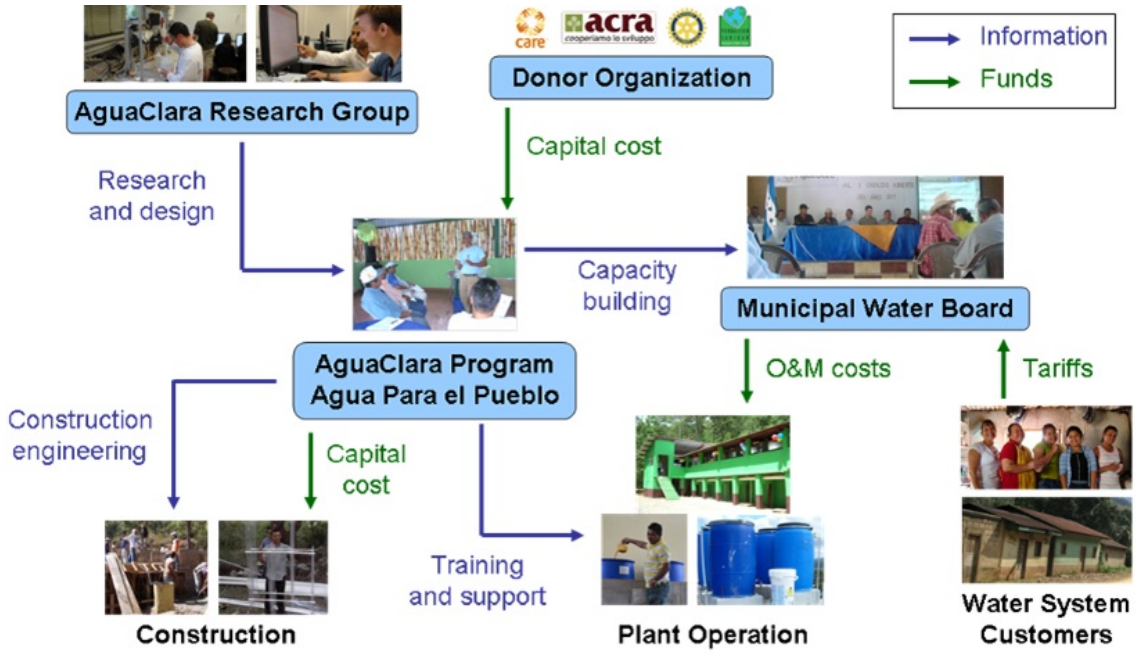

Figure 3. AguaClara Governance Model.
Source: Adelman et al. 2011

APP has been working on creating a fourth level of governance, that of the inter-community level (A. Elvir, personal interview, 10/24/11). In 2010 several meetings of representatives of VWBs were organized to share learning and problems and discuss the creation of an Association of Water Boards that use the AguaClara technology. APP hopes that this level may be where long-term technical support may be financed. APP could still provide a technician to visit plants regularly, but the Association would pay for that support. APP could then focus more attention on new construction, and other short-term training and technical support needs.

Although external to AguaClara governance, so to speak, there are also associations of water boards on national and regional levels. The national association of local boards is the AHJASA (*La Asociación Hondureña de Juntas Administradoras de Agua*) or the Honduran Association of Water Board Administrators. AHJASA represents 500 boards and provides technical and administrative assistance and a space for sharing experiences and information (AHJASA site, undated). There are also *Asociaciones de Juntas de Agua Municipales* (AJAMs) which are regional or municipal association of boards representing rural communities. There are some 50 AJAMs in Honduras (Wikipedia, "Agua Potable y Saneamiento en Honduras", n.d.). Also of relevance, though similarly external to AguaClara governance, are the national regulatory and support organizations, the Sistema Autonoma Nacional de Acueductos y Alcantarillados (SANAA), which is charged with offering technical support, the Consejo Nacional de Agua Potable y Saneamiento (CONASA), responsible for goal and policy setting, and the Ente Regulador de los Servicios de Agua Potable y Saneamiento (ERSAPS), which regulates and supervises water and sanitation services. These are explained in greater detail in a section below.

The Technology

AguaClara has developed technology for treating surface water with over 500 NTU turbidity (NTU, a turbidity measure). These waters have high concentrations of organic and inorganic solids, and are not suitable for human consumption. Furthermore, high turbidity makes the traditional treatment method, chlorination, ineffective, as chlorine reacts quickly with the organics in highly turbid water and does not kill the pathogens that make people sick (Díaz Ordóñez et al., 2009). For chlorination to be effective turbidity has to be low. Most of Honduras's water sources are surface water, e.g. rivers and streams, and

have problems of turbidity that have been exacerbated by deforestation and increased agricultural activity. Turbidity is at its worst during the rainy season (May to November in the interior of the country, where the plants are located), when torrential downpours wash tons of sediment into the river. Turbidity can reach thousands of NTU during high runoff events. Untreated water, which is the norm in most rural villages, will look brown during these months.

The AguaClara plant is designed to reduce turbidity through a process of flocculation and sedimentation. Flocculation is the clumping of particles together, which then weigh more and settle to the bottom (sedimentation). To get particles to clump, operators add a chemical (aluminum sulfate or polyaluminum chloride), and then make the water zigzag through compartments to get the particles to bump into each other and grow in size. The flocculated water then passes to a sedimentation tank where the flocs settle to the bottom and the clear water rises to the top. Chlorine is added to the clean water to kill bacteria and other organisms. Currently, AguaClara is experimenting with an additional component of filtration, using “stacked rapid sand filters” to further reduce turbidity to levels under 1 NTU.

Key innovations of the AguaClara technology include: it doesn’t require electricity, as the water flows through gravity and all materials used for construction and treatment are locally available. Plant design can also be done automatically with the AguaClara design tool, in response to the required flow rate and the dimensions of the materials that will be used in construction.

Honduran Context

As mentioned in the introduction, a 2004 Zamorano study of 43 rural water systems found that most were doing poorly--with 88% of them lacking chlorination and 70% with excessive coliform counts (Zamorano, 2004). The same study found that while 70% of water systems charge a tariff that is sufficient to cover O&M, 80% of these have trouble collecting payments. In urban areas the situation doesn't seem to be much better. Monroe suggested that none of the more sophisticated, electricity dependent systems in Honduran cities are working well due to reliance on technologies with high failure rates and design errors (personal conversation, 8/30/11). A Honduran government study, however, estimated that 75% of urban dwellers and 15% of rural homes had access to potable water (CONASA, 2007).

The legal framework for the water and sanitation sector in Honduras underwent significant changes in 2003, when a new 'water law' was passed which called for decentralization in water and sanitation services. This law is called the "Ley Marco del Sector Agua". The *Sistema Autonoma Nacional de Acueductos y Alcantarillados* (SANAA) had previously been responsible for all water and sanitation systems, but following the new law was to assume the role of technical assistance provider. This devolved the responsibility of owning and operating water and sanitation systems to the municipal or community level. While SANAA is still in the process of devolving some systems, like Tegucigalpa, many municipalities and rural communities have already assumed control of their systems. The law calls for non-profit *Juntas Administrativas de Agua y Saneamiento* (what I refer to as Village Water Boards or VWBs) or Municipal authorities to administer the systems, and establishes the rules and procedures for their creation and operation. As mentioned before, VWBs must be non-profit entities whose officers work on a voluntary basis. They must be elected for terms of two years, and can't serve more than two terms. They also have to have a bank account, and certain control of the finances,

including co-signing transactions and yearly audits. While the law stipulates public ownership of the sector, there are a few exceptions. The large city of San Pedro Sula has a 30-year contract with a private company, and a few municipalities have a mixed system.

The law also called for two new institutions: one with responsibility for setting policy and developing sector plans, which is the *Consejo Nacional de Agua Potable y Saneamiento* (CONASA website, undated), overseen by the Ministry of Health. Regulatory functions are the responsibility of the other institution, the *Ente Regulador de los Servicios de Agua Potable y Saneamiento* (ERSAPS). The ERSAPS site does list the functions of ERSAPS to regulate and supervise water provision in Honduras, but nowhere is there a list of actual regulations (ERSAPS site, undated). CONASA, however, does have on its site a list of policies, strategies and key actors, though the list is brief (CONASA website, undated). While these institutions exist, a 2010 UN report notes that Honduras is one of the few countries without policies regarding water (UN-GLAAS 2010). The same report, however, did list Honduras as having defined and operationalized institutional roles for setting and implementing policy (39) and does have annual reviews of goals and progress (42). It also has a program for investing in rural water systems, but not one for urban water (41). Honduras also received a good score for budget transparency, and for absorbing donor funds (43-4).

The national government has also sponsored the *Plataforma del Agua de Honduras*, which brings together representatives from the above agencies with their counterparts from civil society and the international development community (UNDP, n.d.) to collaborate on water resource management issues. The *Fondo Hondureño de Inversión Social* (FHIS) is another government institution that channels funding from national funds and international donors to

projects to meet the basic needs of the population, including water projects (FHIS website, n.d.)

Having looked at AguaClara's story and the Honduran institutional context I will now proceed to analyze these cases using the framework mentioned earlier.

Analysis

The intent of this research is to assess the strength of AguaClara's governance model, which is one of the program's essential components for effective, long-lasting work with a large impact. While governance is mostly associated with management--decision-making and implementation--I'm assessing the strength of AguaClara's governance by using a capitals framework. That is, I'm looking at the extent which AguaClara has access to, and can marshal, a series of capitals--natural, physical, financial, social, and human--necessary to build and sustain its high-quality water treatment plants. The framework for analysis is based on a close reading of the literature on community-based management, especially of the water sector, and was included in the methods section above.

Natural Capital

This refers primarily to the water source. In my analysis I treat this as a given. AguaClara only goes in to communities that have adequate surface running water to feed the plant. However, it may be helpful to mention here a potential concern. If the water source is not owned by the VWB or community, this can seriously impede the community's efforts to have regular, safe,

and clean water. Also, the function of the Watershed committee is to protect this resource, which communities such as Alauca have done.

Physical Capital

This is perhaps AguaClara's strongest capital, as it is the treatment plant which has received sustained attention and research for over six years by hundreds of minds. The treatment plant has demonstrated its capacity to provide consistent amounts of clean water at a relatively low cost. There is strong evidence demonstrating that rural water users highly value this service, showing this support by voluntarily paying up to twice the amount they formerly paid for the same amount of water in their homes. They produce water that meets Honduran and WHO standards, and it looks like the latest generation of plants will meet U.S. standards for turbidity (NTU < 0.3). These plants provide quality water far above the UN's definition of an 'improved' source; it is potable--something we (reader and writer) would be willing to drink or offer our children. The plants offer almost continuous service, and provide an amount of water per person per day that exceeds numerous standards: Lockwood and Smits (2011), for example, recommend a standard of 60 liters/day/person, and the plants supply well over 100 liters/person/day. The plants furthermore meet many requirements of sustainable, pro-poor technologies: they are made and operated with inputs that are available locally; they don't rely on electricity; they can be run by local people; and may cost less than any other technology that provides a similar level of water quality and volume. While the technology comes from the international level of governance, one might argue that it has been designed to be accessible to all levels of the governance model. That AguaClara has made the design an open access tool lends further weight to this argument.

The success of AguaClara's plant design may be judged using the same criteria that Ostrom (1994) laid out for governance policy and structure, namely, that it must match the natural, human, and cultural resources of the area in which it is built. Monroe made this point: "The technology must be designed to match the institutional capacity. Thus the appropriateness of a technology can't be assessed in isolation. The appropriateness of a technology can only be assessed in context" (personal communication, 2/12/12).By being sensitive to the cultural and natural environment, the AguaClara plants reduce the amount of other capital—e.g. financial, human—necessary for proper plant functioning. That they don't eliminate the need for other capital will be clear from the comments throughout the section.

But stepping back from the water treatment plant, there are two issues of concern. The first has to do with non-plant related infrastructure, such as the distribution system. In the communities where AguaClara has worked this infrastructure existed previously to AguaClara's interventions and may be of variable quality. Water pipes that are of poor quality, poorly designed, and poorly maintained can lead to water leaks, which in turn leads to reduced water pressure, and decreased water availability for some households. Faulty pipes can also lead to the contamination of the water after it has been treated, especially when service has starts and stops (Lee and Schwab 2005). This does not seem to have happened in AguaClara's experience, though it is good to be aware of the potential problem. AguaClara did face a serious problem with leaky water pipes in Marcala, however (Smith, 2010). There, leaky pipes raised demand for water above levels that the plant was able to treat effectively, leading to suboptimal water.

Just as there can be problems after the water is treated, there can be problems before, too. In Agalteca, the "obra de toma"--the pipe that brings in water from the river to the plant--is in

poor condition. This has led to numerous breakdowns, with Antonio estimating that the plant is only functioning 60% of the time during the rainy system.

If AguaClara is to be guided by its vision to provide sufficient, clean, reliable water to poor people, then it has to continue to look beyond the plant, and think about these broader issues. Along the same lines, if the reason it values clean water is the impact on health and quality of life, then it has to look at not only the water going in to homes, but also to that water's egress. If sewage water is untreated then further contamination problems are pushed downstream.

We must not underestimate the importance of physical (infrastructure) capital. But we must not overestimate it either. Infrastructure has traditionally received the most attention in water projects, still does. This may indicate an entrenched paradigm in the field and we must take care not to fall in the rut. Antonio himself spoke of his previous work with USAID installing water treatment plants that were fated to short lives due to their myopic focus on infrastructure. Monroe has suggested that AguaClara's technical strength may be able to compensate for other areas where capital is weak. This is quite plausible. The question is to what extent one capital can compensate another. As Ostrom says (1999), human and social capital are necessary "complementary" inputs to physical infrastructure. Gasteyer was more direct: "Don't think that just because you have a good technology it will be sustainable" (interview, 10/17/11).

Furthermore, infrastructure can be a means for destroying social capital. Fabricius and Collins (2007) suggest that large infrastructure projects carried out in a top-down manner may end up disempowering local governance efforts, reducing their possibilities for effective water system management. Even though, as noted earlier, AguaClara's technology has many elements that are pro-poor, if the plants had been built by outside experts, they might have had this

disempowering effect. By involving communities in decision-making, construction and management, AguaClara may circumvent this issue, but it serves as an important reminder that technology isn't value neutral.

Financial Capital

In order to assess AguaClara's ability to access and leverage financial capital it will be useful to look at the different areas of expenditure incurred over a plant's lifetime. These fall into three categories: engineering studies, construction (capital costs, which includes initial construction and subsequent major repairs or expansions), and operation and maintenance (O&M). This is a simplification. There are other activities such as training that are an integral part of the AguaClara model; however, they don't require a significant outlay of funds.

Having an open-access design tool and a continuous group of engineering students working on AguaClara projects reduces the engineering studies costs significantly. This is a significant strength of the project, as this first step can often be a significant barrier for small communities. There has recently (2012) been an instance of a community offering to pay APP to cover these costs.

O&M costs also seem to be well accounted for in the model. Numerous scholars have written about the imperative of total cost recovery for at least the O&M costs (see, e.g., Carter et al. 1999), which in AguaClara's case, include salaries for the operators, purchase of chemicals, and some administrative costs. AguaClara seems to have achieved this. There seem to be at least three factors behind this success. First, the treatment technology produces abundant and clean water at a relatively low cost. The average tariff is approximately $2.90 a month per household. This figure is calculated by APP based on estimates of salaries for operators,

chemicals, office supplies, etc. Based on figures provided by APP, average household size is 5-6 people, so this works out to be around $0.50 a month per person, or $6.00 a year per person. Carter et al. (1999) suggested providing the service at £2/year, which in today's terms is around $4.50. While the AguaClara plants fall short of this, considering that the minimum salary in Honduras is $250/month (A. Elvir, personal interview, 10/24/11), and that the going rate for a farmhand is $5/day (ibid.), this rate does not seem inordinate. It represents between 1-3% of these salaries, assuming the farmhand works 20 days a month.

There is sometimes a challenge of getting communities to accept even this tariff level, however. Antonio has listed this as one of the most significant obstacles to overcome at the Ojojona plant, for example. That users are remiss to a tariff increase is not surprising, since the increase represents an almost doubling of the previous rate (on average, $1.64/month).

A second reason AguaClara has been able to cover O&M costs is that, as mentioned earlier, people are both willing to pay and do pay the water tariffs. Antonio mentioned that the demonstration of the treatment process, showing the water quality before and after, helped convince people to support the construction of the plant and provided the primary motivation to pay. Some wealthier members of the community who would otherwise be buying bottled water may even end up saving money on water through the plant. (There may also be some incentive for some to think about using the treatment plant to bottle potable water and sell it to other communities.) Antonio estimates payment rates to be high, though he didn't have exact figures. He said that all plants are covering O&M, and some are saving for repairs or other needs in the future. Tariffs cover O&M in Agalteca, but according to Antonio they have been unmotivated to save because the plant is receiving subsidies from a Canadian mine that operates there.

Total cost recovery isn't just achieved when everybody pays the required amount. The administrators then have to properly manage the funds, paying employees on time, and setting aside money for maintenance. This third factor hasn't always been easy to achieve, according to Antonio, but the VWBs seem to be doing it. However, this has to do more with proper management, which I will discuss under social capital.

The third category of costs is capital costs. This component of financial capital may be one of the biggest impediments towards the widespread diffusion of the AguaClara system. While there have been hypotheses that water users themselves could support these costs if amortized into their (higher) monthly water fees (Atkinson Center discussion, 10/7/2011), these hypothesis are untested and unproven. So far AguaClara has depended on third party funding, mostly from international NGOs such as CARE, Rotary and IRWA. Some individuals have also contributed towards these costs.

There are at least two factors that mitigate the challenge of capital financing. First, capital costs for AguaClara plants are lower than for other comparable technologies (Adelman, 2011). Second, communities contribute significantly towards defraying the (lower) capital costs. Antonio estimates that communities offer 30-40% of the total cost through in-kind contributions of materials and labor. This is evidence of how social capital--trust, cooperation, and capacity to organize--can be transmuted, so to speak, into financial capital. More on this under social capital.

But the technology's lower costs and the community's ability to finance some of that do not solve the problem. AguaClara struggles to find funding to further expand the service to other villages and municipalities. And this capacity to find funding is found only among a few people in the whole structure. One person who helped train AguaClara staff in fundraising skills said

that there are currently only three AguaClara engineers working with APP right now with these skills, two of whom are leaving shortly (interview with Chuck Brown, 11/6/11). The one who is staying has just begun receiving some training on writing grants. While capacity to write grants is also found at Cornell, Monroe and some other colleagues and university contacts are generally quite occupied with other responsibilities.

Capital financing is also needed to support major repairs or expansions to water systems. The plants are designed for 20 years (Antonio, interview, 10/24/11), and Gasteyer remarked that the capacity to bring resources in for capital improvements or repairs was a crucial component of ensuring system sustainability. Charles Brown, too, thought this was one of two key challenges for AguaClara's success, and commented that the plant at Ojojona already needed an infusion of capital to bring it up to par, yet capital was not forthcoming. Monroe suggested the difficulties in raising funds might be more connected to the plant's lack of a roof, the fact that only half of the community's water is treated, and the intentions of the water board (personal communication, 2/12/12). As a result of these factors, the community does not value the plant sufficiently to raise the necessary funds for its upkeep. This argument shows, again, how interconnected the different forms of community capital are.

There is a final category of costs that are external to the plant per se, which have to do with questions of equity and access. This refers to money needed to connect those who are currently not benefitting from the water system. This may require subsidizing the water tariff for some; it may also require putting in pipes to connect them to the grid. Connecting the poor and marginalized is a concern of AguaClara's (personal communication with Monroe, 8/30/11), and Monroe has expressed interest in exploring tariff schemes with cross-subsidies. This is one area of focus needed for AguaClara's program to have a greater impact, and reach the poorest.

It will involve close consultations with VWBs and community members and leaders. According to a recent communication with Antonio, Atima is considering this type of tariff (Antonio, personal communication, 2/7/12). SANAA already uses cross-subsidies in communities with water meters (SANAA website, n.d.), and AguaClara may find their scheme useful.

While some authors have said that ultimately water systems need to be supported by different levels of government, in Honduras's case, it seems that governmental support is limited. Antonio stated that the government "neither helps nor interferes" (10/24/11), and he did not expect to receive financial support anytime in the future. The government does seem to have some funds for water projects, however, and an institution to channel these, the Fondo Hondureño de Inversión Social (FHIS). A 2010 UN report states that Honduras is receiving between 50-75% of financing needed to meet the MDG goals regarding water and sanitation (UN-GLAAS 2010). Also, the Honduran government passes on to municipalities 6% of its national budget (Antonio, personal communication, 4/9/12), which could be used to cover water and sanitation expenses. Partial funding for the Alauca plant came from the municipality.

The discussion above illustrates how, although the capitals are listed separately, they are quite interconnected. In this case, accessing funds to finance capital costs depends on different capitals—the community's own local resources (financial capital), the ability of the organization to fundraise and manage funds (social capital), the relationships to people and institutions with capital (political capital), and the specific capacity of individuals within the organization to write up and follow-through on funding proposals (human capital).

Social Capital

This is the main focus on my analysis. As can be seen in the chart presented earlier I have divided up this into four interrelated areas, to which I've assigned the headings of 'Community ownership and trust', 'Good management', 'Learning', and 'Ongoing support'.

Community ownership and trust

Community ownership and trust are the sine qua non of any community-based resource management program. Carter et al. (1999) ascribe this as one of the chief reasons why water systems are not sustained. It is axiomatic that if the community doesn't take responsibility for the system, this will fall into disrepair. Similarly, relationships based on trust significantly enhance collective action (Ostrom, 2010).

These categories are not suited to a binary assessment--that is, it doesn't make sense to talk about either having full trust or none at all--but rather should be looked at falling somewhere on a wide spectrum. That said, there are numerous indicators of community ownership and trust in the AguaClara communities.

First, high payment rates suggest that the communities feel ownership for the plants and recognize the legitimacy of the VWBs as managers. As cited earlier, 80% of rural water systems in a study carried out by Zamorano University had difficulties collecting payments (Zamorano, 2004), even though tariffs were generally about half of AguaClara's. In contrast, Antonio reports that AguaClara communities have high payment rates. For example, Antonio cited the case of Agalteca where, during the five years prior to AguaClara's intervention, only 5000 lempiras (about $250) were collected; whereas the VWB has collected over 120,000 lempiras (about $6000) in the last year.

An example of the importance of community ownership can be found in AguaClara's origins. Before the program was officially started, the "La 34" plant was built on a piece of land owned by the Standard Fruit Company using technology Monroe and his students developed. As recounted earlier, this was a test of the technology and they did not require community inputs. APP was not involved at the time, and there had not been much community involvement in the decision making, or the kind of community education that Antonio has done with later communities. According to Antonio, the lack of community involvement and education--that is, the community did not receive visits explaining the importance of treated water and the impact on people's lives--has led to the plant being underutilized. Antonio suspects that it is only made to function when he comes around to visit, and that typically the community's water quality has not improved. This also underscores the importance of knowledge in contributing to community ownership.

Marcala, too, may illustrate a similar lack of ownership. There, the plant is run by the municipal government. It had a history of problems of delivering and receiving the chemicals for treating the water (Smith, 2010). At times the chemicals would be delivered late; at times they would be left far from the plant, at the bottom of a steep hill. This may be an indication that people involved did not care enough for the plant to ensure proper delivery. That the problem was solved only when IRWA, an international NGO stepped in, also suggests that the community did not feel enough responsibility to do so on its own.

Community participation is both an indicator of ownership and trust and is conducive to the sense of ownership. The main space for broad community participation is in the "Asamblea General", the assembly of water users which elects board members and makes major policy decisions. This assembly is engaged early on in the project, and community members have to

vote on whether they want AguaClara or not. Antonio estimated that community participation is greatest in the smaller communities (size is one of the 'structural variables' conducive to successful community endeavors [Ostrom 2010]), and estimated that 70-90% of water users attended these meetings. The assemblies, however, after the initial period of education and accepting the AguaClara plant, meet generally but once a year.

Since the assemblies are comprised of paying water customers, those who aren't connected to the water system don't have a voice there. This is an obstacle towards addressing the concerns of the poorest and marginalized on a local policy level.

Women are generally the ones whose lives are most affected by the quality of the water system, since they are the ones who are generally in charge of water collection and purification, and cooking and cleaning, which require water. Giving women a voice in assemblies is crucial therefore to ensure the system is designed in a way that meets the consumers' needs. Like in most countries in the world, women in Honduras are not afforded equal standing; however, these patterns of oppression appear to be shifting, albeit slowly. One might consider women's participation in VWB a good indicator of community participation, as it would show that a stakeholder that is both key and traditionally discriminated against--women--is being allowed to participate in decision-making bodies. In the Zamorano study mentioned earlier, women comprised 15% of the membership of VWBs. In AguaClara, women constitute 23% of VWB membership in the five communities with water boards. The sixth system, Marcala, is run by the municipality (though the director of water services there is a woman). The slightly higher average number suggests a small improvement in female representation in the AguaClara systems. But there is still considerable distance to go.

AguaClara is aware of this challenge, and includes gender balance as a goal that VWBs should strive for (APP, "JAA y sus estatutos", n.d.).

Flora (2004) points out that the more elements of participation employed—e.g. reflecting on the community's own resources and context, building a shared vision, consulting on problems that arise, and listening to diverse ideas—the greater the strength of diverse capitals. It is significant, therefore, that in the AguaClara model community participation is not limited to decision-making. Community participation is also required, for example, in the construction of the plants. Antonio said that the contract communities sign requires each household to send workers for one or two days to the site, volunteers which Antonio and the VWBs help coordinate. This helps bring down capital costs (strengthening 'financial capital', in a way). However, participation is not without its own challenges. Those who do not work on construction are later denied access to the water, for example, unless they pay a steep fee (interview Charles Brown, 11/6/11).

Community members also participate in different committees under the VWB (APP, "JAA y sus Estatutos", n.d.). These include construction and repairs committee, in charge of organizing the volunteer labor for construction, and then making repairs; the 'Saneamiento Basico' committee, in charge of promoting basic hygiene among households in village, such as fomenting the use of latrines; and the Watershed committee, responsible for protecting the watershed by delimiting it, getting recognition of it as a protected area, and keeping it clean (ibid.). These generally are most active at the beginning of the project.

The AguaClara projects include several of the 'structural variables' that influence collective action (Ostrom 2010): communities are small, they are dealing with common-pool resources, which are subtractive (i.e. get used up), and there is face-to-face communication between

members of the community, both through formal meetings and through everyday contact. The variables that are associated with an iterative process are also present, such as information about people's past actions, and the opportunity for individuals to enter or exit at will. While I'm not sure whether information about people's payments is publicly available or not, community members were able to see who contributed to the construction and who did not. In one community, this knowledge has been used against those who didn't participate, and are not being allowed to join unless they pay a sizable fee (interview Charles Brown, 11/6/11).

Ostrom has indicated that individual-level variables of reputation, trust and reciprocity can be positively reinforcing. One area in which we might be witnessing this positive feedback is in the Cornell team's participation with APP and the communities. Antonio expressed total appreciation for and trust in the Cornell staff. He also mentioned that the presence of Cornell students working hard on the plants during construction helped inspire community residents to participate as well. Other community members have echoed the appreciation for the Cornell team, calling them part of the "family" (Gonzalez, 2012). That Monroe and the Cornell program have not received money from the Tech Award --all $50,000 went to APP (personal communication with Monroe, 10/28/11)--I think has contributed to their reputation of trustworthiness. Monroe's personal values of respect and love for the people in these small communities can be seen in the immense dedication he has given to the project, and in his respect for local decision-making. This was apparent in a personal communication in which he expressed his yearning for universal water coverage in the towns that AguaClara serves, but his unwillingness to override local VWB decisions (8/30/2011).

This iterative and self-reinforcing process may also be seen in the increased community confidence and trust in the VWBs and the plant. Antonio mentioned that while initially only a

very slight majority of water users may have voted to approve the AguaClara plant, after a few months of receiving clear, regular water, those who were initially opposed became some of its most faithful defenders and consumers.

Good management

The second category of social capital I'm considering is good management, which is seen in the extent to which the water system's structures, policies and practices are efficient, transparent and fair. This includes having appropriate rules for participation, spaces for it, sanctions for misappropriation, formal contracts and commitments for various parties, oversight and monitoring, and plans for the future.

The VWB are supposed to have regulations and statutes, be formally incorporated, and have up-to-date lists of members and of their pay schedules (APP, "JAA y sus Estatutos", n.d.), and according to Antonio, all AguaClara plants have these. All VWBs must have a bank account, and at least two members must sign all checks. Antonio spends time helping the treasurer keep his or her books in order. Antonio also mentioned that communities are sanctioning members that fall behind on payments, first with a notice and then by cutting off service. He attributes higher rates of payment in the communities with AguaClara technologies to these punitive measures. VWBs have also handled other forms of free loading. In Ojojona, the VWB decided to place water meters on several households found to be using and wasting excessive water, which was leaving less for other households, and placing an excessive demand on the treatment plant. Antonio expressed interest in metering all households, as he felt this was an effective way of getting people to appreciate and pay for what they use.

In towns with AguaClara plants, most VWBs meet monthly (A. Elvir, personal interview, 10/24/11) and keep minutes of decisions. This is part of the criteria AguaClara uses when

determining where to build a plant, and part of the work Antonio does to help strengthen the boards. Plant operators also keep records. AguaClara has placed a lot of emphasis on water quality, and operators keep track of this by taking regular measurements of turbidity, and writing down the inputs they've used and the activities carried out during their shift (A. Elvir, personal interview, 10/24/11). These books are in order, as AguaClara directly monitors this.

Fabricius and Collins (2007) point out the importance of having formal contracts for employees as well as mechanisms for getting rid of those who are dishonest. According to Antonio (personal communication, 1/4/12), only the operators in Ojojona and Marcala have contracts; the others do not. No contracts may make it easier for VWBs to fire operators, but it takes away both an incentive for operators, and leaves them without clear guidance as to what their rights and responsibilities are. VWBs do use their authority to cut the service of those who don't pay, as well as to fire operators who are not doing their job well. This occurred in Támara, where, according to Antonio, the operator had left the plant under someone else's care for two or three days. The VWB "punished" him with no pay for a week, and the operator chose to quit. (Antonio then had to help train a new operator.)

Getting rid of underperforming board members may be more difficult, however, since they are elected by the body of water users, and traditional distributions of power may play a big role in election outcomes. In Ojojona, in spite of national regulations that stipulate that members can serve a maximum of two consecutive two-year terms, the VWB members haven't changed since the plant was built in 2006. Antonio suggested that water users allowed this because there they participate little in decision-making. According to him, this apathy was characteristic of larger towns, since Ojojona is like a "mini-city". He was concerned about the board members in Ojojona in part because money has gone missing and people haven't been

held responsible. A 2008 student paper on AguaClara projects provides more insight into these problems in Ojojona (Kite, 2008). The paper states that the VWB had not raised the tariffs even after a year in operation, and consequently, the plant didn't have enough money to buy the chemicals needed to treat the water. It quoted an intern working in Honduras explaining, "several members of the Junta have political aspirations, and this likely makes them reluctant to raise the tariff," especially since elections were coming up (ibid., no page numbers).

But Ojojona was the community that had received the least attention in terms of community education and capacity building, and so it is less surprising that they faced such problems. In another community (Agalteca) that had received Antonio's training, for example, a Board member who had embezzled funds was evicted from the board.

Furthermore, some of Ojojona's problems were overcome. According to Antonio, the greatest challenge that AguaClara faced at Ojojona was changing the water tariff. APP had calculated that in order to pay for the minimum operation and maintenance costs--including paying the salaries of the technicians and the chemicals needed for treatment--the tariff would have to double from around 25 lempiras to some 53 lempiras--approximately from $1.25 to $2.50. Antonio stated that he had to visit the community several times to convince them that the increase was necessary. "After a lot of social and educational work we were able to get people to pay the 53 lempiras regularly. This is what has enabled the plant to continue operating".

This story also touches on the question of incentives, highlighted in the literature as important for sustainable community management. In Ojojona, the board members might have been staying on in order to make a little money off the operations. Antonio suggested that there is little motivation for the VWB members to do a good job, since the national framework states that they must be volunteers. He believes that board members should be able to get paid.

Similarly, the main incentive for operators to do their work well, according to Antonio, is their salary. While they receive a minimum wage (about $250 a month), this is often seen as a good deal in rural areas where stable work is scarce. Before, the operators in charge of the water system were paid a pittance, which led to their and the system's underperformance. While Antonio fixated on wages as incentives, there appear to be other non-monetary incentives for VWB members and other volunteers that may be contributing to better management. For example, an incentive for those who volunteer during construction is the possibility of receiving clean water. Following construction, there are incentives that have to do with community recognition, and the opportunity to offer a service to one's community and participate in its betterment. Antonio suggested that this desire to see one's community improve was behind the strength of the VWB in Támara. Perhaps this incentive is stronger than a pecuniary one. Monetary incentives can sometimes backfire. In Ojojona at least some of the unskilled labor was not volunteer but paid, and Antonio believed that this led to an under appreciation of the plant, as villagers considered it someone else's.

Ojojona's travails also highlight the importance of monitoring and oversight in a successful governance model. APP provides much of this for the technical aspects of the plant's functioning, with Antonio accompanying the operator for much of the first three months of operation. VWBs are also checked on to see that they are meeting, and have their books in order. VWBs are required by law to have yearly audits of their accounts, which provides another level of monitoring. However, this is an internal audit, done by the 'fiscal' member of the Board. Another level of oversight comes from the Ministry of Health, which periodically tests water quality and lets APP, and presumably the VWB, know when it is deficient (interview Antonio, 10/24/11). Donors also monitor APP, especially keeping tabs on spending.

Accessible mechanisms of conflict-resolution are another element towards successful community-based resource management (Ostrom, 1990). There are several mechanisms for resolving conflict within AguaClara's nested governance model. First, there are the general assemblies and VWBs. In both of these venues problems can be hashed out by members of the community. Grievances can also be aired to the local authorities. And APP, too, may help solve some conflicts as well.

Good management is also key to maintaining high motivation and trust. As Ostrom points out, while these and other elements of social capital can be self-reinforcing, they also can deteriorate rapidly. In Agalteca, one of the Board members siphoned money from the water system. Although he was run out of town, this incident was a blow to the community. It took time to rebuild trust in the system, and get users to continue paying their water tariffs (A. Elvir, personal interview, 10/24/12).

Professional facilitation to promote communication between varied participants is also important for learning, maintaining motivation and disarming potential conflicts (Fabricius and Collins, 2007, 93-4). In AguaClara there are spaces in which such dialogue takes place. The research group at Cornell benefits from Monroe's facilitation of this dialogue, for example. He is in conversation with both APP and the students. APP is in communication with communities and passes this on to Monroe. Monroe is then able to come up with research and design challenges for teams of students at Cornell. The annual January trip which he facilitates is another space where dialogue between community members, students and APP professionals takes place. While on a community level there are spaces such as the general assembly and the water board meetings for dialogue between users, administrators, operators and others, the quality of the facilitation of these may sometimes be lacking.

A number of authors have pointed out the importance of making plans to ensure the long-term viability of the water system, including planning for maintenance and asset management, planning for sudden events, and financial planning for all life-cycle costs. One achievement of AguaClara's is helping VWBs put money away for maintenance costs, and most or all of them have some money in bank accounts (A. Elvir, personal interview, 10/24/11). However, the amount that they have saved is not sufficient to handle significant repairs. As pointed out earlier, Ojojona needs a roof among other things, but the VWB doesn't have the money to embark on such a project. More advanced planning for sudden events, like heavy rains and floods, does not exist, nor does asset management planning. As noted earlier, as plants age and require replacement, it is unknown what will happen. Antonio said that they are designed for 20 years, though they could last much longer. But at some time they will need a serious uplift. Maybe the municipalities will find access to financing. The current model merely suggests that the plants will have been completely turned over to the VWBs which will be fully responsibility for them.

One very strong indicator of good management is seen when clean and sufficient water is reaching households each day. And for the most part, in this respect VWBs appear to be running operations efficiently. Plants are operating almost all the time and producing potable water. In one study in Cuatro Comunidades, the plant produced water with NTU < 5 80% of the time (Smith, 2010). Plant operators improve their technique over time, and the number now is much higher. There have been some problems in regularly producing potable water. As mentioned before, in Marcala, which is run by the municipality, the delivery of chemicals to the plant was irregular for some time, leaving the operators unable to treat the water (ibid.). Sometimes the chemicals were delivered, but not to the plant, which was up a steep hill. This

aspect of the problem was only solved when IRWA bought the operators a horse for hauling (ibid., 60).

Learning

This sub-category of social capital addresses the capacity of AguaClara to adapt to learn from experience and adapt to changing conditions, which a number of authors suggest is crucial for sustainable management (e.g. Fabricius and Collins, 2007).

Learning at AguaClara is most apparent in questions of plant design. The research team at Cornell, based on reports from the field, have improved almost every aspect of the plant design, helping reduce cost, improve durability of the plant, comfort for operators, and effectiveness of treatment. For example, current plants are intending to get the NTU below 1 by using stacked rapid sand filtration along with flocculation. While Georgia Kayser expressed doubt as to whether communities appreciate the extra clarity as much as the engineers (Kayser interview, 11/2/11), that the community of Támara paid significant capital upfront and raised tariffs in order to get the improved water suggests they do.

Learning has also taken place in regards to interactions with the community. Antonio has developed a set of training materials based on his own experience. However, this seems to be mostly Antonio's own reflections. When asked about the trainings, he said, "Since my area is social education, I have had certain liberty to do what I've seen fit" (A. Elvir, personal interview, 10/24/11). He did add that AguaClara engineers were supportive of his work.

AguaClara now has a good sense of which communities to work in. When approached by a local community that would like to have an AguaClara treatment plant, APP first makes sure the community meets a series of technical and social conditions (AguaClara website,

"Community Prerequisites", accessed 12/23/11). The technical conditions include a population between one and fifty thousand and a water system that uses surface water with high turbidity. Social conditions include having a well-functioning water board (e.g. that meets regularly, has a bank account, has its books in order), the community agrees to a new tariff that will cover O&M costs, and to providing labor and materials for construction, and that the municipality supports the project.

To gauge the existence of such prerequisites, and to contribute to them, APP spends at least a month meeting with the VWB, water users, municipal authorities, and other local authorities, such as workers in local health clinics, SANAA workers, etc. First, local leaders are contacted, and once they are on board, a meeting of the general assembly—the body comprised of all water users, each one with a vote—is convoked. Antonio Elvir estimates that between 80-90% of water users attend the initial meeting and vote on accepting it.

Another plus in the area of learning for AguaClara, is that it brings together some of three elements of the 'trialogue' suggested by Fabricius and Collins (2007)—scientists, government and local communities. Cornell provides the scientists, and the VWBs represent local communities to some extent. APP, an organization of civil society, provides another valuable perspective. As to government, in its experience in Honduras, AguaClara does not have much interaction with the public sector, with some exceptions. For instance, the plant in Marcala is run by the municipality, not a VWB. Antonio, however, was not very pleased with the way the municipality was running things (the tariff he claims is not enough to cover O&M, and is supplemented with subsidies). His displeasure also suggests that there isn't a shared vision between APP and the municipal government, and may indicate a lack of dialogue. AguaClara also has some contact with health department officials, which APP approaches at the

beginning of a project. Monroe has mentioned that AguaClara also enjoys a healthy relationship with SANAA since 2007 (personal communication, 2/20/12). But lack of a conversation with other government officials responsible for regulating and monitoring water projects may be a weakness in the project.

There are a few promising arenas for collaborative learning. One opportunity is found on the national level, through AguaClara's membership in the Red de Agua y Saneamiento de Honduras (RAS-HON), a national network of organizations from public, non-profit and international development sectors concerned with water and sanitation. This organization has published a number of interesting studies and articles on the state and challenges of water provision in Honduras, highlighting community governance issues, as well as gender, poverty, decentralization and issues related to national governance. There is a similar space sponsored by the government called the "Plataforma del Agua de Honduras".

Another promising space for learning is the inter-municipal association of plants that APP is working on forming. The idea is that here Board members from different villages with AguaClara projects can share experiences and learn from one another. Two meetings have been held so far in which this dialogue has taken place. However, the association is not yet self-sustaining. It depends on APP, and I think Antonio in particular, to organize and convene the meetings.

There are also further opportunities for collaboration and learning regionally with the AJAMs--the municipal associations of boards that represent rural communities--, and nationally with the AHJASA, the organization that represents some of Honduras's VWBs.

Human Capital

No water system is foolproof, and AguaClara's technology is especially sensitive to the ability of its operators. In contrast to many modern systems, which use electro-mechanical control systems and effectively prevent the operator from being able to control the plant while monitoring its performance, AguaClara is designed to be controlled by a plant operator who can observe the processes and adjust them at the same time. In this sense, the plants are designed to reduce to a certain extent the need for high levels of human capital, though not reduce it entirely. The plants are designed to be comfortable and easy, but not to reduce the operator to an automaton, (personal communication with Monroe, 8/30/11). The tasks of measuring turbidity, selecting the appropriate dose of chemicals, observing the water all require a trained operator working at the plant. The operator also records observations, keeps track of chemical inventory, and does regular cleaning and maintenance of the plant. Other skills that are necessary for proper system functioning include accounting skills for the treasurer of the VWB, facilitation skills for the chairperson, secretarial skills for the secretary.

A Fulbright report written by an AguaClara engineer underscores the importance of having capable and committed operators. According to the report, "the presence of the operator [at the plant] was the most important factor for producing good quality water" (Smith, 2010, 3, my translation). The author had found that when operators were not around, the plants didn't work well. The reasons for leaving were varied, sometimes they just were being pushed beyond human limits, assigned to work over 80 hours a week, sometimes negligence or personal emergencies (Smith, 2010). But presence wasn't everything. The same report mentions that some water quality problems resulted from operators' incomplete

understanding of how to work the plant (ibid.: 51), an explanation which was repeated in an interview with Georgia Kayser (11/2/11).

The skills needed for successful running of the AguaClara plants can be organized into three sets--those related to management, those that are technical and have to do with operation and maintenance of the plant, and those that are financial.

The training Antonio carries out contemplates all three sets of skills. The first module he studies is on Organizational Strength (*Cronograma Social Alauca*, undated Excel workbook), and includes short courses on organizational roles and functions of the general assembly, VWB, and committees, leadership and community participation, teamwork, a SWOT analysis and basic accounting for treasurers. The second module is on Water Quality and covers the relationship of water to health, ways of measuring water quality, and the Honduran legal framework for water quality. This is especially geared towards health workers, the mayor and other municipal administrators, and the plant operators. The next module is on Water Treatment, and includes information on both AguaClara technology and other types of treatment systems. It is primarily for VWB members and plant operators. The fourth module is on Basic Math Skills and is intended especially to help the operators learn to measure well and carry out the necessary arithmetic for adding chemical doses. The last model is on Operating and Maintaining the plant, and includes information on calculating appropriate tariff levels. Each module takes 2-3 full days of training (interview Antonio, 10/24/11). The classes are later complemented by on-the-job training, especially for operators. Currently, all trainings are carried out by Antonio Elvir, using slides, handouts, and group exercises.

Training in technical skills is particularly strong. Aside from the modules mentioned above, Antonio budgets three days a week for three months to accompany the operators day and

night with the tasks of the plant, including proper dosing, cleaning, and bookkeeping (APP, "Cronograma Social Alauca", n.d.). After three months are up, engineers still visit each plant every few weeks to check on the equipment and test the water. Antonio visits regularly and transcribes the notes and measurements of the operators to electronic format for APP's analysis.

Training for the other skill sets, however, is less developed. For one, the related training materials appear fairly rudimentary. For example, the presentation on leadership includes slides that list qualities of good and bad leaders, and behaviors to avoid (*Liderazgo* course, undated presentation). This information may be correct, but merely the reading of a list of 13 good characteristics and 13 bad probably won't translate into people internalizing these. It is hard, however, to for me from 1000s of miles away to determine exactly what transpires during the trainings from a reading of the presentations and training schedule. Also, although Antonio mentioned that he did do on-site training for Board members to help them with their tasks as well, no special time is allotted to do so in his six-month plan for Alauca.

Related to, and more important than, the training is whether the human resources with the above skills actually exist. Some proxy measurements for management, technical and financial skills on a water board could include the number of meetings in a year and presence and quality of minutes, the quality of the water from the plant and presence and quality of notes from operators, and collection rates and rate of savings of VWB. According to Antonio, the VWBs are all meeting at least once a month, all of them have up-to-date water user lists, and all of the Boards have savings (personal communication, 1/4/12). All operators monitor the plant functioning on a daily basis, recording their observations in a journal (ibid.).

There is still progress to be made, of course. In Támara, for example, despite the months of training, the operator still made mistakes when applying chemicals, mistakes which affected the water's quality (Smith 2010, 173). The operator continued receiving training and visits once a week, and did improve his skills, but kept on making mistakes when applying the chemicals (ibid.) This operator was replaced.

Other specific skills that the literature has listed of importance include budgeting, contingency and expansion planning, understanding audits, conflict management, and facilitation. While the VWBs may not have the human resources with these capacities, AguaClara as a whole might, at APP and in the Cornell team. But these may be in short supply as well. As noted earlier, the ability to raise funds for capital expenses is mostly limited to Monroe and a few Cornell engineers working for APP. While AguaClara recently has been partnering with staff from other departments and staff at Cornell (including from City and Regional Planning and the Atkinson Center for Sustainability), this is one bottleneck preventing expansion.

The physical working environment can also enhance or hinder the operator's experience. In Ojojona, the lack of a roof, bed, and electricity discouraged the operators from caring for the plant when it rained and at night (Smith, 2010).

Political Capital

In this section I consider two general aspects of political capital. First, the existence and quality of the relationships AguaClara communities and organizations have to power structures, which determine to a great extent the degree of ongoing support—financial, technical, and otherwise—that the communities require for sustaining the projects. Second, I look at the country's policy, legal, and regulatory frameworks, as the literatures refers to these as the enabling environment for proper water system functioning.

Ongoing Support

The need for ongoing, and often external, support was perhaps the idea that received the most attention in recent publications on community-based water system management (e.g. Lockwood and Smits, 2011), and in the conversations I had with experts in the area (Gasteyer, personal interview, 10/17/11; Kayser, personal interview, 11/2/11). There is virtual consensus that small community organizations cannot maintain services over a long term without significant external support. This support comes in many forms, technical, financial, social—for instance, helping repair a clogged filter, accessing financing for a plant expansion, or mitigating problems of corruption in the community (e.g. Tayong and Poubom, 1999).

It should be said, though, that AguaClara's nested governance structure provides significant support for the system overall. VWBs receive broad support from APP, which in turn receives support from the Cornell team, especially in technical questions.

While many authors have underlined the importance of governmental support for the long-term sustainability of the water system, in Honduras, substantive state support does not seem forthcoming. While there is a national legislative and regulatory framework, the relevant institutions do not seem to have the resources to help much. Antonio characterized AguaClara's relationship with the national government and SANAA, the organization in charge of offering technical support to communities, as one in which they neither help nor interfere. SANAA does have a list of water system categories with a list of recommended interventions (SANAA, 2009, quoted in Lockwood and Smits, 2011). Also the legislation does recognize the legitimacy of the VWBs and their legal ownership of the system, a recognition that, according to the literature, goes a long way (Fabricius and Collins, 2007; Ostrom, 1990; Lockwood and Smits, 2011).

While the link to government may be weak--or the state institutions may be weak in themselves--, AguaClara does enjoy strong connections to other key stakeholders, stakeholders whose importance is underscored in the literature. The AguaClara model involves strong partnerships between a university, an NGO, and community organizations--three key partners (Fabricius and Collins, 2007; Carter et al., 1999; Hardoy et al., 2001). It also engages international donors, and some opportunities for connection to public institutions. For example, the VWBs are structured such that the mayor delegates one non-voting member to the Board. According to national water policy, these local water management structures are supposed to be supported by SANAA, be regulated by ERSAPS, in the context of policies and strategies set by CONASA (Ley Marco del Agua, 2003).

Currently, the bulk of the direct support communities receive comes from APP. APP trains board members, operators, helps secure funding for the construction, oversees construction, and then accompanies operators and the VWB during the first six months to a year after construction. Once the plant is operating, Antonio, for example, spends three days a week for three months with the operators at the plant, ensuring they understand how to correctly dose the chemicals, take readings, record observations, etc. He especially makes sure to be there during heavy rains in the rainy season, when turbidity is highest and the plant requires the most attention.

But this support lasts some three months. Afterwards, although APP staff do visit occasionally to check on the plants, communities basically fend for themselves. The administration of the plants and other 'social' components receive little attention after the initial round of training. Antonio mentioned that after that initial period of training "the social problems are outside our reach", and that his energies were focused on the new plants, because "that is where our

salaries come from and there isn't enough funding to attend to the old plants" (interview, 10/24/11). He lamented this situation, as he is aware of several problems currently facing the plants--Marcala's operation and maintenance plans, for example.

Another limitation to APP's support is related to physical proximity. All but one of the nine plants are clustered in the same department as Tegucigalpa, the capital, where APP is also headquartered, or in the departments directly adjacent to it (the exception is Atima). Antonio mentioned that he was able to visit Ojojona in particular as much as he did because it was so close to APP's headquarters. As other plants get built further away from the capital, APP's ability to support them may be more limited.

Antonio mentioned an idea to address the lack of continued support--an association of plants that could pay for a staff person to offer post-construction technical and organizational support to the villages and towns with an AguaClara plant. This person, who is referred to in the literature as a 'circuit-rider', could also offer community education, VWB and operator training and refreshers. While two meetings of members from all the VWBs have been held organized by APP, the association does not yet have a life of its own.

IRWA, which has over 20 years of experience using circuit riders to support rural water providers, including AguaClara projects, could provide circuit-rider training and supervision, and might be able to help find resources to pay or partially subsidize the expense.

A circuit-rider model could provide necessary post-construction assistance with maintenance, which is crucial to long-term quality service (Carter et al., 1999), as well as with ongoing training of the VWBs and operators. The circuit-rider would most likely be able to offer little assistance, however, in another critical phase of the system's life-cycle: when the

infrastructure needs major repairs or expansion. While the plants are designed to last 20 years, communities may face situations earlier that require significant capital to repair or expand the capacity of their plant. As mentioned earlier, Ojojona already needs money for a roof and to repair some parts of the plant. Agalteca also needs financing to fix its water source pipe. Currently AguaClara doesn't have the capacity to offer this kind of support, and the communities are either not connected to other institutions with resources or their connections don't have resources (like municipal and national governments) to finance this work.

Carter et al. state there is empirical evidence that shows community motivation to participate and support the local project may wane two to three years after construction (1999, 195), and that outside intervention is necessary to maintain high levels of commitment and motivation. AguaClara currently does offer continued technical support to communities, both through APP's support, and through periodic visits by members of the Cornell team, including groups of some 20 students who visit for two weeks in January. Monroe visits twice a year. According to Antonio, these visits motivate local water users, and reinforce the importance of the plant in their minds.

But can there be too much external assistance? Chuck Brown suggests that the regular visits of the Cornell engineers working for APP is excessive "handholding", which isn't allowing the local organization the necessary space to strengthen itself (interview 11/6/11).

External Environment

As noted before, this category receives a lot of attention in the most recent publications on sustainable water supply and refers to the presence policy, legal and regulatory framework of a country. A number of authors refer to this as an 'enabling environment', such as the presence of policy that stipulates water is a right, legal recognition of community-based

management, and national institutions that offer support to decentralized water services. This is a component of capital over which AguaClara obviously has little control; nevertheless it is one that is important to look out for, especially as AguaClara considers expanding to other countries. Here I will comment briefly on the environment in Honduras, in order to identify relevant opportunities and constraints there within which AguaClara has to operate.

Honduras has national water policy, and related institutions. This might reflect the country's giving value to providing clean water throughout the country. SANAA, which used to be in charge of all water provision and is in the process of devolving this responsibility to municipalities and water boards, uses "Water ... A Human Right" as its tagline on its website (SANAA site, n.d., the ellipsis is theirs). According to Antonio (personal communication, 4/9/12), the national constitution was recently reformed and refers to water as a human right. The first 'basic policy' CONASA's is to "support the decentralization process with citizen participation and strengthening of local government" (CONASA site, accessed 12/13/2011, my translation). And ERSAPS, the regulatory body, exists with a mission to "ensure the law is obeyed in order to...guarantee all Hondurans have access to services of potable water and sanitation of high quality and efficiency" (although no regulations per se were found on its website [12/13/2011], my translation). These statements suggest that the country intends to support such local initiatives like AguaClara.

APP is a member of RAS-HON, the Honduran Network of Water and Sanitation, which brings together members from government, international donors, national NGOs, UN agencies and others to share information and resources on water and sanitation. It has produced several analyses of the challenges of water provision in the country, and is a good forum for networking and sharing ideas. This may be the key platform where national policy and

regulations can be impacted, and resources leveraged. There is also the nationally-sponsored *Plataforma del Agua de Honduras*, and the associations of VWBs on national and regional levels. These may potentially contribute to an environment that is conducive for water projects, with accessible materials, shared knowledge, technical and financial support, and legal resources.

Analysis Summary

AguaClara's governance model is strong; its various layers of governance appear to have the capacity to steward, develop and marshal the requisite capital needed for sustainable water delivery. AguaClara's physical capital appears particularly robust, which suggests it may be able to compensate for weakness in other areas such as financial and human capital. AguaClara's social capital is also substantial, especially in the areas of trust and community participation. Some weaker areas include financial capital, especially that necessary for major capital investments in construction or repair, and human capital, since a great part of its accumulated learning is found in a few individuals. Political capital, in the form of regular and effective ongoing support, is also of concern—one which AguaClara is actively addressing. A summary of my analysis of all the capitals and the idea of external support is found in the following table.

Table 5. Summary of Analysis

Capital	Question	Evidence
Natural	Does the community have access to a river that can meet its needs for water supply?	This is a criteria used for selecting communities, and is a given in this study. There is some concern over control of the source at times.
Physical	Is the plant and distribution system suited to local condition?	Built with locally available materials and local talent. Run and maintained by locals, with materials they have access to.
Financial	Do system have, or have access to, funds to cover engineering costs, capital expenses, and O & M?	Engineering studies are free. Communities are paying O&M. They contribute 30-40% in-kind for construction. Haven't incurred other capital costs yet. APP and AguaClara has limited capacity to raise funds for capital costs. May be difficult to access funds for future capital expenses for existing plants, and for large-scale expansion of technology. The very poor are currently excluded from water provision.
Social	Do communities feel like the systems belong to them? Is there trust in the community?	-Space to participate in General assemblies, construction, committees, and VWB meetings -Show ownership and motivation by paying--high payment rate -Structural variables present: small communities, face-to-face, CPR, and iterative process contribute to trust -Individual values of trust, reciprocity present and enhance collective action -Solidarity from Cornell staff and students motivate APP and community members -APP and Cornell partners consult together as equals on big-picture planning in Honduras -Community participation mostly in implementation; capacity to participate in consultations or in bigger picture not systematically looked at
	Is the system managed well?	-Have constitutions, though unsure how much use them -Some communities use contracts with operators; most do not -Have graduated sanctions and ways of getting rid of water users and operators who don't behave, but difficult to do the same with VWB members -Some incentives exist: salaries for operators; some remuneration for treasurer; non-monetary incentives like community recognition, opportunity to serve, etc. -Degree of facilitation of communication between various levels of governance, and with community -Minor maintenance schedules and some money saved in banks; however, major repairs, and advanced planning--asset management, sudden events, life-cycle costs--do not exist
	Is AguaClara able to learn from its experience?	-Active, ongoing systematic learning on physical plant -Learning about community-based management has taken place, though most learning centered in single individual (Antonio) -Communities have spaces for reflection and learning--Board and Assembly meetings -Iterative process exists--with respect to working with certain individuals, voting for Board members, management tasks, operating -No formal system for encouraging or systematizing learning

Human	Do Boards members have management skills?	-Training in management skills quite rudimentary -Boards do meet at least monthly, and keep minutes of their meetings -Conflicts can be resolved in Board meetings, or in Assemblies -Board is elected every 2 years, for a max. of two terms, though this isn't respected everywhere. -Some Board members are in it for personal gain; others seem sincerely interested in serving community -High payment rates suggest users happy with service
	Are operators able to run and maintain the infrastructure?	-Strong training, accompanied by three months of accompaniment on site, and regular follow ups. -Plants mostly functional -Strong accompaniment by AguaClara engineers to some plants, who provide continued training and help fix things
	Do Board members (and others) have capacity to manage funds, and solicit more?	-There is training in bookkeeping. -All use bank accounts and have some savings. -Yearly audits are conducted by the 'fiscal' member of the VWB. -Capacity to solicit and manage large amount of funds is currently with Cornell team, especially engineers at APP
Political	Do AguaClara communities receive sufficient ongoing external support?	-Enjoy varying levels of municipal support, in one case plant is run by municipality -Have low level support from SANAA, and health authorities -Regional and national support mostly absent -Connected to several national water networks, where share information, network -Strongest support is from APP and Cornell -Have connections to international NGOs, which support specific projects
	Is there a national enabling environment for water service provision?	-There is a legal framework that requires water to be administered on a municipal level by non-profit water boards -National decentralized funding, which makes money available for water and sanitation for municipalities; however, AguaClara projects have not been successful accessing this money -National framework for policy (CONASA), regulation (ERSAPS), and tech support and service (SANAA); -Several networks for sharing knowledge in the sector (including RAS-HON and the Plataforma del Agua de Honduras) -Regional (AJAMs) and national (AHJASA) associations of Water Boards

Conclusion and Recommendations

The purpose of this report is to gauge AguaClara's sustainability and possible growth through the lens of its governance model. Specifically the report asked whether this model successfully stewards, develops, and marshals the necessary natural, physical, financial, social, human, and political capital to sustain and expand the benefits of its water projects. In the previous section I analyzed the strengths and weaknesses of each form of capital in light of the literature on water governance; in this section I will synthesize the insights from this analysis to provide an answer to the questions of expansion and sustainability--including sustaining the current level of functioning, and enhancing the impact of the water system.

Strong and Weak Capitals

AguaClara communities and institutions count on substantial amounts of each of the six capitals under consideration and appear ready to both sustain their operation for years to come and support a moderate level of expansion. However, deficiencies in certain capitals may affect how long the projects will be sustained, the rate and success of expansion, and the impact of the plants on the communities.

While natural capital in the form of sufficient surface water and land to build on is always present in the communities, there is at least one issue that AguaClara needs to address. This is control over the water source. For AguaClara communities to sustain their operations, they will need to control the source. AguaClara should add this to its list of prerequisites for working with communities. This may be a non-issue if VWBs or municipalities already always control this. However, it would be useful to add to the checklist.

Physical capital appears to be another strong suit. The plants are made locally, with locally-available materials and labor, and are run by local workers. And they work, providing the users with abundant clear, safe water most of the time. This represents a substantial impact. Naturally, for the plants to sustain this accomplishment, the plants have to last. While they are designed to last 20 years, and since they have been made well they may last much longer than this, none have been around this long to test this design. Embarking on serious repairs may be a question that communities have to tackle in a shorter time frame, a task whose difficulties I mentioned in a previous section, and will come back to later. Perhaps more likely, they may have to expand in order to accommodate increased demand, or be upgraded to incorporate improved treatment technologies (e.g. the rapid sand filter).

The distribution system is also part of the communities' physical capital and should be included in AguaClara's calculations and planning. While all the communities where AguaClara is working have piped distribution systems to homes, the condition of these pipes is uncertain. Leaking pipes can lead to insufficient supply. I will comment on the need for a more holistic approach to water supply later in this section.

Financial capital is present at a community level, in the ability of water users to regularly pay the water tariff, and at higher levels of AguaClara governance, in the ability of APP and Cornell staff to solicit and receive grants to cover research and capital costs for the plants. The concern here, of which AguaClara is well aware, is twofold: being able to access increasing amounts of funding for new construction, and doing so to pay for significant repairs or expansion of existing plants. It is AguaClara's intention to completely turn over the plants to local control (in order, in part, to dedicate its efforts towards working with new communities

and plants). If this occurs, these local communities currently do not have the capacity to access large amounts of capital for repairs/expansions that entail a significant outlay of funds.

Some communities may be able to pay for these repairs themselves through debt financing, and AguaClara is currently exploring a model for this. This model may also be used for construction of new plants. However, in either case, the local communities would need help employing the model, and accessing the loan. Municipalities are supposed to have significant amounts of money to support water and sanitation work in their respective towns and villages; if the VWBs could access these funds--which are indeed intended to support their work--this may provide another solution to the dearth of capital financing.

Social capital I looked at in terms of community ownership and trust, good management, and a capacity for adaptation or learning. AguaClara has demonstrated its capacity to learn and adapt over the last six years or so. The improvements to the treatment system is one example of this capacity. In terms of governance, perhaps foremost among the lessons gained is how to create the conditions for community to take ownership of their water system, which has assured the system is cared for, paid for, and protected from malfeasance. This is now accomplished through a series of visits that involve community education, mobilization and training. Since Antonio from APP is the person who has been most directly involved in these activities and in charge of them, he seems to be the person who has internalized many of these lessons. While some of what has been learned has been incorporated into training modules (whose curricula is compiled in a series of slide presentations), my guess is that much has not. How community leaders and members are approached, in what order, what is said or shown to them, when meetings are planned, how people are invited, how they should be organized and conducted, for example, are among the lessons that may primarily be found in

Antonio's mind. Antonio is someone who not only knows a lot about community mobilization and education and the AguaClara technology, but also is someone who seems to be seen by community members as someone who is credible and trustworthy (perhaps akin to what Gramsci describes as an "organic intellectual"). This may be a key factor in empowering a community that will then take charge of its water system, versus another approach that may convince the community but end up disempowering them.

I mention this especially in regards to future expansion of AguaClara's technologies. If AguaClara ends up partnering with other 'implementation partners', NGOs like APP or even private companies, it may not be easy to find people who can work on the ground like Antonio. He may embody a significant amount of social capital, and may be crucial for unlocking this capital in the communities. Finding and/or training people like Antonio may prove to be a significant challenge towards expansion.

It is not only Antonio who contributes significantly to the project's social capital. Other AguaClara staff also bring in valuable contributions to this spirit of trust and ownership. The spirit of service that characterizes Monroe's involvement, as well as that of many of the students in the research program, provides a regular source of motivation to community members who may feel validated by their visits, and inspired to be part of an international network of sorts.

AguaClara's present work with small communities further lends itself to building trust, as these small communities tend to possess the structural variables Ostrom (2010) identifies as essential for collective action. If it were to work with larger towns or cities, some of these factors would be no longer be present, and AguaClara would have to establish trust in the

model through other means, or use other governance systems that don't rely as heavily on collective action. This should be kept in mind as AguaClara seeks to multiply its plants.

In the previous section I have outlined some of the strengths and weaknesses of the management practices--especially of the local water boards. While the VWBs appear capable of running the water system, since this management ability is so crucial, it could benefit from additional attention. The training in management practices offered to the communities is very rudimentary, and VWBs could profit from continued support as challenges emerge over time. Perhaps the intermunicipal association of plants could be a forum where such support and shared learning could be addressed. An experienced circuit-rider may also be able to provide such support. Whatever advances Boards make in their management will surely spill over to other collective endeavors the community undertakes, and make it worth the investment.

The importance of human capital has already been underscored above in the comments made on the key role Antonio—a single individual—plays in the success of AguaClara's projects. That operator error is the primary cause of plant malfunctioning also highlights its importance. Furthermore, human capital is lacking both at Cornell (Monroe can only do so much) and in Honduras at APP: Monroe and the AguaClara engineers can only handle a certain number of plants at a time and currently their hands are full. Since human capital is so important, training and retaining talent will be crucial for both sustainable community water system functioning and AguaClara's expansion to other areas. Antonio and other AguaClara staff are already aware of the importance of paying operators an attractive wage, so I will not go into that here. I will, however, expound a little on the importance of training.

Training is one of the factors that is related to proper plant functioning in the six communities where AguaClara has worked. Where the period of training and community education did not

take place (Ojojona and La 34), the communities struggled with mismanagement and a lack of ownership. Antonio has done his best, with some help, to put together a series of training modules on governance, water quality, plant operations, and basic math skills. However, this curriculum could be significantly improved with a relatively small effort. (Operator training is currently robust, and may not need such revision.) Perhaps Antonio could be helped to think through what the community, the VWB members, the operators need to know and be able to do, then come up with the relevant concepts to understand and skills to master, and then craft materials with pertinent readings and exercises. Especially if Antonio can draw on real examples of problems and exercises that have come up in the field, these materials can be much more effective than they currently are. Continued training could also be offered through circuit-riders, who could be expected to contribute real-life problems and cases to the evolving educational materials. The curricular design might benefit from consultations with other people and institutions, including other organizations in the RAS-HON network. University scholars in fields of community development and adult education may also be helpful for developing better materials.

I looked at political capital in terms of ongoing external support, and an enabling political environment. As noted before, external support in the form of financial, technical and other forms of assistance is critical to sustaining functioning water systems. The lack of a plan for ongoing support for AguaClara communities perhaps constitutes the greatest threat to the sustainability of their water systems.

There are three possible sources for this support--municipal and national government, circuit-riders, and the association of communities with AguaClara plants. Some authors claim that ultimately it is the public sector that has to step up to the plate in order to ensure sustainable

provision, and this possibility should receive topmost attention. If municipalities are indeed receiving 6% of the national budget, then municipal governments would be in the perfect place to offer such support. APP and VWBs in each locality would do well, then, to build strong relationships with their respective municipal governments in order to help channel the funds appropriately. Circuit-riders and an association of plants may well not have as much capacity to access significant amounts of funds, though they may well be best suited to offering long-term technical and educational support. The associations of water boards, AHJASA and AJAMs, and the FHIS may also provide potential outlets through which to influence government in order to receive support. Different kinds of external support may come from different sources, not a single backstopping agency.

Why doesn't AguaClara work with IRWA as they have over two decades of experience with circuit-riders in Latin America? One study showed that the cost of the circuit rider model was under $1 a year per household (Kayser, 2011). If incorporated into tariffs, this would amount to less than a 10 cent increase per month, or 3% increase from present average rates. However, Daniel Smith suggested that IRWA was no longer in Honduras and that the circuit-riders from ADEC which they helped set up don't have a good reputation (group conversation 2/6/12). Another option is to support APP in developing the capacity and the financing model in order for it to be able to provide backstopping support.

Honduras is making progress towards creating an enabling environment for community-managed water systems. As noted in earlier sections, it has regulatory, policy-making, and technical support institutions at various levels of functioning. These have to be strengthened, of course. However, the country seems to be taking water seriously, and at least in some ways supports AguaClara's work (e.g. water system management has been decentralized, and

funding is made available for water and sanitation to municipalities). This is important to keep in mind as AguaClara thinks of building new plants and venturing into new (national) territories. Whether other countries have as good a political environment, better, or worse, should enter into the equation.

In a group conversation on 2/6/12, Jeff Will, a Fulbright Scholar in Honduras, mentioned that SANAA has expressed its desire to use AguaClara technology for all their new plants. If this is so, it seems like opportunity not to be missed, as having SANAA behind the new plants would address questions of financing and long-term external support.

External factors cannot be ignored. The creation of an enabling environment--through appropriate legal, policy, and regulatory frameworks, and a supportive government--is the grease to the machine. Things can work without it, but with great difficulty. AguaClara needs to pay attention eventually to contributing to the creation of this environment, by building relationships with relevant national authorities, participating and promoting dialogues in the sector, and advocating for such policies and support on a national level. AguaClara is already doing this. Both through APP and with Cornell's staff it has been building relationships with SANAA, the health department, and participating in national dialogue and organizations such as RAS-HON.

Expansion, sustainability and impact

The concern I've heard most from people associated with AguaClara at Cornell is the rapid multiplication of AguaClara plants around the world. Monroe has talked about "scaling up", about the technology "go[ing] viral" (Weber-Shirk, AguaClara ScaleUp, 10/15/2011). There was a sponsored discussion of the topic at Cornell's Atkinson Center for a Sustainable Future in

October, 2011, and a number of consultants have gone to Honduras with the question of how to expand.

First of all, “scaling up” might not be the most appropriate term. It often means taking a technology and growing it to reach a scale where it is more efficient--i.e. reducing the cost of production per unit. If I understand correctly, this is not what AguaClara is doing, although cost reduction is a concern. What AguaClara wants is to *diffuse* or *disseminate* its technology. (SURWS [2005], however, does use the term *scaling up* in terms of multiplying successful models of water supply to achieve sustainable universal coverage.)

These discussions on AguaClara dissemination have been framed in a particular way: AguaClara plants are considered ripe for expansion because the world needs this innovation, and the major bottleneck is financing--for building the plants, and to pay for technical support for the new implementation partners. The discussion at the Atkinson Center focused entirely on financing alternatives for new plants, with a focus on debt financing and for-profit schemes. In a document on Scaling Up written by Monroe, he underscored the need for financing to pay for “adequate technical support for new implementation partners”, and that this was “the critical missing component at Cornell” for AguaClara “to go viral” (Weber-Shirk, 10/15/2011).

While finding sustainable sources of financing for plants and technical support are a real challenge, there is a real danger that AguaClara may overemphasize the importance of the physical infrastructure and technical support at the expense of social factors, which, as amply illustrated throughout this report, are crucial to water system functioning.

Antonio spoke of this danger. Although his words may not be applicable to AguaClara engineers, who I think are becoming increasingly aware of the social dimensions of water systems, they serve as a useful reminder:

> In Honduras engineers could care less about the educational component [of water systems]. The engineer will tell you, "Give me cement and steel and I'll build you something". But they never participate in community meetings because they think it's a waste of time, that the people there are ignorant and won't pay attention to them, and that people just don't care. … I, on the other hand, as an agent of social development, believe in people. I believe that we have to teach them, and believe they can learn. This is what has helped us a lot in AguaClara--make sure the people become educated, help them learn by example, with patience, with spirit, with enthusiasm. This is what makes us different; this is what ensures the plants are maintained" (interview, 10/24 /11).

AguaClara engineers are becoming aware of this. Daniel Smith, an AguaClara engineer working for APP in Honduras, said "right now our tech capacity is exceeding our institutional capacity", and spoke about governance as "pivotal", adding: "Governance is what stays after the six-months [of construction and training] is over. And it needs to be a goal of the project to facilitate that part …" (interview, 11/10/11). In a more recent group conversation, other engineers expressed similar hesitation. Michael Adelman highlighted the human capital limits: in Honduras APP and the Cornell engineers can't support any additional plants; and in Ithaca the research team is also already stretched to be able to support more plants and do administrative work. Jeff Long added that the technology itself was "not ready to package, spread and replicate" (group conversation, 2/6/12).

Governance and social capital in general take a long time to build. They deal with intangibles such as trust, honesty, and community participation, and require changes in culture (ours and others). In this context it may be encouraging to remember that the benefits of social capital extend beyond ensuring the success of water systems (which are important in their own right).

Building up relationships based on mutual understanding and reciprocity will enable materially poor communities to extend their problem-solving capacities beyond water, and tackle other pressing issues the community is facing and may face in the future. Since such work requires resources--especially staff time--, it will be important for AguaClara to help donors appreciate the "long-term positive pay-offs" of such efforts, as Flora said (2004, 12).

The insights into the vital role of governance may have implications for AguaClara's "open source" philosophy. In particular, I can imagine that the open-source design tool may work against AguaClara's goals of expansion and provision of quality water to the poor. The open-source design tool may give the appearance that the plants are a kind of stand-alone, do-it-yourself technology; however, we know that technology is only half of what makes the AguaClara plants function. If you get the plants built and installed correctly, which probably isn't easy in itself, you still have to worry about the processes encompassed in governance--building trust, managing money, dealing with conflicts, maintaining the plant, and so on. This knowledge is difficult to explain in a manual (which doesn't exist anyway). As noted before, much of what has been learned about this is incorporated into the way AguaClara's staff function. If other communities, NGOs, or even SANAA, use the design tool to directly build a plant, the water system may not be successful if the governance issues aren't addressed. The community and institution may end up becoming disheartened with the technology as well, thwarting future possibilities of collaboration, and sullying AguaClara's record in the eyes of potential donors.

One of AguaClara's burning questions in regards to expansion is who to partner with, and is considering different implementation partners and models, NGOs, public, and private. As noted in the literature review, there is a raging and large debate regarding the relative benefits

of public vs. private provision of water. Without opening this Pandora's box, there are a few considerations AguaClara should have in mind if considering a partner from the private sector. Foremost among these is that a for-profit approach may compromise the spirit of trust and collaboration that has been central to the success of the AguaClara plants in Honduras. People contributed time, labor, and money not only because they were receiving a good product, but because they have a sense of ownership of the plant. Private companies may also find it more difficult to reconcile their aims of profit with the needs for community education and participation, as these can be costly, without any direct or immediate monetary returns. That said, there may be some private firms whose values may make them potential partners for AguaClara.

Some authors are convinced that community-based management may be the best strategy for water provision in rural communities (SURWS, 2005) in the face of current political and financial constraints. If communities don't do it themselves, so goes the argument, no one else will--the public sector is either incompetent or too corrupt, and the private sector can't make a profit there. While this may be accurate, AguaClara may find over time that different communities are served best by different ownership and governance models. Ostrom (2004) placed great emphasis not on a particular institution to manage common pool resources such as water, but rather on the *match* of these institutions to each community's particular physical, natural and social circumstances. Marcala, for example, does not use community-based management; the municipality runs it, and runs it successfully (though Antonio has some qualms about it). This is AguaClara's largest plant, and may indicate that larger communities may allow for and/or afford other kinds of governance structures that don't rely as heavily on some aspects of social capital, like community participation. They even may be better served by these.

It may make sense then to talk not of a single governance model, but of governance models that suit the different realities of diverse communities. While much has been learned regarding community-based management in small communities--which may well be the main model for such communities--other models may emerge over time. AguaClara's governance model may be partnering with an organization that is well acquainted with the community, and which can set up a local governance structure that fits well in the context. Understanding what types of governance models work well in what contexts would be a useful future study.

Now a few words on impact. In keeping with the spirit of service in which AguaClara was founded and currently operates, AguaClara's desire to expand is not for expansion's sake, but to have a large impact on the lives of people in communities that adopt the technology.

Carter et al. (1999) suggested that water and sanitation projects be evaluated through the two lenses of impact and sustainability. These two are obviously interconnected, since to ensure impact over time one must sustain the intervention. The AguaClara plants appear to meet or exceed almost all the criteria spelled out in Carter et al.'s framework which appears in Table 6 below.

AguaClara plants serve hundreds of liters a day of clean water per capita in each of the six communities. This is much more than the benchmarks of 60 liters/day/capita on demand that Lockwood and Smits qualify as high service level (23). The water is clean, with NTU below 5 for most of the time and no coliforms. With stacked rapid sand filtration, e.g. as in Támara, it is likely under this benchmark virtually all the time. Monroe suggested using turbidity and residual chlorine levels as proxies for water quality (personal communication, 2/12/12).

Table 6. AguaClara Impact and Sustainability

Carter et al. (1999) objectives in relation to "Impact"	AguaClara	Carter et al. (1999) objectives in relation to "Sustainability"	AguaClara
a. Achieve a daily consumption of at least 20 liters/household	1780 liters/household average plant capacity	a. Caretakers should be in post and fulfilling their assigned job descriptions	This is generally true. Operators who have left their post have been fired.
b. Reduce the time spent in water-carrying to a maximum of one person-hour per day	Water is piped to homes. Negligible time spent collecting.	b. Committees should be meeting regularly, keeping minutes, and functioning in a manner which is acceptable to the community	Water boards meet regularly, keep minutes, and seem to meet community standards
c. Bring about significant improvements in water-carrying technology	Piped to homes.	c. Revenue collection should be taking place in the manner agreed at the construction phase, or in some other effective way	Water rates are set by the general assembly, and are collected according to agreed upon methods.
d. Achieve a water-quality target of 10 faecal coliforms/100 ml at the point of use	No coliforms measured (Smith, 2010: 86)	d. The backstopping agency (government or NGO) should be in regular and effective contact with the community	While in principle AguaClara turns over the plant to the communities after 6 months, APP is in regular contact with most of the communities, though mostly for technical and water quality issues.
e. Achieve equity in all aspects of service provision	While water rates are low, some households are not connected to clean water.	e. The use of water supply … should be continuing at high levels	Water supply is continuous.
f. Supply these services [water and sanitation] at a per capita one time capital cost of no more than $42	Per capita one time capital cost between $12-35	f. Physical infrastructure should be fully functional	Six plants fully functional.
g. Supply these services at a per capita recurrent cost of no more than $4.2/annum	Per capita annual O&M costs between $3-7.		

Source: Carter et al. (1999). Figures cited in the original are expressed in constant 2012 dollars.

Obviously, these issues beg the question of AguaClara's intent. If good treatment plants are its mission, then it could rest on its laurels; but if it is concerned with bringing clean water to poor, often marginalized peoples, then it will have to broaden the scope of its analysis and activities. For example, if it is not only concerned with water, but more broadly about health and quality of life, then it may also have to think about sanitation and community education in its planning and operations. Otherwise people may have clean water but not have clean hands or a way to properly dispose of sewage.

The "Service Delivery Approach" (SDA [Lockwood and Smits, 2011]) is one approach to water services that goes beyond the implementation of a (good) water treatment and distribution system and encompasses long-term post-construction support. AguaClara should adopt this approach, so that explicit and systematic work building local capacity for financial and asset planning, and long-term assistance is included from the outset in project proposals and executions.

Evaluation

AguaClara may want to adopt a framework for evaluation based on some of the considerations specified earlier. In addition to data on the cost of water and its quality at the point of use, AguaClara may consider its question of equity. In particular, it may want to evaluate the percentage of people in a community that have access to, and are receiving the service. In this respect, as AguaClara, in consultation with the VWBs, looks for ways to provide universal access to water, it might be useful to remember that this need not mean that everyone needs to receive piped water in their own home (though this is arguably the best scenario). If cost is an issue, other distribution technologies such as public standpipes can be used to provide access to populations that can't pay. As Satterthwaite and McGranahan (2007) point out, what

is needed is "… the best possible mix between good-quality convenient provision, what [communities] can afford, and what can be managed locally" (42).

Other indicators that AguaClara might consider using to evaluate its impact and sustainability are related to proper management and participation. Two relevant proxies may be payment and savings rates for proper management, and the proportion of women in the Water Boards and as operators as a proxy for participation. Below is a possible framework for evaluation.

Table 7. Recommended Guidelines for Evaluation Based on Recent Literature and Author's Analysis

Impact	Standard	Sustainability	Standard
Quantity	a. Achieve a daily consumption of at least 60 liters/per capita/day[a]	*Payment rate*	a. Most or all of the tariffs are collected
Quality	b. < 10 faecal coliforms/100 ml at the point of use[b]; NTU < 5 and residual chlorine at specified targets[c]	*Savings*	b. VWBs should be saving a certain percentage of monthly revenue
Cost	c. Supply these services at a per capita capital cost of no more than $42 and a per capita annual cost of $4.2[b].	*Maintenance*	c. Physical infrastructure (intake, plant and pipes) should be fully functional[b]
Equity	d. Approximate universal service	*External support*	d. The backstopping agency (government or NGO) should be in regular and effective contact with the community and should be accessible to the community[b]
Participation	e. Women and minority groups should be fully represented on the VWBs		

Sources: a. Lockwood and Smits, 2011; b. Carter et al., 1999, updated to 2012 dollars; c. Weber-Shirk, personal communication, 2/12/12; Author's analysis

I think AguaClara can take rightful pleasure in what it has accomplished in terms of technological innovation and learning about community-based governance systems. Its future

is bright. But it still has a long way to go. Which is good news for the program: there are lots of questions to explore and lessons to learn!

I will give the final to word to Antonio Elvir, who sums up much of this report with an apt analogy:

> We should not neglect to follow up with the social education part. It would be a mistake to think only in the technical aspects--in improving the flocculators, the sedimentation tanks, the dosification of chemicals. If we neglect the educational and social component, we are planting for a meagre harvest[1] (personal interview, 10/24/11).

[1]The original is more poetic: "… estamos sembrando para poco tiempo."

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