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Sustainability of Community-Managed Rural Water Supply Systems in Amazonas, Peru: Assessing Monitoring Tools and External Support Provision

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Sustainability of Community-Managed Rural Water Supply Systems in Amazonas, Peru:

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by

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DEDICATION

To my parents, John and Linda, thank you for everything.

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ABSTRACT

Globally, there is still a large number of people without access to safe drinking water; a known health risk. In rural areas of countries like Peru, when potable water systems are built the responsibility for maintaining these systems is given to volunteer water committees. Despite its prevalence as a management model, there is a consensus that community management alone cannot ensure sustainable water service. Therefore, the overall goal of this research is to assess the sustainability of community-managed water systems in rural areas of the department of Amazonas, Peru. Specifically, this research examines two mechanisms that have been shown to improve the sustainability of rural water systems: 1) monitoring for asset management and service delivery, and 2) provision of long-term external support.

In Amazonas, three sustainability assessment tools have been used recently to monitor the service level and management of water systems. These assessment tools are: the Rural Water and Sanitation Information System (*SIASAR*, in Spanish), Tracers in Rural Water and Sanitation (*Trazadores*, in Spanish), and the Diagnostic Survey for Water Supply and Sanitation (*Diagnostico,* in Spanish). The three tools were assessed using a question mapping technique as well as a sustainability assessment tool evaluation matrix. This analysis identified the SIASAR assessment tool to be the most appropriate for ensuring sustainability of rural water supply systems.

This research also used the data collected with the SIASAR and Trazadores assessment tools to assess the state of community-managed rural water systems in Amazonas. The analysis

showed that 81% of systems in the SIASAR analysis and 58% of systems in the Trazadores analysis have deficiencies that are beyond the ability of the water committee to overcome.

In recent years, the Peruvian government has prioritized the creation of an office in each district dedicated to providing external technical support to local water committees. This office, called the *Área Técnica Municipal de Agua y Saneamiento* (ATM), is charged with formalizing and training water committees which are given the name, *Juntas Administradoras de los Servicios de Saneamiento* (JASS).

In order to examine the provision of long-term external support provided by the ATM to the JASS, field research was conducted in six districts in Amazonas. Valuable anecdotal evidence was provided by the field research that helped to form recommendations for strengthening the capacity of the ATM office at the local municipal level.

The results of this research demonstrate that currently a large number of community-managed rural water systems in Amazonas are not sustainable but that the prioritization of monitoring and external support is an encouraging sign. If these mechanisms continue to be prioritized then it is highly likely that water systems throughout Amazonas and Peru will become more sustainable, bringing benefits to millions of Peruvians in rural areas.

CHAPTER 1: INTRODUCTION

With the aim of ending extreme global poverty by 2030, the United Nations in 2015 adopted seventeen Sustainable Development Goals (sustainabledevelopment.un.org). These goals, while commonly seen through a reductionist viewpoint as separate global issues, are increasingly interdependent and will only be attained through coordinated synergy. Zhang et al. (2016) have identified Goal 6, availability and sustainable management of water and sanitation, as one of the system leverage points for improving the quality of life for many of the world's poor. Under Goal 6, Target 1, it is proposed to "achieve universal and equitable access to safe and affordable drinking water," while also proposed under Target 6.B to "support and strengthen the participation of local communities in improving water and sanitation management" (United Nations, 2015).

Established as a basic human right in 2010 by the United Nations, access to safe drinking water is still out of reach for far too many of the world's population. Globally, as of 2015, there were 844 million people who still lacked access to basic drinking water service with the vast majority living in rural areas (JMP, 2017). This number includes those who have access but whose service level is inadequate due to poor reliability, quality, affordability, and quantity. The negative impact to public health presented by inadequate water supply is one of the most pressing concerns for the development sector. For example, globally in 2012, 1.5 million deaths were caused by diarrheal diseases, (WHO, 2014) which accounted for 53 of every 100,000 deaths in lower income countries. A systematic review of interventions aimed at improving water quality as a means for preventing diarrhea has shown that there is a strong link between treated drinking water and a reduction in the prevalence of diarrhea (Clasen et al., 2015). Shifting focus to the rural population, in 2015 14 percent were still using surface water and unimproved sources which is down from 28 percent in 2000, a decrease of over half a billion people. Much of the progress made in reducing that number has come from providing piped water on premises (JMP, 2017) through the construction of water supply systems which in many rural areas of the world are primarily managed by the community.

Community-based management of rural water supply was widely adopted as the default management model during the 1980's International Drinking Water Supply and Sanitation Decade (Schouten & Moriarty, 2003). Adopted by many stakeholders for a variety of different reasons, the transition to community-based management and the demand-responsive approach was a paradigm shift from the largely government-centered traditional supply-driven approach (Sara & Katz, 1997). Governments, non-governmental organizations (NGOs), and other agencies quickly learned that simply building infrastructure was not enough to ensure lasting benefits for the underserved, rural poor and thus gave rise to the demand-responsive approach. Under the demand-responsive approach, communities assume responsibilities throughout the entire lifetime of the project including small financial contribution, labor, and post-construction management with the hope that they will take greater ownership of the system. This usually takes place through the formation of a community water committee that is in charge of operation and maintenance, charging the user tariff, and performing repairs to the system.

Community-based management and the demand-responsive approach have not come without their challenges and critiques which still remain almost thirty years after their adoption. What on one side seems like empowerment of the community can also be seen from the other side as the government washing their hands of the responsibility for ensuring long-term sustainability of the investment. This failure largely takes place in countries where their policies include the demand-responsive approach in name, nonetheless in practice the implementation of those policies aligns much more closely with the traditional supply-side approach. Imperfect implementation of the community-based management approach notwithstanding, community-based management is still the most common approach in rural water supply. In a 13 country study, Lockwood & Smits (2011) found the formal adoption of community-based management as a nationally recognized management model in all 13 countries as compared to management by a private operator, which was only recognized in 8 countries. Because of its prevalence, great effort has been made to make community-based management more sustainable. Part of that effort has been to view rural water supply not just as infrastructure provision but also as service delivery, which takes into account both the hardware (e.g. physical system) and the software (e.g. institutional capacity) in order to prioritize sustainable services over the entire life-cycle of the system (Lockwood & Smits, 2011). It will thus be necessary to adopt this new paradigm shift globally if the sector desires to truly implement sustainable development.

While it may seem elementary it is worth noting that the term sustainability is widely and diversely used across not only academia, but in the development sector and society-at-large. In each use its definition can vary, and thus it is important to discuss how it will be defined in this paper. The term ‘sustainable development’ is famously defined by the Brundtland Commission as development “that meets the needs and aspirations of the present generation without compromising the ability of future generations to meet their needs” (WCED, 1987). As explored by Mihelcic et al. (2003), even by referencing this definition, interpretations of sustainability can be broad and can cater to various needs and aspirations. They do make note of the common understanding across different disciplines, however, of the three pillars of sustainability: economic, environmental, and social. In the rural water supply sector the term sustainability has also been widely used. For example, Schweitzer & Mihelcic (2012) wrote that "sustainability is characterized by: equitable access amongst all members of a population to continual service at acceptable levels providing sufficient benefits, and reasonable and continual contributions and collaboration from service providers, consumers, and external participants" (p.21). One of the more widely used definitions is: the indefinite provision of water service with certain agreed characteristics over time (Lockwood & Smits, 2011). From this central point, it becomes a matter of defining which specific indicators will serve as the agreed upon characteristics to monitor and then collecting data to evaluate the level of sustainability. In this research, the above definition of sustainability as provision at an agreed upon service level over time will be adopted and will be further developed in the following chapters.

Traditionally, monitoring and evaluation in the water supply sector has been largely implementation-focused in that the main indicators have been inputs and outputs. For example, $1 billion (input) was invested to build 10,000 rural water supply systems (output) providing access to 1,000,000 people (expected outcome). However, as has been mentioned previously this implementation-focus fails to capture the sustained outcomes and impacts during the remaining life-cycle of the investment (see Figure 1.1). As part of a service-delivery approach that seeks to ensure sustainability it is important that governments and organizations prioritize the adoption and implementation of sustainability assessment tools into their existing monitoring policies and frameworks. A sustainability assessment tool is characterized by the use of specific content and a clear methodology to understand, measure, or predict sustainability of water, sanitation, and hygiene (WASH) interventions. Schweitzer et al. (2014) review 25 sustainability assessment tools that, as of 2014, had been used 92 times in 52 countries. While these tools represent a great investment towards monitoring and evaluating for results in the WASH sector there is still work to be completed in validating their impacts as well as increasing their utilization by governments on both large and small scales.

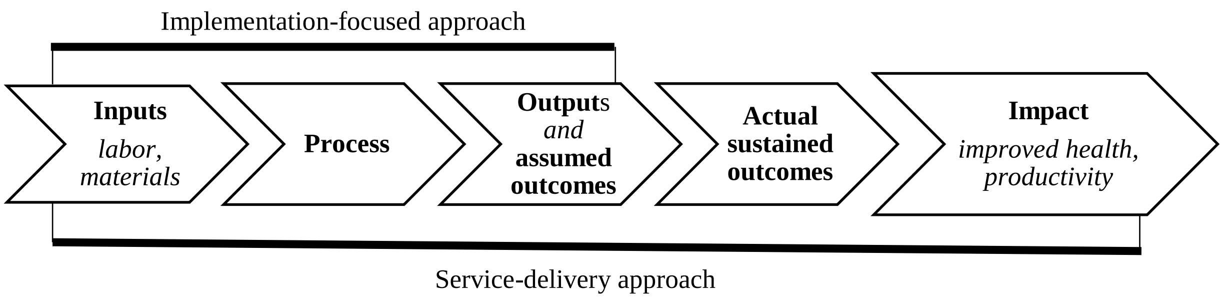

Figure 1.1: Service-delivery approach vs. implementation-focused approach for results based project framework

In addition to improved monitoring through the use of sustainability assessment tools, it has been widely identified that the long-term sustainability of community-managed rural water supply systems is dependent on the provision of external support (Lockwood & Smits, 2011; Schweitzer & Mihelcic, 2012; Hutchings et al., 2015). External support provision is defined as the sum of financial, technical, administrative and operational support provided by an outside entity. Globally, this is provided by non-governmental organizations, regional community-based management associations, and both national and local government entities. This outside support does not negate the responsibilities of local communities, on the contrary it can only be considered sustainable with the active engagement of community-based service providers. Continued research is needed to better understand the long-term costs of this external support and the exact modalities by which it should be provided (Smits et al., 2015).

While the central themes of this paper (community management, rural water supply, sustainable development, external support, and monitoring & evaluation) are perhaps clear by now, the question remains: What is the value of this research to the greater body of work of the civil engineering discipline? Civil engineering, which is one of the oldest engineering disciplines, is primarily concerned with the design, construction, and maintenance of the natural and built environment for the proper functioning of civil society. However, as the problems of the 21st century become ever more complex the engineers of society must become increasingly interdisciplinary and globally competent. One of the programs seeking to develop core global competencies in today's civil and environmental engineers is the U.S. Peace Corps Master's International program offered at the University of South Florida (Manser et al., 2015; Mihelcic et al., 2006). One of the central tenants of the program is that engineering graduate students perform interdisciplinary field research in sustainable development associated with pressing problems in water, food, energy and climate change. This guided professional field experience takes place during two years of service internationally with the U.S. Peace Corps. In the case of this thesis author, 42 months were spent in Peru as a WASH engineer and it is from that in-country experience that this research will draw its motivation.

The study location for this research is within the country of Peru, a South American country situated on the Pacific coast of South America. Peru, commonly referred to as one of the most bio-diverse countries in the world, is home to over 30 million people spread out over a land area of 1,279,996 sq. km. (CIA, 2017). A large exporter of mineral resources, Peru has one of the fastest growing economies in South America over the last decade having reduced both moderate and extreme poverty ($4 PPP and $2.5 PPP in 2005) by 26.2 percent and 18.6 percent, respectively (World Bank, 2017). The country is made up of 25 political regions (previously known as departments) as seen in Figure 1.2. The country is commonly divided into three broad geographic areas: *la costa* (Pacific coastal region), *la sierra* (Andean highland region), and *la* *selva* (rainforest including the Amazon). Due to geographic and historical differences each part of Peru has a different culture and presents different challenges and opportunities. With that in mind, to conduct a research study that encapsulates the reality in the entirety of Peru would be a vast undertaking. Therefore this study focused on one region in the northeastern part of the country, Amazonas (see Figure 1.2).

Figure 1.2: Political map of Peru. (CIA World Factbook, 2017. Public domain.)

Amazonas is one of the 25 political regions of Peru. It is located in the northeast of the country. It is surrounded by the neighboring regions of: Cajamarca (to the west); La Libertad (to the south); and, San Martin and Loreto (to the east). Amazonas also shares an international border with Ecuador to the north. The region's 422,629 inhabitants are dispersed throughout 39,249.13 sq. km. contained in seven provinces and 83 districts (INEI, 2015). The seven political provinces (and their capitals) are: Bagua (Bagua), Bongará (Jumbilla), Chachapoyas (Chachapoyas), Condorcanqui (Santa Maria de Nieva), Luya (Lamud), Rodriguez de Mendoza (Mendoza), and Utcubamba (Bagua Grande). The seat of government is located in Chachapoyas. The geography of the region primarily consists of low- and mid-elevation rainforest, cloud forest, high plateau and mountain ranges.

There were three reasons for the selection of Amazonas as the location of this study:

1. Incidence of extreme poverty – According to the most recent national survey data available, Amazonas ranks among the top three departments in Peru for poverty level and among the top four departments in Peru with greatest incidence of extreme poverty (8.8% - 12.3%) (INEI, 2016).

2. Lack of accessibility – Until recently, Amazonas was arguably the least accessible department of Peru from the country's capital, Lima. The capital of Amazonas, Chachapoyas, is one of four regional capitals that does not have a direct commercial flight from Lima. Of those four, Chachapoyas is the furthest from Lima by bus (22-24 hours). Since Peru is still very centralized it can be assumed that this accessibility issue has made it harder for government interventions to take place in the region.

3. Location of Peace Corps service for the thesis author – Lastly, the author served 24 months as a WASH engineer in the region of Amazonas. This experience provided special

insight into the cultural context of the region as well as facilitated local contacts to aid in realizing the research study.

Management of rural water supply in Amazonas is the responsibility of community-based, volunteer water committees known as *Juntas Administradoras de los Servicios de Saneamiento* (JASS). Because of readily available surface water and artesian springs in the mountainous region of Amazonas almost all water supply systems are gravity-fed piped schemes (Mihelcic et al., 2009). Water is captured at the source and conveyed via pipes to a reservoir close to the community. The members of the JASS are responsible for maintaining these systems as well as charging the user tariff. It has been well documented inside and outside of Peru that a majority of these volunteer water committees struggle to perform at sustainable levels (Schweitzer & Mihelcic, 2012; Prokopy et al., 2008). However these studies also emphasize the importance of external support provision, or post-construction support. Through the process of decentralization in Peru, it is the responsibility of each local municipality to oversee and support the management of all water systems in their jurisdiction.

In recent years the central government has promoted the creation of a permanent technical support provider position in each local municipality called the *Área Técnica Municipal de Agua y Saneamiento* – ATM (Municipal Technical Area for Water and Sanitation). Ideally the staff person in this position provides continued supervision, oversight, capacity building and technical support to the service providers, JASS, throughout the district. However, as has also been demonstrated in Bolivia with their similar Basic Sanitation Municipal Management Offices (Fogelberg, 2013), there are many challenges with this support provider position including: high staff turnover, low motivation of staff, and logistical challenges of supporting hard to access rural areas. While this support provider to service provider relationship has encountered its difficulties, it is still a relatively new intervention in Amazonas and has shown reasons for optimism in the overall goal of ensuring sustainable development in the rural water supply sector.

1.1 Research Goal and Objectives

Based on all of the information discussed, the overall goal of this research is to assess the sustainability of community-managed water systems in rural areas of the department of Amazonas, Peru. Here, the sustainability of a community-managed water system is defined as the indefinite provision of water service at a predetermined quantity, quality, and continuity. This goal will be met by addressing the following four objectives:

1. Describe the history of rural water systems in Peru, drawing specific attention to the implications this history has on present day service provision.

2. Compare and contrast three sustainability assessment tools being used by government officials in Amazonas, Peru and use these three tools to assess the state of community-managed rural water systems.

3. Examine the role of the *Área Técnica Municipal* (ATM) in providing support to the direct service providers (*Juntas Administradoras de los Servicios de Saneamiento* - JASS) in Amazonas, Peru through the use of collected field data.

4. Provide feedback to the local and national government of Peru concerning: the overall sustainability of water service delivery in rural areas of Amazonas, Peru; the progress of the implementation of the ATM model for support provision; and, make recommendations concerning the future use of the sustainability assessment tools.

The remainder of this thesis will be organized in the following manner. Chapter 2 will provide a review of the current and pertinent literature related to sustainability assessment tools and community-managed water systems. In this chapter the history of the rural water sector in Peru and its implications for present day will also be explored. Chapter 3 will present the research design and data collection methods for the analysis that was performed. Chapter 4 will go in to a detailed discussion of the three sustainability assessment tools and the results of the statistical analysis. Here the support provision by the ATM will also be discussed. Finally, in Chapter 5 the conclusions and subsequent recommendations will be offered for national and local stakeholders in Peru.

CHAPTER 2: BACKGROUND AND LITERATURE REVIEW

As was stated in the first chapter, this research seeks to assess the sustainability of community-managed water systems in rural areas of the department of Amazonas, Peru. While this research looks specifically at one geographic region of a South American country the situation examined here is part of a global narrative about the process of delivering quality water service to every cross-section of society. While great progress has been made worldwide in the past decades an unacceptable percentage of water infrastructure still fails globally. This even includes economically advanced developing countries like India, Mexico, and South Africa (Starkl et al., 2013). This problem persists despite the knowledge of key principles for success in water and sanitation interventions (i.e. consideration of local context & user priorities, technically safe & hygienic infrastructure, and post implementation support). One of the agreed upon causes of failure is a lack of institutionalized monitoring in the water supply sector. To help correct this issue, Smits et al. (2013) present a four-step framework to institutionalize monitoring of rural water services. This framework consists of: 1) analysis of current monitoring practices, 2) definition of monitoring system, 3) definition of institutional arrangements, and 4) costing and responsibilities for financing.

This chapter examines several of these steps for the case of Peru. First, an overview of the rural water sector in Peru will be provided, specifically looking at the two main actors in water service provision: the service providers, *Juntas Administradoras de los Servicios de Saneamiento (JASS)*, and the technical support providers, *Área Técnica Municipal (ATM)*. This is followed by a review of work that has been done regarding the sustainability of community-managed rural water supply internationally, with emphasis on assessment tools that have been used. Finally, this chapter will conclude with an overview of the three sustainability assessment tools that have been used for monitoring service delivery in Amazonas, Peru.

2.1 Peruvian Water and Sanitation Sector

A discussion of the current state of community-managed rural water supply in Amazonas must begin by taking into account the recent history of Peru and how that impacts the sector at present. As far as it concerns the rural water supply sector at present in Peru, recent history can broadly be divided into two periods: pre-1990's centralization and post-1990 decentralization. Since the time of the Spanish conquest and subsequent rule of Peru, and even before under the Incan Empire, Peruvian culture has been typified by a centralization of power in the hands of an elite few (Crabtree, 2003). Except for periods of military rule, Peru has been a presidential democracy since its independence in 1821. While presidential rule has oscillated between liberal and conservative ideologies, the responsibility (or lack thereof) for water infrastructure in rural areas remained primarily in the hands of the central government until the constitution was re-written in 1992 (Castillo & Vera, 1998). Prior to this change, the management of rural water supply was the responsibility of the Peruvian Ministry of Health (MINSA) and the Office of Rural Basic Sanitation Management (DISABAR) whose work was organized through 17 Rural Basic Sanitation Offices (Oblitas de Ruiz, 2010).

Following the government restructuring of 1992, a new law was passed that governed water and sanitation services in the country which replaced the 1962 version. The *Ley General de Servicios de Saneamiento* (Ley No. 26338, 1994) placed the responsibility for rural water service in the hands of local municipal government, thus shifting from a centralized approach to a decentralized approach. This change was not easily assumed by the local municipal governments as evidenced by a World Bank study carried out by Castillo & Vera (1998) in Peru to understand the process of decentralization. The main findings of that study were: 1) decentralization is a slow process that is impeded by both bureaucratic inefficiency at a national level as well as low institutional capacity of governments at the local level, 2) local governments need to be empowered not only financially but also technically and politically in order to make rural service provision sustainable, 3) to handle their new responsibility local governments should create a specialized technical unit to provide support to rural service providers, and 4) an information system should be created to register infrastructure and monitor water quality. As will be shown in the following sections these lessons are still pertinent 20-years later.

While responsibility for rural water service has been in the hands of local government since the early 1990's the central government has still played a large role not only in providing supervision but also in financing construction of infrastructure. From the author's experience and from review of existing databases, many water systems in Amazonas were built in the mid to late 1990's. While communities often do not remember who was responsible for financing the systems, it can be assumed that a large number of the systems were built through the National Social Development Compensation Fund (FONCODES) which has been a major source of rural investment even through to present day.

Oblitas de Ruiz (2010) points out that this program has largely overlooked the development of local capacity for operation, administration, and management as well as social awareness in the community. This has had an unsurprisingly negative effect on the sustainability of these systems as evidenced by a study carried out in 2003 by the Ministry of Housing, Construction and Sanitation (MVCS, 2003). The MVCS study was carried out in 10 different regions of Peru. It reported that 31.7% of systems were sustainable, 44.3% were in process of decline, 22.1% were in extreme process of decline, and 1.9% collapsed.

To calculate the sustainability scores the MVCS study considered various indicators grouped under three factors: 1) state of the system, 2) management, and 3) operation & maintenance. The results of this study are contrasted with the results of an external research project carried out two years later that was part of study of community-managed rural water systems in Bolivia, Peru and Ghana (Whittington et al., 2009). That study, which collected data specifically in the Cusco region of Peru, found that 95% of water taps were functioning at the time of community visit. One possible reason for the discrepancy between the two studies is that in the Whittington et al. study sustainability was defined as functionality at one point in time while the MVCS study defined sustainability by a more representative set of indicators. Additionally it should be noted that the Whittington et al. study only considered one region of Peru and only systems constructed under two projects: FONCODES and SANBASUR. The latter was financed by the Swiss Agency for Development and Cooperation (COSUDE) which has a long history of interventions in Peru, not only in infrastructure but most importantly in creating a knowledge base concerning community-managed rural water systems. For a review of COSUDE's involvement in Peru, Calderon-Cockburn (2004) discusses several of their projects as well as other projects that have been implemented in rural areas of Peru.

With the contributions of many studies like the MVCS study just covered, the various levels of government have made much progress in improving policy and support structures to move towards a service delivery approach focused on sustainability. The Ley 26338, which is still the governing piece of legislation for the water and sanitation sector in Peru, has had many amendments and clarifications, the latest of which is Decreto Legislativo 1280 (2016) which emphasizes the role of local government to create an *Área Técnica Municipal* (ATM) to monitor, supervise, and provide technical support provision to the service providers. Decreto Legislativo 1280 also charges local government to collect and maintain updated information about the sustainability of rural water service provision. Beyond the local government the main government actors that are involved with community management of rural water supply are depicted in Figure 2.1.

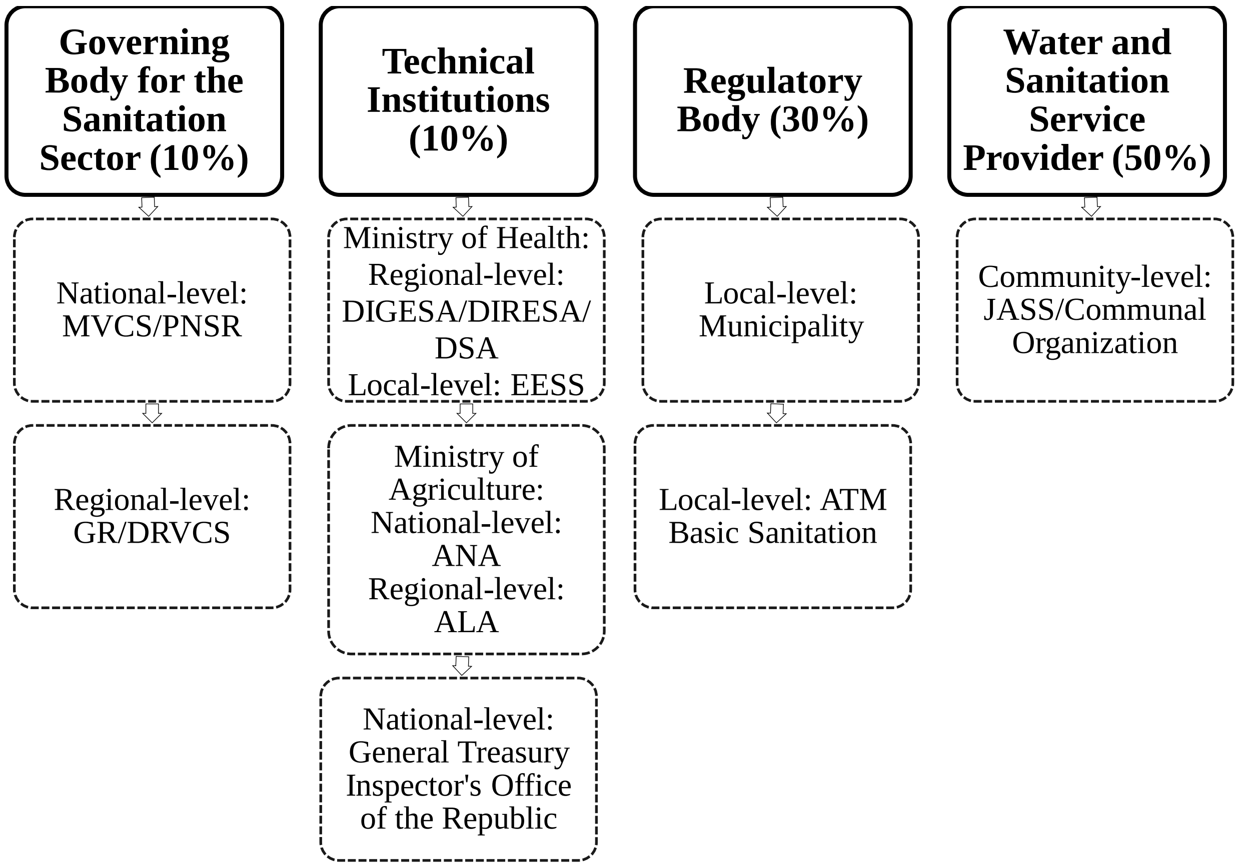

Figure 2.1: Division of responsibilities among actors involved in community-managed rural water supply in Peru.

As can be seen from Figure 2.1 the majority of responsibility lies with the JASS and the local municipality which primarily intervenes through the office of the ATM. From the technical perspective of community management the Ministry of Health is involved through the General and Regional Health Management Offices (DIGESA/DIRESA), Office of Environmental Health

(DSA) and the local health centers and posts (EESS). The Ministry of Agriculture is involved through the National and Local Water Authorities (ANA/ALA). Fiscal supervision is provided by the General Treasury Inspector’s Office of the Republic. The governing body at a national level is the Ministry of Housing, Construction and Sanitation (MVCS) through the National Program for Rural Sanitation (PNSR) and at a regional level the governing body is the Regional Government and the Regional Management Office of Housing, Construction and Sanitation. In name, each of these entities has a role to play in providing sustainable services at scale throughout Peru however in actuality there is still a lack of synergy between all of the different actors. (See Appendix B for detailed institutional arrangements in the Peruvian water and sanitation sector.)

In 2016 the MVCS published a report written by one of the ex-ministers of the MVCS that explores the current baseline snapshot of the water and sanitation sector in Peru (MVCS, 2016). In the report a long list of deficiencies in the rural water sector are identified including: deficient local technical management (JASS, Operators, Engineers, and ATM), poorly determined tariffs (income does not cover costs), low prioritization for rural sector on a ministry level (see Figures 2.2 and 2.3), program and project strategies are not integral (technical and social component), gaps in the norms and policies (specific roles and responsibilities, especially of the ATM), low level of empowerment of local government and service providers, and low water quality (lack of priority and supervision). This list of deficiencies presents no small task if the government and rural populations of Peru want to attain sustainable water service. Fortunately, the recently developed National Sanitation Plan for 2017-2021 (DS 018, 2017) presents a roadmap for how these deficiencies can begin to be addressed especially through much more attention given to the ATM and JASS, the support provider and service provider, respectively. These two entities and their role in rural water supply in Peru will be discussed in Section 2.2.

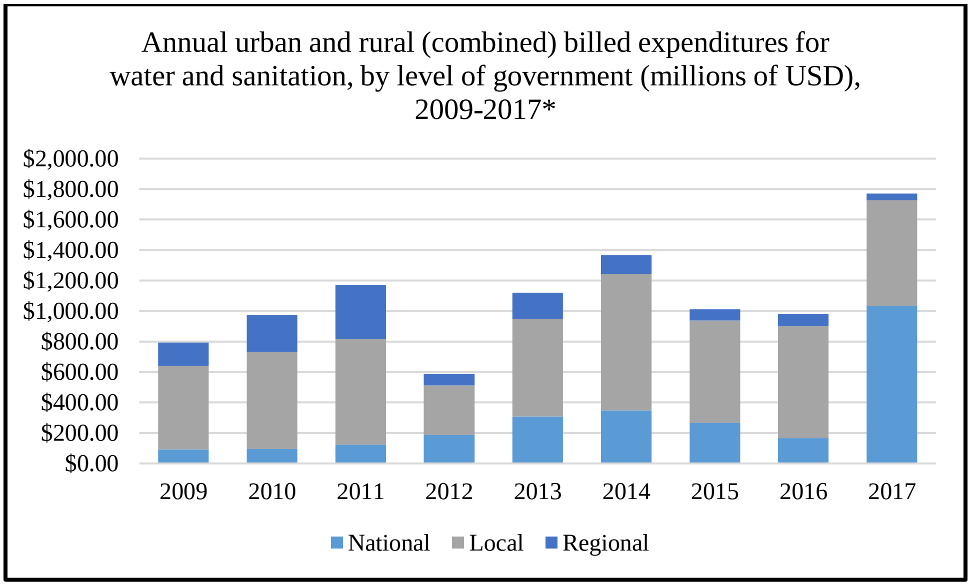

Figure 2.2: Peruvian government spending on water and sanitation, by level of government, 2009-2017 (year to date)

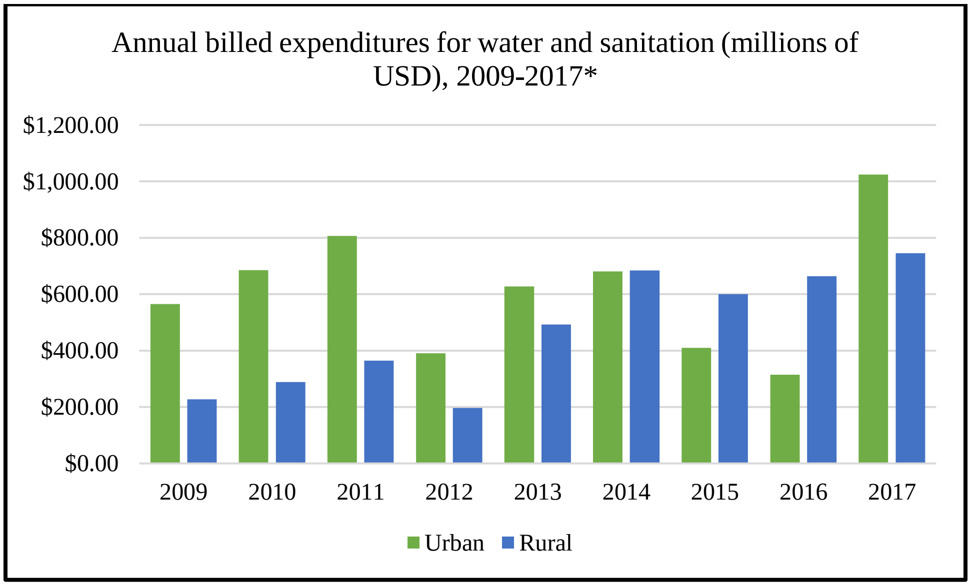

Figure 2.3: Peruvian government spending on water and sanitation, urban and rural, 2009-2017 (year to date)

2.2 Área Técnica Municipal (ATM) and Juntas Administradoras de los Servicios de Saneamiento (JASS)

In Peru, the idea of entrusting the management of rural water service provision to a communal organization has its roots as early as the 1962 Sanitation Law. These communal organizations are often referred to as water boards, or *juntas*. When the Ministry of Health was in charge of overseeing rural water service provision these organizations were called *Juntas Administradoras de Agua Potable*, or JAAPs (MINSA, 1997). At present, government documents largely refer to these boards as *Juntas Administradoras de los Servicios de Saneamiento*, or JASS. The former name only includes potable water while the latter extends to all sanitation services (water, sewer, and solid waste). In practice, the change has been largely in name only as most JASS still focus solely on potable water provision. Current roles and responsibilities of the JASS are dictated by two government documents published in 2010 by MVCS: RM No. 205 (2010) and RM No. 207 (2010). The first document establishes the following: basic definitions related to rural water and sanitation provision, model for bylaws that govern the function of the JASS, and model for rules for service provision. The second document establishes: the framework for regulating rural service provision, the process for creating the annual work plan, and the process for calculating the user tariff.

A JASS consists of three bodies: the Managing Board, the General Assembly, and the *Fiscal*. The Managing Board, or *Junta Directiva*, like many water committees internationally has a president, secretary, treasurer, and two *vocales* (one responsible for sanitary education and the other responsible for promoting attendance at the meetings). The General Assembly consists of all of the system users: one member from each household connected to the water system. The *Fiscal*, which translates as attorney or prosecutor, is responsible for supervising the management of the managing board to safeguard against fraud and inactivity. The managing board should meet at least once every three months and the general assembly should meet twice a year. In most cases the managing board contracts a member of the community to operate and maintain the system, however in some cases the same members of the board perform these duties with community help during communal work days, or *faenas*. A manual produced by the Peruvian NGO, AguaLimpia (2013), gives a more detailed overview of the basic framework for the functioning of the JASS.

While this study focuses solely on rural water systems that are managed by a JASS it is important to briefly mention the alternative models that exist in Peru. The legislation states that for rural towns with a population of less than 2,000 inhabitants the water system should be managed by a JASS (DS No. 023, 2005). While this is the most common method, the law also leaves room for other alternatives (see Table 2.1). In some cases the local municipality assumes the management and operation of the system. In this case the municipality should create a separate entity called the Management Unit, or *Unidad de Gestión*. This is also the suggested model for towns with a population of between 2,000 and 15,000 inhabitants. This Management Unit is staffed by an office worker and resembles a typical water utility.

Table 2.1: Management models for water service provision, according to population

Population	Zone	Service Provider	Regulator
Up to 2,000	Rural	- Juntas Administradoras de Servicios de Saneamiento (JASS)	Municipality and JASS
2,001 - 15,000	Small Town	- Municipal Management Unit - Specialized Operator	Municipality and JASS
15,001 -	Urban	- Empresas Pequeñas de Saneamiento (Private operators) - Urban Utilities	SUNASS

The last option for rural water service provision is management via a Specialized Operator. This is the least common option in Peru. In this case a private company operates and administers the water service. In most situations the disperse nature of rural settlements does not lend itself to the feasibility of this business model. However, there are instances where a rural town is in close proximity to a larger urban settlement and the water utility assumes water provision service to the rural town. Kleemeier (2010) provides a helpful desk review of private operators in several countries and how they can help work towards the sustainability of rural water supply systems.

Experiences with community-managed rural water supply, both inside and outside of Peru, point to the unsustainability of the model without some form of external support. One of the leaders in Peru in institutionalizing this support has been the Swiss Agency for Development and Cooperation (COSUDE) which, through their project SANBASUR, promoted the idea for the creation of the ATM at the local government level. The creation of the *Área Técnica* was first stipulated in the legal framework in DS-031-2008-VIVIENDA and RM-269-2009. Despite being mandated in the law, explicit specifications are scarce concerning the roles and responsibilities of the ATM beyond its charge to monitor, supervise, and provide technical support to JASS. Gobierno Regional de Cusco (2013) provides a relatively in-depth guide that overviews the tasks that the ATM could perform, though they are only suggestions.

Commonly, the ATM consists of one technician in each local, district municipality. In small municipalities the ATM reports directly to the mayor, while in larger municipalities the ATM reports to a smaller office such as the department of public services (see Figure 2.4, p. 23, for an example organizational chart). The ATM provides technical support to all of the JASS in the different communities in their district. This support can take the form of the activities listed in Table 2.2. This model of support provision is similar to the Circuit Rider model in El Salvador and the Basic Sanitation Municipal Management Offices of Bolivia (Kayser, 2014; Fogelberg, 2013). Under the Circuit Rider model a traveling technician visits roughly 25 communities on a regular basis to perform water quality testing and to facilitate trainings for the water committee. The technicians report to decentralized government offices, which is in contrast to the ATM in Peru and the Basic Sanitation Municipal Management Office in Bolivia which are both integrated into the local municipality.

Table 2.2: Technical support activities of the Área Técnica Municipal (ATM) (Source: Gobierno Regional de Cusco, 2013)

Areas of Work	Technical Support Activities
1. Institutional Capacity Building	• Collection of monitoring data • Chlorine distribution to JASS • Register and legalize new JASS • Local policy lobbying • Water resource management
2. Community Capacity Building	• Organize community training to accompany new construction projects • JASS training • Household hygiene training
3. Water Quality Control	• Coordinate with health center to test water quality
4. Water and Sanitation Infrastructure Oversight	• Promote integral project development

As an entity within the local government, all funding for the ATM comes from the municipal general fund and is allocated at the discretion of the mayor and the commission of councilors. It is the responsibility of each ATM office to prepare an annual work plan that includes a budget. This is then submitted to the mayor and commission for review and approval. This should also include the salary for the technician(s) who fills the role of the ATM. As with any budget, the final expenditures vary significantly from what was proposed.

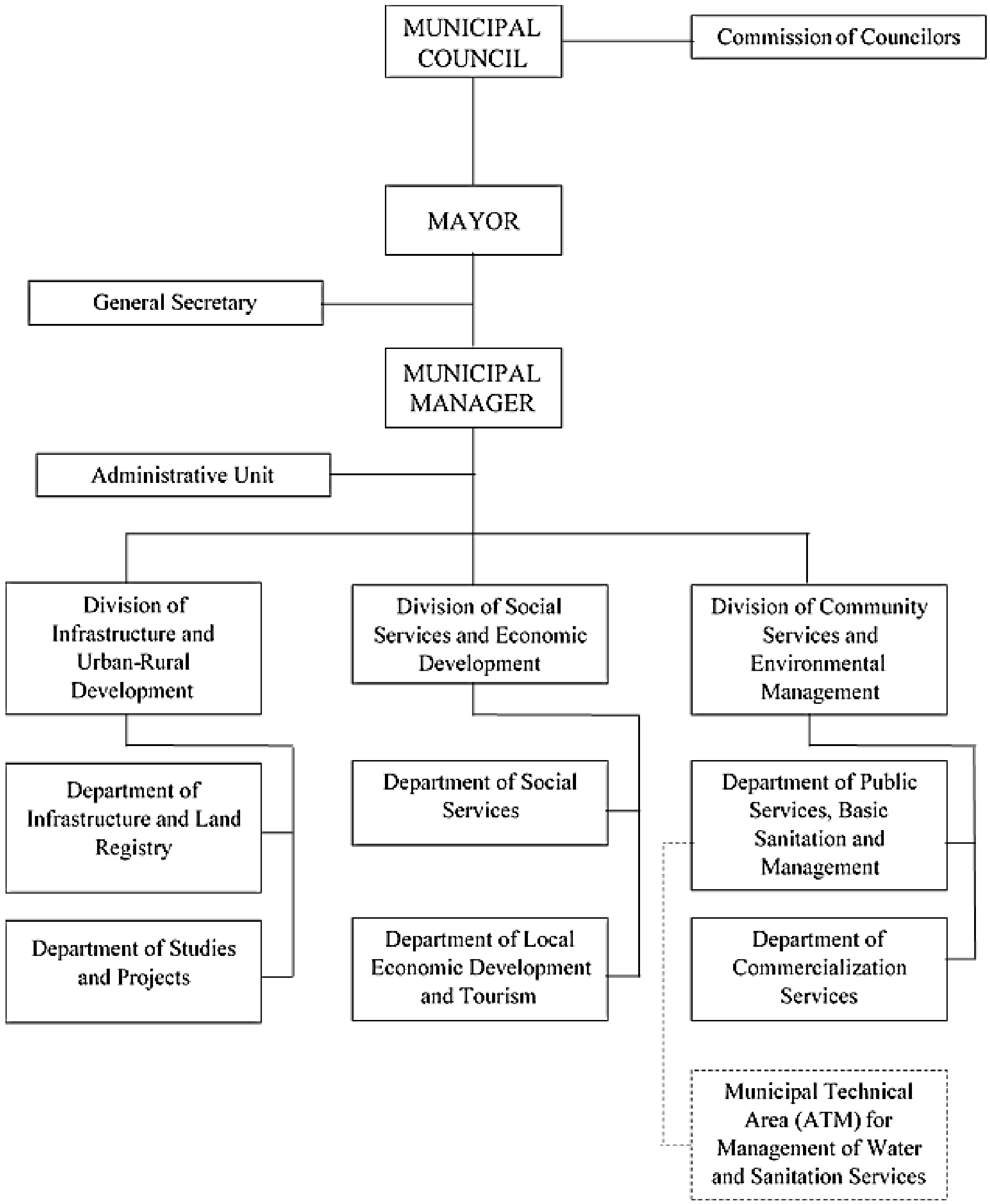

Figure 2.4: Example of a municipal organizational chart with the Área Técnica Municipal (ATM) included

Since 2015, the MVCS in conjunction with the Ministry of Economy and Finance has promoted the creation of the ATM office in local municipalities through its program called "Incentives Program for the Improvement of Municipal Management" (http://pnsr.vivienda.gob.pe/portal/programa-de-incentivos-pnsr/). Under this program each municipality has a set of goals according to the size of their district capital. These goals cover a variety of sectors including community health, education, and environmental management among others. For each goal there is a set of activities that the municipality must complete in order to qualify for additional funding (i.e. incentives). For these purposes, rural municipalities are divided into two groups: municipalities with more than 500 households in the capital city (classified as Type “C”) and municipalities with less than 500 households in the capital city (classified as Type “D”).

In 2015, the first year of the incentives program, there were two goals (Goal 40, Goal 11) both for Type “C” municipalities. Goal 40 consisted of the following activities:

- Activity 40.1) formally create the ATM office,
- Activity 40.2) develop roles and responsibilities for the ATM,
- Activity 40.3) create a registry for JASS and/or other communal organizations,
- Activity 40.4) fill the position of ATM.

Goal 11 incentivized the following activities:

- Activity 11.1) participate in a training for the ATM,
- Activity 11.2) complete diagnostic surveys of the water systems in half of the communities of their district,
- Activity 11.3) collect water quality samples demonstrating levels of free chlorine in at least two water systems in the district.

If the municipality completed a satisfactory number of activities in 2015 they were awarded the financial incentive in fiscal year 2016. In 2016 there were two goals in total as well, this time one for Type “C” and one for Type “D” municipalities. In this instance, the Type “D” municipalities had to complete both of the goals from 2015, while the goal for Type “C” municipalities consisted of a new set of activities that included developing an annual work plan for the ATM and designating a budget for the ATM office, among others. This program has been largely successful as a first step towards more sustainable rural water service delivery.

It is worth noting that the initiative of the government's Incentives Program is only one of recent positive efforts nationally in Peru to aid local government in assuming their role in rural water service provision. Three of those efforts are: SABA+, PNSR, and ROMAS. Project SABA+ (Basic Sanitation Plus) is the joint effort of COSUDE and international NGO CARE to institutionalize the ATM office in district municipalities in fourteen regions of Peru. PNSR (National Program for Rural Sanitation) functions under the MVCS nationally and executes integral water and sanitation projects that prioritize technical and organizational capacity building of local government, ATM and JASS. ROMAS (Replacement, Operation, and Maintenance of Potable Water Systems) is an initiative of FONCODES (National Social Development Compensation Fund) that seeks to rehabilitate water systems in each region of Peru while at the same time equipping the ATM office to better perform their job.

This section has provided an overview of the structure and function of rural water service management in Peru. Since the initiative to implement the ATM is still relatively new there have not been many studies performed to identify weaknesses in the scheme. This research will seek to provide some useful insights that can be used to strengthen the abilities of the ATM to ensure sustainable rural water service provision. Additionally, this research will look at the aforementioned diagnostic surveys of the water systems that are being completed as part of the Incentives Program and their use as a monitoring tool for sustainability assessment. Section 2.3 will overview the development of sustainability assessment tools and will identify agreed upon indicators for sustainability.

2.3 Sustainability Assessments of Community-Managed Rural Water Systems

Within the Peace Corps Master's International Program (http://cee.eng.usf.edu/peacecorps/) there have been several studies conducted that have sought to assess the sustainability of community-managed rural water systems. These studies have been based in Madagascar, Mali, the Dominican Republic, and Panama. Annis (2006) carried out a study in Madagascar with 28 communities using Rapid Rural Appraisal to assess the state of potable water infrastructure, examine the community management in each case, learn what is not working and provide some suggestions for how to improve. Results show that there are many problems with the poorly trained volunteer water committees who lack the authority to adequately provide AOM. Annis states that much of this responsibility lies with poor implementation by outside entities before, during, and after construction of the water system. This research utilized participatory methods focused around six themes: 1) community profiles, 2) physical function of water systems, 3) typical maintenance and cleaning arrangements, 4) technical capacity, 5) community management schemes for the water systems, and 6) fund collection. This specific methodology lent itself to relatively quickly ascertain detailed and important information about the systems included in the study, however the possibility of scaling up is limited as is the quantification of results and comparison between systems.

McConville & Mihelcic (2007) sought to improve upon this limitation by creating a sustainability matrix to evaluate WASH development projects that is based off of agreed upon aspects of sustainability and principles of streamlined life cycle assessment. A 5 x 5 matrix was developed with five sustainability factors (sociocultural respect, community participation, political cohesion, economic sustainability, environmental sustainability) in one direction and the five project life stages (needs assessment, conceptual designs and feasibility, design and action planning, implementation, operation and maintenance) in the other direction. For each of the 25 matrix elements there is a long series of questions used to evaluate the project and provide a 0-4 score. The tool is best used as a conceptual framework and for in-depth analysis, however, for scaling-up and on-going national monitoring it could be cumbersome and due to its subjective nature does not lend itself to consistency. While it could be used on a wide variety of WASH development project design/implementation/monitoring it does not take into account indicators or benchmarks for specific technologies (i.e. community-managed gravity-fed water systems).

Based largely off of a study conducted in Peru in 2003, Suzuki (2010) sought to evaluate the state of water systems constructed by Peace Corps and the non-governmental organization Waterlines in Panama. The author developed a set of 10 indicators that included: 1) watershed, 2) source capture, 3) transmission line, 4) storage tank, 5) distribution system, 6) system reliability, 7) willingness to pay, 8) accounting & transparency, 9) system maintenance, and 10) active water committee members. Overall results showed high scores for many of the systems.

Schweitzer & Mihelcic (2012) continued where these three studies left off and created a sustainability assessment tool to monitor and evaluate the performance (and predict future performance) of community-managed rural water supply systems in the Dominican Republic. The tool uses 8 (a-h) indicators grouped in 3 general areas (1-3): 1) organization/management (a. activity level, b. participation, c. governance), 2) financial administration (d. willingness to pay, e. accounting records & transparency, f. financial durability), and 3) technical/service (g. repair service, h. system function). The results from this matrix were then analyzed to find the correlation between specific factors and the overall sustainability score. The most noteworthy correlations to sustainability score were: system age (negative), plumber wage, and hours spent on maintenance activities per month. Overall, recommendations were to: prioritize more visits by outside supporting organizations, ensure transparency in accounting, and sustain external support because sustainability declines as the systems age. The authors state that the assessment tool is best used as a diagnostic tool for prioritizing attention and determining which specific needs are most urgent in each community.

These studies take place in a larger context of important studies that have been done over the last 20 years concerning the sustainability of community-managed rural water systems. One of the first in-depth studies into the sustainability of rural water supply was a six-country study done by Sara & Katz (1997) for the World Bank. This study sought to accomplish three things: 1) clarify what is meant by "demand-responsiveness" both in theory and in practice, 2) assess the degree of demand-responsiveness in project rules, and 3) evaluate the relationship between demand-responsiveness and sustainability of water systems. The analysis used the following indicators: indicators of demand-responsiveness (project initiation, informed choice, contribution) and indicators of sustainability (physical condition of system, consumer satisfaction, O&M practices, financial management, willingness to sustain system). Here sustainability is defined as, "the maintenance of an acceptable level of services throughout the design life of the water supply system" (p.30). This sustainability has three components: technical (physical condition), institutional (O&M, financial management), and social (consumer satisfaction, willingness-to-sustain).

The main conclusions of the study were: 1) sustainability of water systems is improved by implementing a demand-responsive approach in the project design, 2) project design is key, but implementation must improve in order to ensure optimal system performance, 3) projects must include a social component that trains households and water committees, and 4) design standards must be flexible to the desires of the community.

This study was followed up by a literature review and desk review by Lockwood et al. (2003) that further explored the definition of sustainability of rural water supply and also assessed the role of follow-up support to communities. The review concluded that the biggest determinant of sustainability for community-managed rural water is the presence of some form of long-term external support. The study identified five main groupings of factors that determine sustainability: technical, financial, community and social, institutional and policy, and environmental factors. Another determining factor that proved most prominent was the ability of tariff collection to cover recurring costs.

At the same time that the previous study was being performed, Shouten & Moriarty (2003) were publishing their book on community management of rural water supply. The authors argue that the following four characteristics are what define community management: 1) community control, 2) community operation and maintenance, 3) community ownership, and 4) community contribution to costs. Additionally, the book concludes that equitable, sustainable community management is largely determined by these five elements: 1) management capacity of the community, 2) appropriate service level and technology, 3) water resource availability, 4) total finances – capital and recurrent, and 5) efficiency/capacity of intermediate level actors. These authors also concur with Lockwood et al. that the involvement of intermediate level actors in support provision is key to sustained benefits from the water system.

Lockwood & Smits (2011) further contribute to the understanding of community-managed rural water supply, specifically the shortcomings of the past and how the international water sector can move towards the Service Delivery Approach which is defined as, “the conceptual approach taken at sector level to the provision of rural water supply services, which emphasizes the entire life-cycle of a service, consisting of both the hard (engineering or construction elements) and software required to provide a certain level" (p. 169). This approach is in contrast with the project oriented, water system approach and the largely informal volunteer-led community management system. To conduct this study the authors looked at 13 countries that represent a variety of socio-economic levels and their management of rural water service delivery. The study identifies 10 'building blocks' for moving towards the Service Delivery Approach. Figure 2.5 presents these 10 factors which are the synthesis of the general trends identified from the country studies. Because these are general trends, they are not a prescription and should be considered on a country by country basis.

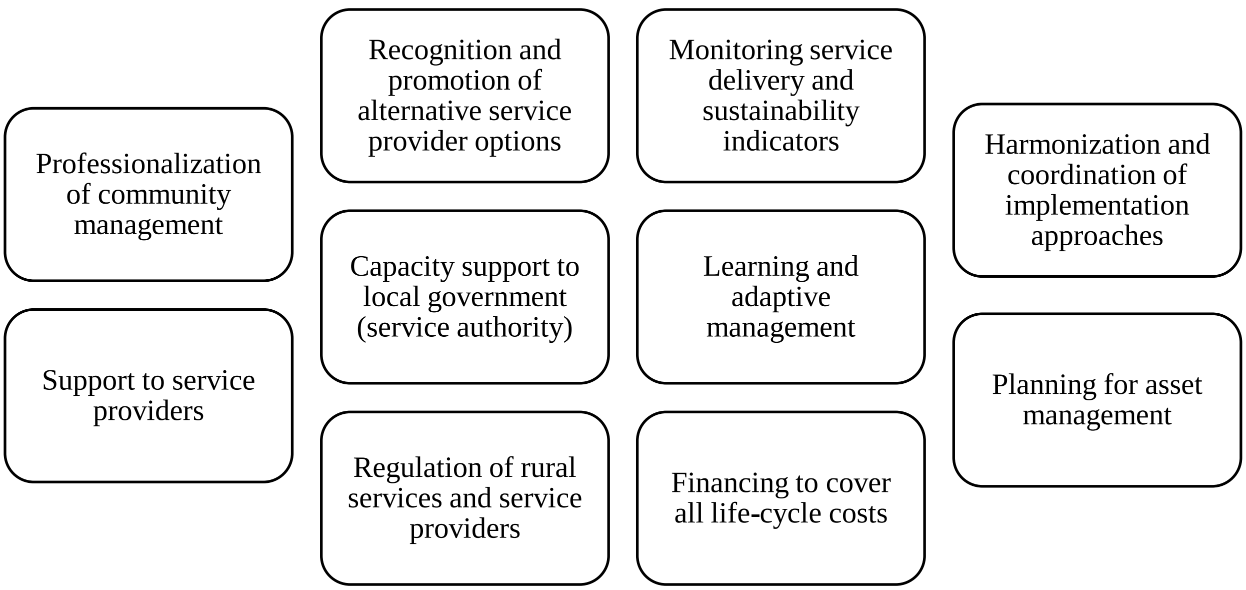

Figure 2.5: Factors that lead towards a service delivery approach to rural water supply (Own elaboration with information from Lockwood & Smits, 2011)

A more recent meta-analysis of 174 successful community management case studies reaffirmed the following conclusion: long term external support is needed for community based management to succeed often involving financial support, technical advice and managerial advice (Hutchings et al., 2015). From a community-level view, internally collective initiative, strong leadership and institutional transparency were the key factors for success. Another trend the authors found was that as a country's socio-economic wealth increased so, too, did the success of community-based management.

With a similar goal of systematically summarizing the existing literature on rural water supply, Walters & Javernick-Will (2015) used a system dynamics modeling approach to understand the dynamic relationships between different factors and their influence on long-term functionality of rural water supply systems. First the authors identified and aggregated the key elements that influence water system functionality. These factors (and sub-factors) include: government (laws and policy, management, governance), community (participation, demand, satisfaction), external support (type of support, cooperation, post construction support), management (maintenance, skilled operator, women involvement), financial (cost recovery, financial management, cost of system or part), technology construction and materials (spare part availability, technical appropriateness, construction quality), environment and energy (resource management, source protection, energy availability/reliability), and water system functionality (quality, quantity, reliability, coverage). Once these factors were identified they then surveyed water sector experts to identify the strength and polarity between factors. Finally the authors used system dynamics modeling to identify the most important feedback mechanisms. The most important feedback mechanisms contained a combination of these 6 factors: 1) water system functionality, 2) community, 3) financial, 4) government, 5) management, and 6) technology. The most dominant feedback mechanism was: water system functionality – community – finance – management. An obvious omission from this main conclusion is the importance of external support, which has been consistently cited as a key for long-term sustainability.

With the vast knowledge about the factors that most influence the long-term sustainability of community-managed rural water supply, the obvious next step is to formulate ways to monitor these factors, or indicators, as a way to predict and provide feedback about sustainability. This idea of monitoring sustainability of rural water supply is part of a larger discussion about monitoring in the water, sanitation, and hygiene (WASH) sector. Shouten & Smits (2015) identify the five most common purposes for WASH monitoring: 1) project cycle monitoring, 2) project or program result monitoring, 3) inventories for asset management, 4) service delivery monitoring, and 5) monitoring the enabling environment. This research will focus primarily on purposes 3 and 4. Inventories for asset management refers to a system that tracks and registers infrastructure in a given geographical area regardless of project type and provides information about the functionality or repair status of the asset. Service delivery monitoring goes a step further and collects information about various service level indictors such as water quantity, quality, reliability, affordability, and accessibility as well as information about the performance of the service provider.

Schweitzer et al. (2014) review 25 WASH monitoring tools that have been used internationally to measure sustainability in the WASH sector. For their study they defined a 'tool' by four criteria: 1) track record of use, 2) specific content (i.e. questions or framework), 3) clear and reproducible process, and 4) synthesis of data to produce an output. Using these four criteria and the two purposes for monitoring this study has identified three sustainability tools that have been used to monitor community-managed rural water systems in the Amazonas region of Peru. These three tools will be introduced in Section 2.4.

2.4 Community-Managed Rural Water Supply Sustainability Assessment Tools Used in Amazonas

In the past three years the Peruvian government has begun to implement more advanced monitoring programs for rural water service provision. These programs replace previous limited monitoring of indicators such as systems built and percent of population that gained access, which had been prioritized as part of the Joint Monitoring Program data collection. Three of the tools that have been used to monitor rural water service in the region of Amazonas are: the Rural Water and Sanitation Information System (*SIASAR*, in Spanish), Tracers in Rural Water and Sanitation (*Trazadores*, in Spanish), and the previously mentioned Diagnostic Survey for Water Supply and Sanitation (*Diagnostico*, in Spanish). Table 2.3 shows the level of implementation of each of the three tools.

Table 2.3: Level of implementation of the three sustainability assessment tools in Peru

Tool	Communities	Departments/Regions
SIASAR	10,098	21
Diagnostico	96,902	24
Trazadores	5317	16

SIASAR (2012) is the product of the collaboration between the governments of Honduras, Nicaragua, and Panama with the help of the World Bank. The tool considers four components or entities: Community, System, Service Provider, and Technical Assistance Provider. Each component is graded on an A-D scale (A being the highest grade). The SIASAR system consists of a mobile application (or paper collection), data entry into the web system, and a visualization system for analysis. Data can be aggregated at varying levels of political division. A user's manual is available to guide the use of the system. The community component consists of 33 indicators, the system component consists of 37 indicators, the service provider component consists of 39 indicators, and the technical assistance provider component consists of 44 indicators. Key indicators from these lists are then considered in a matrix to calculate the final score or grade for each component (number of indicators provided in parentheses): community (8), system (8), service provider (5), and technical assistance provider (7). The community score includes a general proxy index called the Sustainability of Water Service Index (ISSA). This is calculated using three factors: the total number of houses in the community, the number of houses associated with the system, the classification of the system, and the classification of the service provider. The weights used are: A (1.00), B (0.66), C (0.33), and D (0.00). The calculation is determined as follows:

$$ISSA = \frac{\sum_{i=1}^{n} No.houses\ in\ system\ i\ \times\ System\ i\ weight\ \times Service\ Provider\ i\ Weight}{Total\ No.of\ houses\ in\ the\ community}$$

To date SIASAR has been utilized in eleven different countries (siasar.org) in Latin America or the Caribbean. The first nationwide study that looks at factors affecting sustainability was done with SIASAR data from Nicaragua (Borja-Vega et al., 2017). The study used regression analyses and survival functions to identify determinants of water system sustainability. Their findings confirmed many of the conclusions that have been previously mentioned. Moritz (2017) also used the SIASAR data from Panama to determine the effect of connectivity on the function of rural water supply and sanitation systems. The author developed a tool to measure connectivity based off of relevant frameworks that included roadway infrastructure, telecommunications, energy, proximity to other communities, and inclement weather. These data were used in conjunction with information in the SIASAR database about the community, system, and service provider. A regression analysis was performed to determine the relative impact of individual indicators upon the sustainability score for each community. These two cases give an early indication of the potential application of the SIASAR tool to further develop the understanding of how to best support the sustainability of rural water supply.

The second sustainability assessment tool that has been used in Amazonas is the Trazadores application created by the Swiss Agency for Development and Cooperation (COSUDE). To support the implementation of the framework laid out by the Ministry of Housing, Construction, and Sanitation in Peru, this tool was created to help guarantee sustainability by providing a snapshot of the present reality of basic services in rural areas (trazadores.org). This tool considers three components or entities: General Sustainability Index, JASS Management, and ATM Performance. The General Sustainability Index is composed of six tracers: 1) water quality, 2) service quality, 3) condition of infrastructure, 4) service administration/operation/maintenance, 5) sanitary behaviors, and 6) institutional support. Altogether those six tracers consider 20 different indicators (note: some of these indicators are also considered in the JASS and ATM components). This General Sustainability Index is comparable to the system score from the SIASAR tool. It uses weights for the different tracers to calculate a final score which falls under 1 of 4 grades: 1) adequate, 2) with some deficiencies, 3) with serious limitations, or 4) deteriorated/inoperative. The JASS Management component is composed of two tracers: 1) technical-operational level and 2) administrative-financial level. These two tracers consider 6 different indicators. Lastly, the ATM Qualification component considers five different indicators. This tool was created specifically for the Peruvian context and has been used in 15 different political regions of Peru.

The last tool that has been used in Amazonas, and the most recently used one, is the Diagnostic Survey for Water Supply and Sanitation (Diagnostico). This tool has been the most widely used throughout Peru as it has been incorporated into the Municipal Incentives Program. Developed by the MVCS, the tool consists of a 97-question survey made up of three modules that collect information about the community, service provision, and the water system and service quality. That is the extent of the tool as there is no further analysis or sustainability calculation based off of the information. The MVCS currently has only used to information to summarize basic indicators such as access and number of people served. A more depth analysis of these three tools will be provided in Chapter 4.

In summary, this chapter has sought to provide an overview of the rural water sector in Peru, specifically looking at the two main actors in water service provision – the JASS and the ATM – and the enabling environment that seeks to support them. This was followed by a review of work that has been done regarding the sustainability of community-managed rural water supply internationally. The consensus is clear that community management is dependent on long term external support and institutionalized monitoring in order to most accurately prioritize government policies and programs. The chapter continued with a review of different WASH monitoring and assessment tools that have been used. Finally, this chapter concluded with a look at the three sustainability assessment tools that have been used in Amazonas, Peru. The following chapter will give an explanation of the primary research that was conducted to fill in some of the gaps that exist in understanding the work of the ATM. Chapter 4 will further examine the three tools that have been introduced in this chapter and provide recommendations on how to best institutionalize these monitoring activities to ensure sustainability.

CHAPTER 3: METHODS

3.1 IRB Approval

The research methods described below were approved under expedited review by the Institutional Review Board (IRB) of the University of South Florida under IRB# Pro00029379 because the surveys and interviews used in this current study were assessed to present no more than minimal risk to human subjects. Additionally, recording of informed consent of the human subjects was waived according to federal regulations in 45CFR46.117(c). Appendix A provides the IRB documentation for this study.

3.2 Data Sources

The research conducted in this study makes use of survey methodology and data from four main sources: 1) Rural Water and Sanitation Information System (SIASAR, in Spanish) developed by the World Bank, 2) Tracers in Rural Water and Sanitation (Trazadores, in Spanish) developed by the Swiss Agency for Development and Cooperation, 3) Diagnostic Survey for Water Supply and Sanitation (Diagnostico, in Spanish) developed by the Peruvian Ministry of Housing, Construction, and Sanitation (MVCS, in Spanish), and 4) field data collected by the thesis author.

The data that are used from the sustainability assessment tools were accessed from current databases related to the tools. In the case of the SIASAR data, this information was accessed publically from the SIASAR organization website (www.siasar.org) where there are also data from the other countries where the tool has been used. The data are available in downloadable spreadsheets. For the Trazadores tool this information was accessed from the publically available website created by the Swiss Agency for Development and Cooperation (www.trazadores.org). The data can be accessed that covers the different regions of Amazonas and can be output in region specific reports. In the case of the MVCS Diagnostico, this information is not publically available, however, access was granted to the thesis author by the staff of the regional office of MVCS in Amazonas. These data were accessed via the password protected website designed for the Municipal Incentive Program mentioned in Chapter 2. The questions asked on the survey forms used for these three tools can each be found in their entirety in Appendix C of this thesis.

For the case of the data from SIASAR and Trazadores, the data were readily imported into Microsoft Excel. The data sets were cleaned to isolate only the communities and systems for the Amazonas region of Peru and to identify outliers and missing data points that might skew the analysis. The data from the MVCS Diagnostico is not available for download into spreadsheet format. It is only currently available for viewing one community at a time and to individually enter data from this tool for analysis is beyond the scope of this thesis.

3.3 Research Design

The design of this research study can be deconstructed into three tasks based on the objectives laid out in Chapter 1. The two objectives that are most pertinent to this chapter are Objectives 2 and 3. Objective 1, history and overview of the rural water sector in Peru, was covered in Chapter 2 and Objective 4 will be addressed in Chapter 5. Objective 2 is to: compare and contrast three sustainability assessment tools being used by government officials in Amazonas, Peru and use these three tools to assess the state of community-managed rural water systems. Objective 3 is to: examine the role of the Área Técnica Municipal (ATM) in providing support to the direct service providers (Juntas Administradoras de los Servicios de Saneamiento - JASS) in Amazonas, Peru through the use of collected field data.

Beginning with Objective 2, this research study needed to complete two tasks: 1) compare and contrast the three sustainability assessment tools, and 2) determine the current state of community-managed water systems in Amazonas. For task 1, the analysis is performed using data obtained from the three sustainability assessment tools as well as the content of the tools themselves. The process for this analysis is further elaborated in Section 3.6. For task 2, it was decided to use only the data collected with the SIASAR and Trazadores tools to determine the state of community-managed water systems in Amazonas because they are the two that calculate a sustainability score. The process for analysis using these data sets is further elaborated in Section 3.7.

In order to address Objective 3 it was determined that field data collection was needed to: 1) have outside data in order to better comment on the content collected using the three sustainability assessment tools, 2) learn more about the implementation of the Área Técnica Municipal (ATM) in rural municipalities and 3) examine the support provided by them to the direct water service providers, JASS.

The above research design and methods discussed below were heavily influenced by a meeting coordinated with the regional office of the Ministerio de Vivienda, Construccion, y Saneamiento (MVCS) in Chachapoyas the capital of the region of Amazonas. Because the regional office of MVCS is the entity charged with regional planning and oversight of the rural water supply systems as well as providing support to local government municipalities it was important to collaborate with them regarding current issues with community-managed rural water supply systems. A meeting was coordinated with three available consultants who work in the regional MVCS office, including the regional supervisor of the data collection for Diagnostico. During the meeting the three sustainability assessment tools were presented and discussed. Additionally, the following proposed data collection plan was presented to office staff for comments and suggestions. The next section contains the final data collection plan approved by USF IRB.

3.4 Field Data Collection Design

3.4.1 Data Collection Techniques

Data collection for this research utilized a mixed-methods approach that involved collecting both quantitative and qualitative data via focus groups, interviews, and observation. This approach implemented Rapid Rural Appraisal techniques (Freudenberger, 2008) to best capture information related to water service level, service provision activities and organization, and support provision to direct service providers. The instruments formulated to collect this data are described in the following section.

3.4.2 Data Collection Instruments

The following data collection instruments were formulated using three different sources. The initial versions were modeled after tools used in a research study carried out in the Dominican Republic concerning the sustainability of community-managed rural water supply (Schweitzer, 2009). Using this as a starting point, questions were edited to better consider the Peruvian context using wording and vocabulary also used by the *Instituto Nacional de Estadistica e Informatica* for JMP monitoring and reporting. Additionally, questions were added from the SIASAR survey forms including a new tool to be used with the ATM concerning support provision. Lastly, additional qualitative questions were added based off of the experiences of the thesis author in rural water supply.

The four data collection instruments used follow. Each can be found in their entirety in Appendix C of this thesis:

1. JASS (Focus Group) Survey Form
2. ATM Interview Form
3. Plumber-Operator Survey Form
4. Technical Data Sheet

The purpose of the JASS (Focus Group) Survey Form is to collect data concerning the level of service provision being offered by each JASS and understand the support provided to them by the ATM in their district. The tool consists of 83 questions. Some are quantitative in nature while others are open ended and qualitative. Questions cover topics that include: Water System Information, Organization and Function of the JASS, JASS Finances, System Service Level, and Operation and Maintenance of the System. The tool was administered by the thesis author to available members of the JASS in a focus group format. In total six focus groups were held, one in each community during the months of February and March of 2017. The focus group took place during approximately an hour and a half in the community meeting building of each community.

The purpose of the ATM Interview form is to collect information about the implementation of the ATM in the district and the work that the ATM has done to provide support to the communities in their jurisdiction. The tool is made up of 24 questions, both a mix of quantitative and qualitative questions. Questions cover topics including: Abilities of the ATM, Support provided to the ATM, Support provided by the ATM, and Work with the JASS. The tool was administered by the thesis author to the technician in charge of the ATM in a one-on-one interview format. In total six interviews were conducted, one in each of six district capitals during the months of February and March of 2017. The interview took place during approximately one hour in the municipal building of each district.

The purpose of the Plumber-Operator form is to collect data about the work done by the water system operator and/or plumber. The tool is made up of 18 questions quantitative in nature. Questions cover topics including: Professionalization of the Position, Maintenance Activities, and Level of Service of the System. The tool was administered by the thesis author to the plumber or operator of each of the six water systems, or whoever was responsible for operation and maintenance activities, in a one-on-one interview format. In total six interviews were conducted, one in each community during the months of February and March of 2017. The interview took place during approximately 20 minutes in the communal building of each of six communities.

The purpose of the Technical Data Sheet is to collect general information about the community and the water system. The tool is made up of 31 quantitative questions. Questions cover topics including: Demographics and Livelihoods, and Water System Data. The tool was use by the thesis author primarily through observation and informal interviewing of the JASS and Operator/Plumber. In total this tool was used six times, one in each community during the months of February and March of 2017. The interview took place during approximately 20 in each of six communities.

3.4.3 Sample Size

The department of Amazonas has a total of 7 different provinces which are split up in to 83 district municipalities. Selection of districts for participation in this research study was determined by the following criteria:

1. Participation in the Municipal Incentive Program

2. Implementation of the ATM Office

3. Stratification across the different provinces of Amazonas

4. Presence of a Peace Corps Volunteer

Criteria 1, Participation in the Municipal Incentive Program, was important because beginning in 2014, the Peruvian Ministerio de Economía y Finanzas in coordination with the MVCS included in their annual Incentive Program financial incentives for local, district municipalities to promote the creation of the ATM in each municipality. For fiscal year 2014 and 2015, the incentives were only available to district capitals with greater than 500 households. If the municipality completes the different requirements for each incentive they are transferred varying amounts (depending on the size of district) of financial incentive the following year. In this case, if completed in 2014, the money is received in 2015; if completed in 2015, the money is received in 2016. There is no stipulation about what the municipality must spend this money on, but the idea is that this money could be reinvested into providing more support to JASS district-wide. This criteria narrowed the possible districts to 18 municipalities.

Criteria 2, Implementation of the ATM, was important because not every district actually achieves the goal required to receive the incentive. Of the 18 municipalities able to access the incentives in Amazonas, 16 completed the incentives both fiscal years and actually created the ATM in the municipal structure and hired someone to fill the position. For research purposes, this presented an intriguing research sample because hypothetically each of these districts have now been providing external support to water committees district-wide for at least two whole years. This criteria narrowed the possible districts to 16.

Criteria 3, Stratification across the different provinces of Amazonas, was important because results spread across the entire region would provide better feedback. Of the seven provinces in the region, one, Condorcanqui, was intentionally left out because of its limited accessibility and potential danger from native communities. Thus, one district was chosen from each remaining provinces. This narrowed the possible districts to six.

Criteria 4, Presence of a Peace Corps Volunteer, was important because of time limitations in the field. Utilizing a well-integrated Peace Corps Volunteer as a contact in the district helped with logistics and coordination. Thus six districts were chosen that had the presence of a volunteer.

3.4.4 Community Selection

Each district has anywhere from 2 to 100 communities within the jurisdiction; thus, it was necessary to also select which specific community to visit in each district. This was primarily done with the help of the ATM in each district. Because one of the main focuses of the research is on the support relationship between the ATM and the JASS, each ATM was asked to select the JASS with whom they had worked the most. This thus meant that two of the prerequisites for selection are that the community had a water system as well as a JASS formed and implemented. Consideration was also given to proximity of the community to the district capital. In this manner six communities in total were selected from the six districts.

3.4.5 Participant Selection

Within communities, adult subjects (older than 18 years of age) were selected with no requirement for physical/mental/health status, gender, occupation, or medical diagnosis. The only requirement was that the person currently fills the position specified by the survey (e.g. system operator, JASS member, ATM, etc.). No one was excluded from participation in the surveys. Participation was completely voluntary and enlistment was carried out with the help of the ATM and Peace Corps Volunteer in the district.

3.4.6 Privacy and Informed Consent

No personally identifiable information about the participants was recorded on the written surveys and no names were asked during the audio recordings. Additionally, there were no potential risks to the subjects. Questions focused on water service provision, community information, and work tasks and did not cover personally invasive topics. Participation was completely voluntary and participants could choose to discontinue the surveys at any time. Similar surveys are conducted regularly by the national and regional government, thus the format of the data collection was not new or intimidating; there was no experimental procedure or interventions. No information collected jeopardized the participants standing in the community. Lastly, there was no expected benefit to the research subject beyond trickle down effects of having a better understanding of how to help ensure the sustainability of community-managed water systems.

The thesis author requested exemption from the USF IRB in collecting signed informed consent. The investigation presented less than minimal risk to the research participant and no personally identifiable information was collected. In the case of the surveys a signed consent form would be the only link between the data and the human subject. Additionally, due to cultural conditions, illiteracy is very common in the area where the research was carried out and by asking participants to read and sign a form they could be discouraged from participating. A verbal consent and information form was read to each participant before participation in order to give them time to decide if they would like to participate.

All surveys collected remained in the thesis author’s possession until they were stored in a locked file cabinet in a locked room. They will be kept for a period of five years after the thesis has been published at which point they will be shredded. All digital information and audio recordings remain on the thesis author's password protected computer. No actual names were recorded through the survey process. Individual answers were aggregated as soon as possible following the survey.

3.5 Field Data Collection Process

Section 3.4 detailed the process for formulating the research methods. This section describes the actual field data collection process that was used in the six communities listed in Table 3.1. Figure 3.1 shows their locations.

Table 3.1: Districts and associated communities included in primary data collection in the region of Amazonas, Peru

District	Community	Province
Cajaruro	El Paraiso	Utcubamba
Florida	Carrera	Bongara
Jazan	Suyubamba	Bongara
La Peca	La Tranquilla	Bagua
Leymebamba	Palmira	Chachapoyas
Luya	El Molino	Luya

3.5.1 Timeline

Field data collection took place over the span of a month between February and March of 2017 in the region of Amazonas. Visits in each individual district spanned between three to four days. Travel time between districts took between two to three days.

3.5.2 Coordination

Contact information for key staff in the districts was received from the regional government. Using this and the help of Peace Corps volunteers in each district, the visits were coordinated. To allow for flexibility in each district, coordination was not made with the subsequent district until arrival in the preceding district. The intention was to have exact meeting times and days coordinated before arrival, however this was often unattainable. Upon arrival in each district there was still the need for face to face coordination. Coordination with the community and JASS members was facilitated by the ATM in each district.

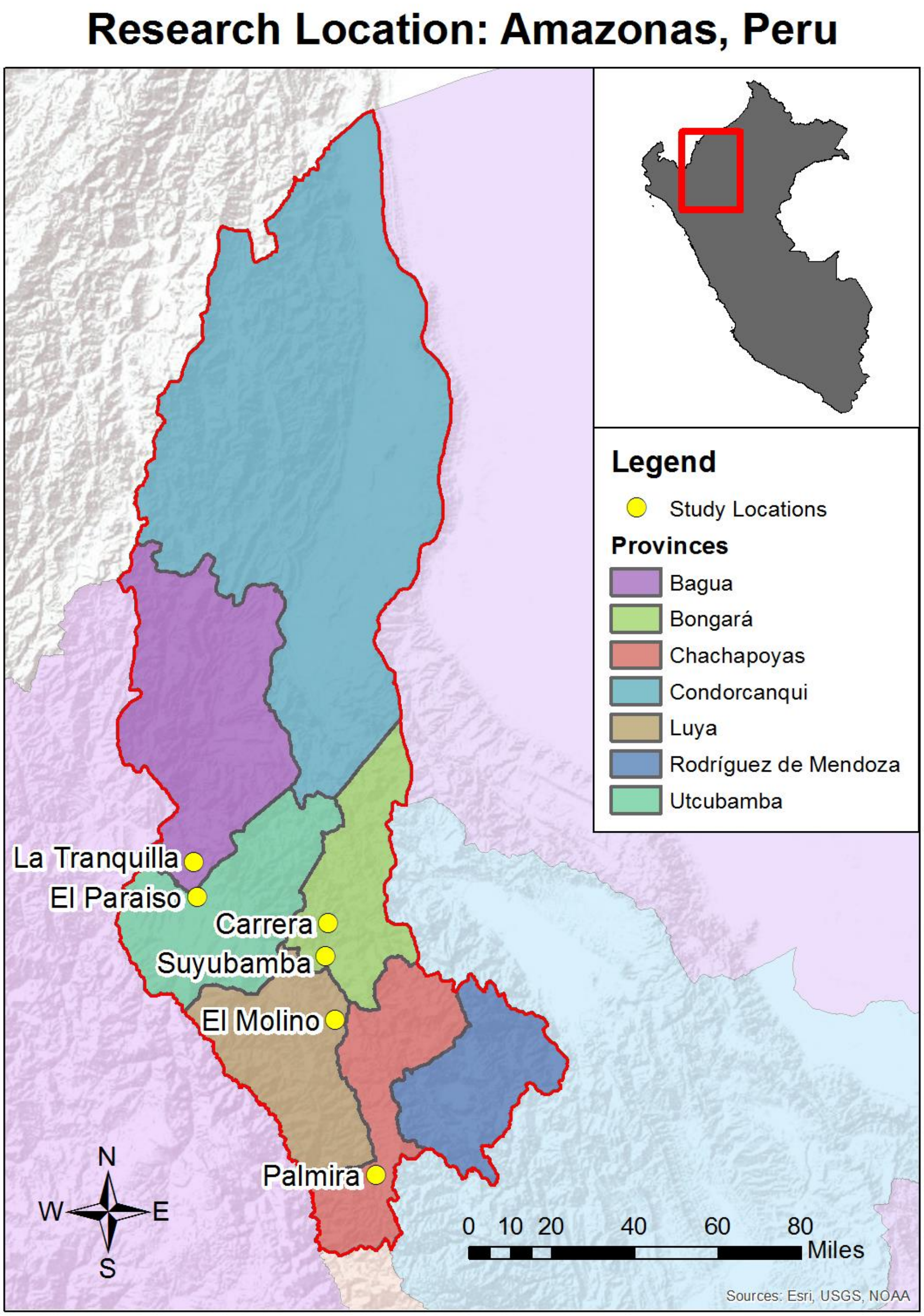

Figure 3.1: Map showing region of research focus and six individual communities visited for field data collection in Amazonas (Source: Map data from Esri, USGS, and NOAA)

3.5.3 Community Visits

Upon arrival to each district, a meeting was held with the ATM to present in-person about the research study. At that time coordination was also made for the actual interview with the ATM. Coordination was also made to visit the community to hold the focus group with the JASS, interview the operator/plumber, and fill out the technical data sheet. The interview with the ATM was performed in a private area in the municipal building. Interviews were recorded in order to facilitate future processing of the data and to be able to better pay attention during the interview. The JASS meeting was set-up with whichever members were available from the current JASS and the operator, where possible. In several cases there was no current operator, or the members of the JASS also performed the duties of the operator. This meeting took place in a community building or house of one of the JASS members.

3.6 Comparison of the Three Sustainability Assessment Tools

In order to compare and contrast the three sustainability assessment tools that have been used to monitor community-managed rural water supply in Amazonas it was necessary to establish a methodology. This methodology consisted of two parts: 1) question mapping of the content of the three tools (SIASAR, Trazadores, and Diagnostico), and 2) evaluation of the design, process and product of the three tools. Question mapping was selected as the best way to compare and contrast the content collected by the three tools. This was achieved by translating the three tools to English and comparing side-by-side-by-side the individual questions and thematic areas covered in each of the three tools. In this way it was possible to identify the particular strengths and weaknesses of each tool as it concerns the sustainability data considered. This process was guided by the results of the literature review and the consensus of experts in the field as to what factors are most important in monitoring the sustainability of community-managed rural water supply systems. The synthesis of these factors and indicators is found in Table 3.2. A summary of the question mapping process can be found in Chapter 4 and the detailed results are provided in Appendix E

The evaluation of the design, process and product generated by the three tools was based on the methodology utilized by Schweitzer et al. (2014). Additional criteria were considered for this study based on the thesis author's experience. These evaluation criteria can be found in Table 3.3. Each tool was evaluated using the criteria listed and then for each criteria the three tools were ordered (1-3) based on their appropriateness, 1 being the best score (most appropriate) and 3 being the worst (least appropriate) of the three tools. Appropriate for this context is defined as: how well does the tool help ensure the sustainability of community-managed rural water supply systems? Appropriateness was further assessed using the sub-criteria listed in Appendix D. The scores were then computed with the lowest total score indicating the most appropriate tool going forward.

Table 3.2: Consensus of sustainability factors from literature review

Sustainability Factor	**Common Indicators**
1. Technical	Appropriate service level and technology; functionality; condition of the system; system reliability; hygiene
2. Environmental	Watershed; water resource availability
3. Government	Institutional and policy; efficiency/ capacity of intermediate level actors
4. External support	Access to advice (technical/ management); capacity building; financial support
5. Management	Management capacities of the community; leadership; governance; collective initiative; activity level
6. Operation and Maintenance	Repair service
7. Financial	Financial durability; funds collection; willingness to pay; affordability; accounting & transparency
8. Social	Sociocultural respect; acceptance; demand

Table 3.3: Sustainability assessment tool evaluation criteria

Criteria	Description
1. Target audience	Who are the results of this tool intended for?
2. Life cycle stage	When can this tool be used?
3. Level of effort	What is the time and economic requirement?
4. Data level	Where is data collected?
5. Scope of the tool	What systems and services does this tool include?
6. Content areas	What questions are asked in the tool?
7. Sustainability indicators	How does this tool define sustainability?
8. Data collection methodology	How is data collected and documented?
9. Data entry methodology	What is the process for adding individual data to a database?
10. Data processing capability	What level of processing and calculation is included in the tool?
11. Outputs	What are the outputs of the tool?

3.7 Analysis of the State of Community-Managed Rural Water Systems in Amazonas

As was stated previously, it was decided to use the data from the SIASAR and Trazadores data sets to assess the state of community-managed rural water systems in Amazonas. It was determined that this would be best completed by calculating descriptive statistics from both of the data sets and also by displaying the results graphically in geographic information system maps. Descriptive statistics from these two data sets were generated using IBM SPSS Statistics version 23. Mapping was completed using ArcMap 10.2.

3.8 Processing of Field Data and Analysis of Support Provided to JASS by the ATM

The data collected in the field research of this study consisted of audio recordings from interviews and focus groups and paper surveys. For analysis purposes, the SIASAR sustainability assessment framework was used to calculate sustainability scores for the JASS and the ATM. Additional qualitative information collected was transcribed from the audio recordings of the interviews and focus groups to be used in the discussion of the results. The results from the field data were analyzed to find anecdotal evidence to examine the provision of external support to the JASS by the ATM. Qualitative information from the interviews was summarized to find common difficulties among those who fill the ATM position.

CHAPTER 4: RESULTS AND DISCUSSION

This chapter presents the results from the study methods and analysis described in Chapter 3. First, the results from the question mapping and sustainability assessment tool evaluation will be presented and discussed to determine appropriate recommendations for future monitoring of rural water system provision in Amazonas, Peru. Next, an assessment is made concerning the current state of community-managed rural water supply systems using the results collected with the SIASAR (Rural Water and Sanitation Information System) and Trazadores (Tracers in Water and Sanitation) assessment tools. Lastly, the results from the primary field data collection will be presented and used to assess the ATM (Área Técnica Municipal) model for direct support provision to JASS (Juntas Administradoras de los Servicios de Saneamiento).

4.1 Results from Question Mapping and Sustainability Assessment Tool Evaluation

The aim of this part of the analysis was to compare and contrast the three sustainability assessment tools used in Amazonas. Going forward a coherent rural water and sanitation monitoring plan is necessary not only for the region of Amazonas but for all of Peru. It is inefficient to use three different tools that measure similar aspects of rural water supply service. Thus, in order to best ensure the long-term sustainability of rural water supply in Peru government agencies should choose one tool or determine how to build off of the strengths of each one. Sections 4.1.1 and 4.1.2 provide helpful analysis to inform this decision.

4.1.1 Question Mapping

The procedure for the question mapping was explained in Chapter 3 and the detailed list of questions can be found in Appendix E. Table 4.1 breaks down the content of each tool question-by-question into the sustainability factors and indicators identified from the literature review. An individual question was defined as a unique response collected by the tool.

Table 4.1: Summary of question distribution by sustainability factor for content of three sustainability assessment tools (Diagnostico - D, SIASAR - S, and Trazadores - T)

Sustainability Factor	Indicators	Number of Questions and % of Total					
		D*	%	S*	%	T*	%
Technical	Appropriate service level	33		62		3	
	Functionality	5		2		1	
	Condition of the system	101		5		10	
	System reliability	4		1		2	
	Hygiene	7		13		4	
	Sanitation	9		24		8	
	Subtotal	**159**	**42.5**	**107**	**41.0**	**29**	**64.4**
Environmental	Watershed	10		14		1	
	Water resource availability	3		8		1	
	Subtotal	**13**	**3.5**	**22**	**8.4**	**1**	**2.2**
Government	Institutional and policy	0		0		0	
	Efficiency/capacity of intermediate level actors	12		18		0	
	Subtotal	**12**	**3.2**	**18**	**6.9**	**0**	**0.0**
External support	Access to advice (technical/management)	11		18		6	
	Capacity building	16		13		1	
	Financial support	3		0		0	
	Subtotal	**30**	**8.0**	**31**	**11.9**	**7**	**15.6**
Management	Management capacities of the community	24		17		1	
	Leadership	1		1		0	
	Governance	6		7		1	
	Collective initiative	3		0		0	
	Activity level	42		22		0	
	Subtotal	**76**	**20.3**	**46**	**17.6**	**2**	**4.4**
O & M	Repair service	35		3		2	
	Subtotal	**35**	**9.4**	**4**	**1.5**	**2**	**4.4**
Financial	Financial durability	3		2		1	
	Funds collection	28		18		1	
	Willingness to pay	3		1		0.5	
	Affordability	4		1		0.5	
	Accounting & transparency	8		8		0	
	Subtotal	**46**	**12.3**	**30**	**11.5**	**3**	**6.7**
Social	Sociocultural respect	3		3		0	
	Acceptance	0		0		1	
	Subtotal	**3**	**0.8**	**3**	**1.1**	**1**	**2.2**
	Total	**374**	**100.0**	**261**	**100.0**	**45**	**100.0**

*D - Diagnostico, S - SIASAR, T - Trazadores

In total, Diagnostico (Diagnostic Survey for Water Supply and Sanitation) consists of 374 questions, SIASAR 261 questions, and Trazadores 45 questions. In looking at Table 4.1, several trends can be identified. Across the three tools, each focuses the majority of content on Technical factors related to the water service (41% - 62% of total content). From there, Diagnostico and SIASAR place second most importance on Management (20% and 18% respectively), while Trazadores places more emphasis on External Support (16%). Third most importance is given to either External Support or Financial. It should also be noted that relatively little attention is given to either Government or Social.

To better contrast the individual tools, the relative strengths – that is, content areas that provide richer detail about service sustainability – and weaknesses of each tool were identified. These results can be found in Table 4.2. The rankings identified in this table are not absolutes but rather express comparative strengths and weaknesses relative to the other tools. That is to say, where a tool does not have a strength identified it does not mean that the information is not covered, only that the other tools also cover the same information in equal or greater detail. Likewise, where a weakness is not identified it does not mean that the information is covered per se, but that the other tools also leave out the same content areas.

Table 4.2 shows that for the Technical factor, Diagnostico goes in to great detail in asking about the condition of each component of the system however it only includes residual chlorine level as a water quality parameter. SIASAR pays special attention to the service levels at important institutions that might exist in the community such as schools and health posts. Data are collected on water and sanitation coverage for both the male and female population of each institution. SIASAR lacks emphasis on system reliability (i.e. hours/day during different times of the year, service interruptions, etc.). Trazadores asks specific water quality questions however does not go into detail about water system coverage or the appropriateness of the technology.

Table 4.2: Relative strengths and weaknesses of content contained in each Sustainability Assessment Tool (Diagnostico, SIASAR, and Trazadores), by sustainability factor. The label "+" indicates a relative strength compared with the other two tools and "-" indicates a relative weakness.

Sustainability Factor	Diagnostico	SIASAR	Trazadores
Technical	+ condition of each component of system	+ schools and health centers + system schematic	+ water quality parameters
	- water quality parameters	- system reliability	- appropriate service level and technology
Environmental	--	+ watershed conservation	--
	- health of watershed	--	- watershed
Government	+ distance from capital	+ planned interventions	N/A
	- policy	- enabling environment	N/A
External support	+ support provided	+ function of Área Técnica Municipal	+ establishment of Área Técnica Municipal
	- info on Área Técnica Municipal	- financial support	- training provided to JASS
Management	+ involvement of ea. board member + administrative books + legal standing	+ specific activities	--
	- leadership	- community initiative	- capacities and activities of management
Operation and Maintenance	+ tools and equipment + down time causes + maintenance activities	--	--
	--	- maintenance activities	- repair service
Financial	+ expenditures + tariff structure	+ accounting and transparency	--
	--	--	- accounting and transparency
Social	--	--	--
	- acceptance	- demand	- sociocultural setting

For the Environmental factor, SIASAR collects detailed information about deforestation and watershed management activities. All three tools ask about water resource availability in different seasons, but SIASAR is the only one that goes deeper into conservation issues. Continued consideration of the effects of climate change on water availability is crucial.

For the Government factor, Diagnostico asks several questions about the distance of the community from the district capital and how to get there. SIASAR asks multiple questions about previous, current, and/or planned interventions in water, sanitation, or hygiene in the community. None of the tools truly measure the enabling environment at a regional or national level beyond that. This perhaps can be explained away since the primary audience of the tools is the government which already is assumed to have a good grasp of their policies and support programs.

For the External Support factor, Diagnostico collects valuable information about the type and frequency of support provided (technical, management, financial) to the community however does not have a section dedicated to the ATM. (This is remedied in the 2017 cycle of surveying as part of the Ministerio de Vivienda, Construccion y Saneamiento Incentive Plan, however this was not available at the time of writing and so was not included.) SIASAR goes into quality detail about the office of the ATM and the support provided to the communities in their jurisdiction but does not collect information about financial support provided by the local municipality. Trazadores has a section dedicated to the office of the ATM but does not ask any questions about the type of capacity building or other support provided to the JASS by the ATM.

For the Management factor, Diagnostico thoroughly covers the level of involvement of each board member, the use of different administrative tools and books, and the legal standing of the JASS with the municipality. SIASAR collects detailed information about specific management activities, especially related to watershed management and water safety planning. Both tools do a poor job of measuring the softer indicators such as leadership and community initiative. Trazadores only dedicates two questions to management indicators and does not go into detail about participation of board members, organization or specific management activities.

For the Operation and Maintenance factor, Diagnostico asks about specific inventory of tools and equipment, reasons behind system service interruptions, and maintenance activities carried out by an operator or the JASS. SIASAR and Trazadores ask if an operator exists but do not go into great detail about maintenance activities or repair service.

For the Financial factor, Diagnostico covers specific itemized expenditures and tariff structure. SIASAR emphasizes accounting and transparency as well as rate of payment. Trazadores does not provide much detail beyond tariff collection rates and income versus expenditures.

For the Social factor, all three tools fail to collect any data about the sociocultural context, user acceptance, or demand for service. Despite these being important components as discussed by previous researchers (Sara & Katz, 1999; Lockwood et al., 2003; McConville & Mihelcic, 2007), they are harder to quantify in the short periods of time during which these surveys are typically conducted in the communities.

4.1.2 Sustainability Assessment Tool Evaluation

With the Sustainability Assessment Tool evaluation matrix presented in Chapter 3 as a guide, each tool – the entirety of its development, objectives, processes, and outputs – was evaluated against the other two tools. This matrix utilized 11 different criteria: 1) target audience, 2) life cycle stage, 3) level of effort, 4) data level, 5) scope of the tool, 6) content areas, 7) sustainability indicators, 8) data collection methodology, 9) data entry methodology, 10) data processing capabilities, and 11) outputs. Each of the eleven criteria was looked at for each tool with the responses being found in Table 4.3. Information was gathered from the tools themselves, from the supporting documentation and from the author's knowledge of their implementation.

Table 4.3: Sustainability Assessment Tool evaluation matrix with information from each of the three tools (Diagnostico, SIASAR, and Trazadores). Information from each tool is organized according to the evaluation criteria in the leftmost column.

Criteria	Definition	Diagnostico	SIASAR	Trazadores
Target audience	Who are the results of this tool intended for?	In-depth: National and Regional decision makers. On surface: local stakeholders	Donor agencies, national government, regional and local stakeholders	National, regional, and local stakeholders and decision makers
Life cycle stage	When can this tool be used?	Post-construction, baseline	Continuously over the lifespan of the system, post-construction	Post-construction, regularly
Level of effort	What is the time and economic requirement?	Medium. Training needed for enumerator. Long survey.	Training required, surveys are multiple but straightforward and can be collected using a mobile application	Low. Relatively short survey. Can be filled out by technical assistance provider. Self-explanatory
Data level	Where is data collected?	Community	Community, and municipal level	Community, and municipal level
Scope of the tool	What systems and services does this tool include?	Water/Sanitation systems, Service provision, Community, (technical support provider (ATM) added in 2017)	Community, water/sanitation system, service provider, technical assistance provider (ATM)	Community, system, service provider, technical support provider (ATM)
Content areas	What questions are asked in the tool?	Community characteristics, Water & Sanitation coverage, Service provision, Management capabilities, Water system function, Water system components condition	Community information, sanitation and hygiene, school and health center service level, interventions, service provision, financial info, O&M, System condition, Technical support provider (ATM)	Water quality, Service quality, Condition of infrastructure, Management, Household hygiene practices, Institutional support, Technical support provider (ATM)
Sustainability indicators	How does this tool define sustainability?	Coverage	Community (Coverage, Environment, Hygiene), System (Flow, Physical condition, Water quality, Watershed), Service Provider (Management, Tariff, Financial durability, O&M, Watershed management), Technical Assistance Provider (ATM) (Diagnostic info, Visits, Water quality monitoring, Staff/Equipment, Budget)	Water quality, Service quality, Condition of infrastructure, Management, Household hygiene practices, Institutional support
Data collection methodology	How is data collected and documented?	Collected by technical support provider (ATM), or through technicians from national program, on paper surveys	Traveling technicians from central government, paper surveys and/or mobile application	Information is filled in online by the technical support provider (ATM) using their records
Data entry methodology	What is the process for adding surveys to database?	Data is added via MVCS website accessed on a computer	Direct to mobile or via website accessed by computer	Information is collected and added at the same time
Data processing capability	What level of processing and calculation is included in the tool?	Limited data processing. Summary statistics (coverage, etc.) displayed on map	Generated summary reports by country, with detailed responses, interactive info on maps	Website calculates scores, and generates reports disaggregated by political division
Outputs	What are the outputs of the tool?	An interactive map with coverage data and summary tables and graphs	Sustainability scores, downloadable database information, interactive maps on website	Sustainability scores, reports in HTML, PDF, or Excel

Then, for each criteria the tools were ranked in order from one to three, with one being the most appropriate and three being the least. 'Appropriate' for this context was defined as how well the tool helps ensure the sustainability of community-managed rural water supply systems and further specified by the sub-criteria included in Appendix D.

4.2 Discussion of Question Mapping and Evaluation Matrix Scores

Using the point rankings (1-3), scores were added up for each tool with the lowest total score being the tool that is most appropriate. The score results from the evaluation matrix can be found in Table 4.4.

Table 4.4: Scores from the Sustainability Assessment Tool evaluation matrix

	Diagnostico	SIASAR	Trazadores
Target audience	3	1	2
Life cycle stage	3	1	2
Level of effort	2	3	1
Data level	3	1	2
Scope of the tool	2	1	3
Content areas	1	2	3
Sustainability indicators	3	1	2
Data collection methodology	2	1	3
Data entry methodology	3	1	2
Data processing capability	3	1	2
Outputs	3	1	2
Total Score	28	14	24

As can be seen from Table 4.4, SIASAR rated out as the most appropriate of the three tools for measuring the sustainability of community-managed rural water systems. While this might seem surprising after the results of the question mapping (Table 4.1) in which it seemed Diagnostico covered many of the important sustainability factors in great depth, it became clear through the evaluation matrix that Diagnostico as a complete package falls short of the other two tools. The biggest drawbacks of Diagnostico as a sustainability assessment tool are mainly focused on its applicability after data has been collected. While the data that it collects is very rich in detail, the tool does not include the ability to calculate sustainability scores or generate useful summary reports. In addition, the tool itself does not have a robust definition of sustainability (as is, it is defined as 'functionality' and does not include metrics for service level –quantity, quality, continuity – or service provision) and the results are not very accessible to local government, much less rural communities.

Trazadores offers many of the analysis tools that Diagnostico does not however it still falls short in several different areas. What the tool lacks in content it makes up for in its simplicity and level of effort. Every question that is asked is directly involved in the calculation of a score (general, JASS, or ATM). The results are easy to interpret and provide a rapid yet useful way to assess the needs across a district or in a specific community. However, what is gained by its simplicity is also lost in its robustness. For instance, the JASS score is just a composite of several of the system indicators from the general score plus the addition of two more. This leaves much to be desired concerning its usefulness to the JASS or ATM in diagnosing problem areas related to management, operation, and maintenance. Additionally, there is no paper form or mobile application for data collection. The tool only is accessed via desktop computer and thus the technician or ATM who is collecting data must create their own paper survey to use during their visit to the community, or use separate data from other records they might have.

SIASAR, on the other hand, while not perfect, excels in many of the ways that Diagnostico does not and improves on the things that Trazadores does do well. Sustainability scores are clearly defined, data collection is easily integrated into mobile devices, and the website provides reports and interactive maps for exploring the different scores geographically. SIASAR also lends itself to continuous use throughout the lifecycle of a water system whereas Diagnostico is much more useful as a broad, baseline study. Information was not available about the exact implementation of SIASAR in Peru, but as will be discussed in Section 4.3, the dataset downloaded from the SIASAR website was incomplete in some sections and data were not collected about the ATM despite the existence of the ATM form. This raises questions about buy-in among the different levels of the Peruvian government. The SIASAR authors encourage individual countries to adapt the tool to their specific context, which perhaps led to resistance in its adaptation in Peru, however that is all postulation and should be confirmed with government officials at the central level. Regardless, the data collected have proved useful to help better understand the state of community-managed rural water supply systems in Amazonas, as will be discussed in Section 4.3.

As has been made clear in the past several years through the Municipal Incentive Plan program from the MVCS, the focus currently is on collecting data country-wide with the Diagnostico tool. While any coherent monitoring plan is better than a haphazard one or none at all, the usefulness of the Diagnostico results will be limited by what the MVCS develops to analyze and present the data. As is, the main indicator that is being presented at this time from the tool is coverage. However, as discussed in Chapter 2, the literature demonstrates that for sustainable service delivery to be achieved at scale, the focus must shift to a more holistic approach that monitors service delivery and sustainability.

4.3 Identification of Diagnostico Data for Use with SIASAR Framework

At the time of writing it was unclear what the government of Peru was planning as far as the Diagnostico data are concerned. From the SIASAR website (www.siasar.org), Peru is still participating in the Latin America regional SIASAR initiative. If the Diagnostico data could be adapted for use with the SIASAR tool, then it could serve two purposes. In light of this, an analysis was completed of the Diagnostico tool to identify which information corresponds with the SIASAR questions and if it could be compatible. In 2016, SIASAR adopted a new conceptual model which includes a different framework for calculating a sustainability score (SIASAR, 2016). Since the SIASAR data that were included in this research predate the new conceptual model it was not deemed necessary to use it in the rest of the research, just for this part of the discussion. However, for the future it is necessary to use the new framework.

The new framework calculates one comprehensive score for each community called the Water and Sanitation Performance Index. This is a composite of six different partial indices: Water Service Level, Sanitation and Hygiene Service Level, Schools and Health Centers, Water System Infrastructure, Service Provision, and Technical Assistance Provision. Each of these partial indices consist of four indicators. Each indicator is calculated from information from different questions on the surveys and forms. For the analysis these questions were summarized and then corresponding questions were identified in the Diagnostico survey. A complete list of these can be found in Appendix F. As Table 4.5 shows, the Diagnostico survey does not contain information for 28 of the 106 unique questions necessary for the SIASAR framework.

The new conceptual model does have certain flexibility for dealing with missing information, however if 14 out of the 24 indicators cannot be calculated because of missing information it is likely that the calculation of the final Water and Sanitation Performance Index will not be very accurate, or at the very least it will not be comparable across countries. For several indicators Diagnostico is only missing a question or two, but for the others Diagnostico does not cover any of the necessary questions.

Table 4.5: Summary table of evaluation of Diagnostico data necessary for SIASAR sustainability assessment tool

Total indicators	24
Total questions	106
Missing questions	28
Affected indicators (listed)	Quality, Personal hygiene, Household hygiene, Community hygiene, Water supply in schools, Water supply in health centers, Sanitation and hygiene in schools, Sanitation and hygiene in health centers, System autonomy, Water catchment area protection, Treatment system, Operation and maintenance management, Economic management, Environmental management
Affected indicators (number)	14

One of the main topics that the Diagnostico survey does not address is the service levels in schools and health centers. The Diagnostico survey also does not collect important information concerning the environmental hazards that are presented at the water system source and the preventative maintenance that the JASS should carry out to mitigate these hazards. The last main topic that the Diagnostico survey does not cover that is included in SIASAR assessment framework is hygiene at a household and community level. Beyond these main topics, Diagnostico covers the majority of questions needed for the SIASAR assessment tool. Because of this, a modified score could be calculated for use within Peru, which would provide a better snapshot of sustainability than the currently used indicator of coverage that the Diagnostico tool calculates. However, these scores would not be comparable with other scores from across the region.

4.4 State of Community-Managed Rural Water Supply Systems in Amazonas

Despite the shortcomings of the datasets from the SIASAR and Trazadores assessment tools, it was still possible to use the data to better understand the current state of community-managed rural water supply systems in Amazonas. The shortcomings of the datasets being that there was not complete data for all of Amazonas, and the lack of ATM scores for the SIASAR data. Information about user tariffs, coverage, and scores follows in sections 4.4.1 and 4.4.2.

4.4.1 SIASAR

Data from the SIASAR database represent 25 districts across 6 provinces in the region of Amazonas. Only gravity-fed systems that were managed by a communal organization or JASS were included. A total of 68,401 people were served by the 202 systems represented. The data were collected between July and December of 2015 and at this time the average reported monthly user tariff was a little more than $0.50 USD per household. Coverage rates are high for both water and sanitation service, however the gravity fed water systems are on average more than 15 years old. See Tables 4.6 – 4.8 for detailed descriptive statistics.

Table 4.6: Summary statistics for cases included in the SIASAR analysis

No. of Districts	25
No. of Communities	202
Total Population	68,401
No. of Systems	202

Table 4.7: Monthly user tariff information for communities included in SIASAR analysis

	Peruvian Nuevo Soles	**U.S. Dollars**
Mean	1.77	$0.54
Std. Dev.	1.80	$0.55
Median	2.00	$0.62
Range	16.00	$4.92

Table 4.8 shows that coverage rates for both water and improved sanitation are high (greater than 86% in all cases) and consistent across the different provinces. SIASAR defines

improved sanitation coverage as a flush toilet or a latrine with a slab. Also of note is that the average number of hours of water service per day is high, between 19 - 22 hours per day.

Table 4.8: Average service level for systems included in SIASAR analysis, by province

Province		Potable Water Coverage (%)	Improved Sanitation Coverage (%)	Age of System (yrs.)	Hrs. Service
Bagua	Mean	86.41	92.96	14.7	21.81
	Std. Dev.	*(22.51)*	*(23.34)*	*(7.86)*	*(6.48)*
Bongara	Mean	91.58	88.63	14.2	22.2
	Std. Dev.	*(11.35)*	*(25.65)*	*(6.29)*	*(3.33)*
Chachapoyas	Mean	92.24	95.88	13.9	22.22
	Std. Dev.	*(15.91)*	*(9.15)*	*(8.58)*	*(2.77)*
Luya	Mean	86.50	85.91	17.6	21.88
	Std. Dev.	*(15.41)*	*(26.33)*	*(7.63)*	*(5.50)*
Rodriguez de Mendoza	Mean	93.54	83.22	9.1	--
	Std. Dev.	*(11.58)*	*(21.40)*	*(3.48)*	--
Utcubamba	Mean	90.55	90.33	20.1	19.2
	Std. Dev.	*(14.80)*	*(23.56)*	*(7.95)*	*(7.90)*
	Missing	0	0	30	58

The SIASAR tool provides three sustainability scores: 1) community, 2) system, and 3) JASS or service provider. Each one is evaluated on a set of criteria which can be found listed in Appendix D. These criteria are a subset of the different indicators that are collected from the questions included in the survey forms. Numeric scores are then grouped, high to low, into grades of A – D based on predetermined point thresholds. For community scores: A: 3.5 – 4, B: 2.5 – 3.49, C: 1.5 – 2.49, D: 0 – 1.49. For system scores: A: 25 – 32, B: 17 – 24, C: 9 – 16, D: 0 – 8. For JASS scores: A: 3.5 – 4, B: 2.5 – 3.49, C: 1.5 – 2.49, D: 0 – 1.49. These grades adopt a stoplight scheme of green-yellow-orange-red, with 'A' corresponding to green (best case) and 'D' to red (worst case). Summaries of the community, system, and JASS scores for Amazonas are provided in Tables 4.9 – 4.11, respectively.

Table 4.9: Summary of community scores for communities included in SIASAR analysis, by province. (A: 3.5 – 4, B: 2.5 – 3.49, C: 1.5 – 2.49, D: 0 – 1.49)

Province	No. of Cases	Mean	Std. Dev.	A	B	C	D
Bagua	81	2.65	0.528	0	55	24	2
Bongara	13	2.85	0.376	0	11	2	0
Chachapoyas	10	2.90	0.316	0	9	1	0
Luya	36	2.53	0.506	0	19	17	0
Rodriguez de Mendoza	14	2.64	0.497	0	9	5	0
Utcubamba	48	2.88	0.334	0	42	6	0
Total Cases	202	--	--	0	145	55	2

Table 4.10: Summary of system scores for systems included in SIASAR analysis, by province. (A: 25 – 32, B: 17 – 24, C: 9 – 16, D: 0 – 8)

Province	No. of Cases	Mean	Std. Dev.	A	B	C	D
Bagua	36	15.61	3.045	0	17	19	0
Bongara	10	12.90	2.283	0	0	10	0
Chachapoyas	9	14.78	1.641	0	1	8	0
Luya	34	12.82	2.139	0	3	31	0
Rodriguez de Mendoza	14	13.86	1.562	0	0	14	0
Utcubamba	41	15.10	1.428	0	6	35	0
Total Cases	144	--	--	0	27	117	0

Table 4.11: Summary of JASS scores for JASS included in SIASAR analysis, by province. (A: 3.5 – 4, B: 2.5 – 3.49, C: 1.5 – 2.49, D: 0 – 1.49)

Province	No. of Cases	Mean	Std. Dev.	A	B	C	D
Bagua	81	2.22	0.447	0	19	61	1
Bongara	13	2.23	0.439	0	3	10	0
Chachapoyas	10	1.80	0.422	0	0	8	2
Luya	36	2.17	0.378	0	6	30	0
Rodriguez de Mendoza	14	1.93	0.267	0	0	13	1
Utcubamba	48	2.29	0.459	0	14	34	0
Total Cases	202	--	--	0	42	156	4

Table 4.9 shows that for community scores, the majority of communities are graded as ‘B’ and ‘C’ with a few graded ‘D’. In every province there are more ‘B’s than ‘C’s. ‘B’ signifies

that the community has good but not complete water and sanitation coverage and/or has lacking environmental health. 'C' signifies that the community has serious deficits in water and sanitation coverage and poor environmental health. 'D' signifies that the community has dangerously low coverage in water and sanitation and extremely poor environmental health. It should be noted that none of the communities included in this analysis achieved a score of 'A'. While water and sanitation coverage levels are high, in looking at the raw data there is an overall lack of community hygiene and environmental health which negatively affects the community scores. As was discussed in Chapter 2, the community score for SIASAR also includes a composite indicator which reflects the scores from the corresponding JASS and water system from each community. Thus if a JASS and/or water system does not score well, it logically affects the overall score of the community. A graphical summary of the total cases can be found in Figure 4.1.

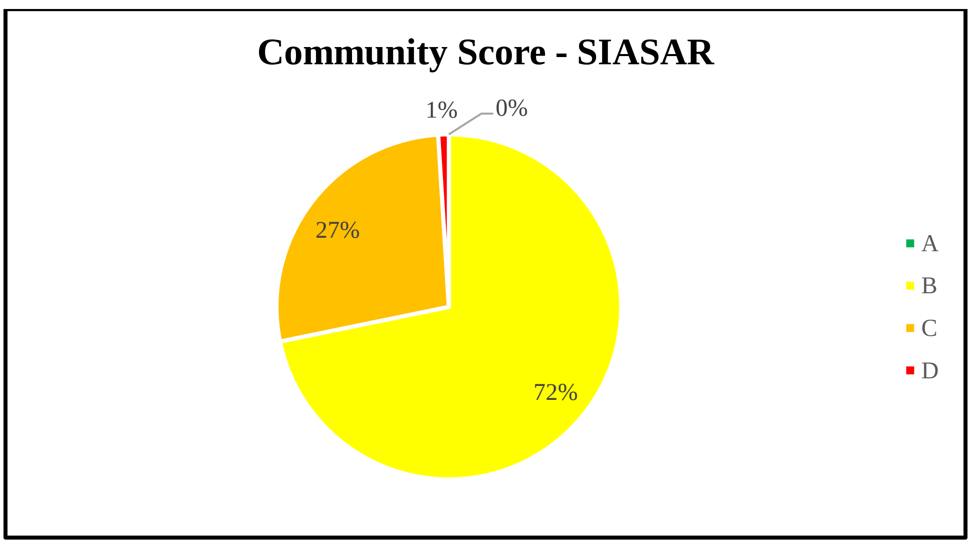

Figure 4.1: Distribution of community scores in SIASAR analysis (n = 202)

For system scores, all systems are graded as 'B' and 'C'. However, in this case in every province there are more 'C's than 'B's. For the system score, a 'B' corresponds with a system that is not completely functioning correctly or has a breakdown that the JASS is capable of repairing. A grade of 'C' corresponds to a system that has serious problems that cannot be attended to by the JASS alone. As with the community scores, no system included in the SIASAR analysis scored a grade of 'A'. In looking at the raw data these low scores are primarily due to the poor physical condition of the systems. This is a reflection of the age of the systems (average of 15 yrs.) throughout Amazonas. A summary of the score distribution for the systems is located in Figure 4.2.

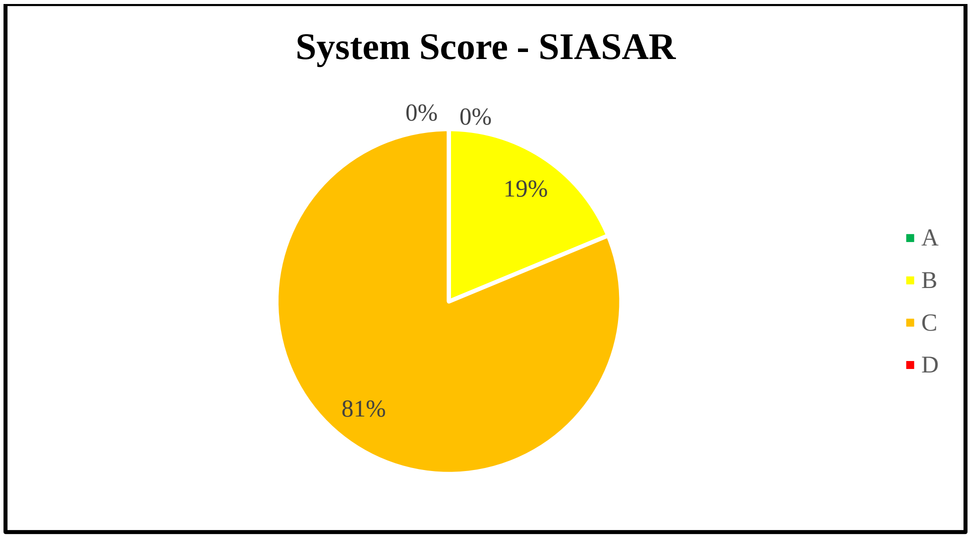

Figure 4.2: Distribution of system scores in SIASAR analysis (n=144)

For JASS throughout Amazonas, the majority of JASS earn grades of 'B' or 'C' with several earning a 'D'. A grade of 'B' signifies that the JASS has an average level of organization and maintains a sustainable service level. A grade of 'C' signifies that the JASS has a low level of organization and is not sustainable. Lastly, a grade of 'D' signifies that the JASS is not active and the system is at risk of falling into complete disrepair. Again, no JASS graded as an 'A' which would signify they are well organized and adequately equipped with the training and resources needed to guarantee a sustainable service level. The data suggest that a large reason for the poor JASS scores is a lack of financial durability and low accounting and transparency. Additionally, in 2015 when this data was collected the MVCS Municipal Incentives Program, which has prioritized registering JASS with the local municipality and thus providing legal status, was still in its infancy. Therefore many JASS scores from SIASAR were negatively impacted by lack of legal status. A summary of the JASS score distributions can be found in Figure 4.3.

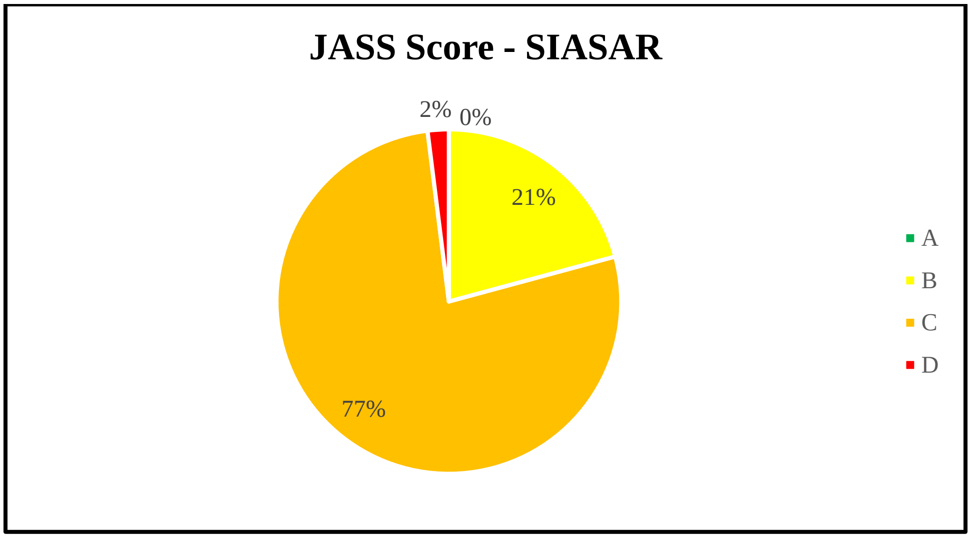

Figure 4.3: Distribution of JASS scores in SIASAR analysis (n=202)

4.4.2 Trazadores

Data from the Trazadores database represent 18 districts across 5 provinces in the region of Amazonas. Only gravity-fed systems that were managed by a communal organization or JASS were included. A total of 33,945 people were served by the 158 systems represented. The data were collected between August 2016 and July 2017 and the average reported monthly user tariff was $0.69 USD per household. Trazadores does not collect information about coverage or system age. Tables 4.11 and 4.12 summarize statistics about the analyzed Trazadores data.

Table 4.12: Summary statistics for cases included in the Trazadores analysis

No. of Districts	18
No. of Communities	158
Total Population	33945
No. of Systems	158

Table 4.13: Monthly user tariff information for communities included in Trazadores analysis

	Peruvian Nuevo Soles	U.S. Dollars
Mean	2.23	$0.69
Std. Dev.	1.91	$0.59
Median	2.00	$0.62
Range	10	$3.08

For system and service provision Trazadores calculates two scores: 1) a general sustainability score for the system and community, and 2) a JASS score. The general score is categorized into four thresholds: 1) Adequate, 2) With some deficiencies, 3) With serious limitations, and 4) In decline. The JASS score is categorized into three thresholds: 1) Adequate, 2) With limitations, and 3) Deficient. Tables 4.14 and 4.15 contain summary information for each of the scores grouped by province. For the general score, a score is classified adequate if it is between 0 – 0.4, with some deficiencies between 0.4 – 0.8, with serious limitations between 0.8 and 1.2, and in decline if greater than 1.2. For the JASS score, greater than or equal to 85 is adequate, between 50 and 85 is with limitations, and less than 50 is deficient.

Table 4.14: Summary of general sustainability scores for systems included in Trazadores assessment tool analysis, by province

Province	No. of Cases	Mean Score	Std. Dev.	Adequate	With some deficiencies	With serious limitations	In decline
Bagua	3	0.46	0.186	1	2	0	0
Bongara	6	0.83	0.546	2	1	1	2
Chachapoyas	3	1.34	0.232	0	0	1	2
Luya	55	0.99	0.373	5	10	21	19
Utcubamba	91	0.84	0.411	15	30	22	24
Total cases	158	--	--	23	43	45	47

* No data for Mendoza

Table 4.15: Summary of JASS scores for JASS included in Trazadores assessment tool analysis, by province

Province	No. of Cases	Mean Score	Std. Dev.	Adequate	With limitations	Deficient
Bagua	3	80.00	8.660	2	1	0
Bongara	6	60.00	25.690	1	3	2
Chachapoyas	3	41.67	15.275	0	1	2
Luya	55	51.55	19.073	4	21	30
Utcubamba	91	58.79	20.741	14	43	34
Total Cases	158	--	--	21	69	68

*No data for Mendoza

For both the general score and the JASS score the results from Trazadores shows slightly more positive results than the SIASAR results. While there are a multitude of deficient scores there are also many more cases reaching the highest service level. Examination of Tables 4.14 and 4.15 suggests that the majority of cases come from the provinces of Luya and Utcubamba and that the majority of adequate cases are found in the province of Utcubamba for both general score and JASS score. Looking at the mean scores, the best scores are from Bagua and Bongara, however this is skewed by the low number of cases. Figures 4.4 and 4.5 show the graphical representation of the score distributions for all of Amazonas. Compared with the SIASAR scores, the distribution for Trazadores is more even among the different grades or thresholds.

Figure 4.6 presents the aggregated sustainability score (district average) by district for each of the two tools. For SIASAR, the system score was used as this most closely compares with the general sustainability score of the Trazadores tool. Data are only shown for districts whose data was available in the respective database for each tool, thus not each district can be compared across tools. The map's main goal is to represent the general state of systems across the region of Amazonas. While the SIASAR map shows no variation (all grade 'C') between different districts, the Trazadores map shows greater variation. This difference can be attributed to the lack of representative distribution of scores across districts and the different criteria and thresholds used to calculate each grade/score.

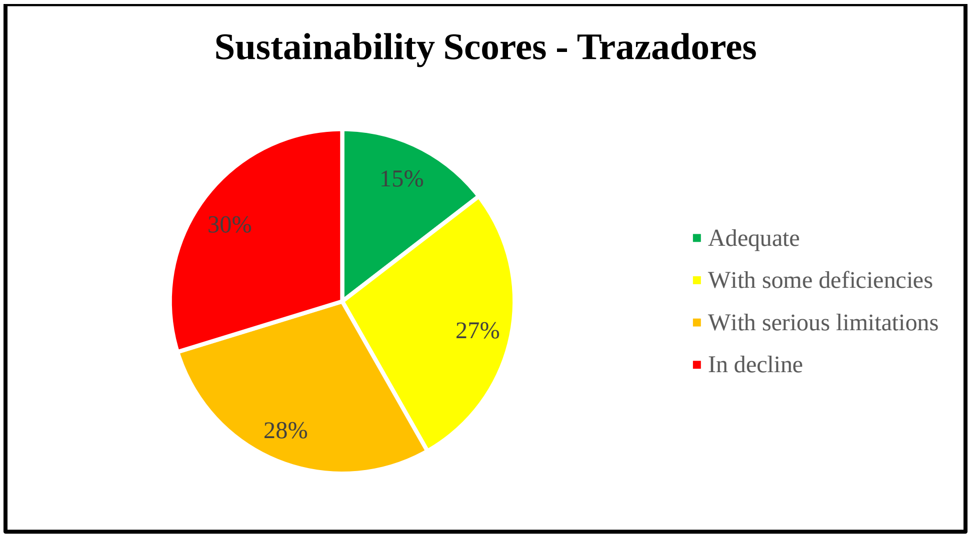

Figure 4.4: Distribution of sustainability scores of communities in Trazadores assessment tool analysis (n = 158)

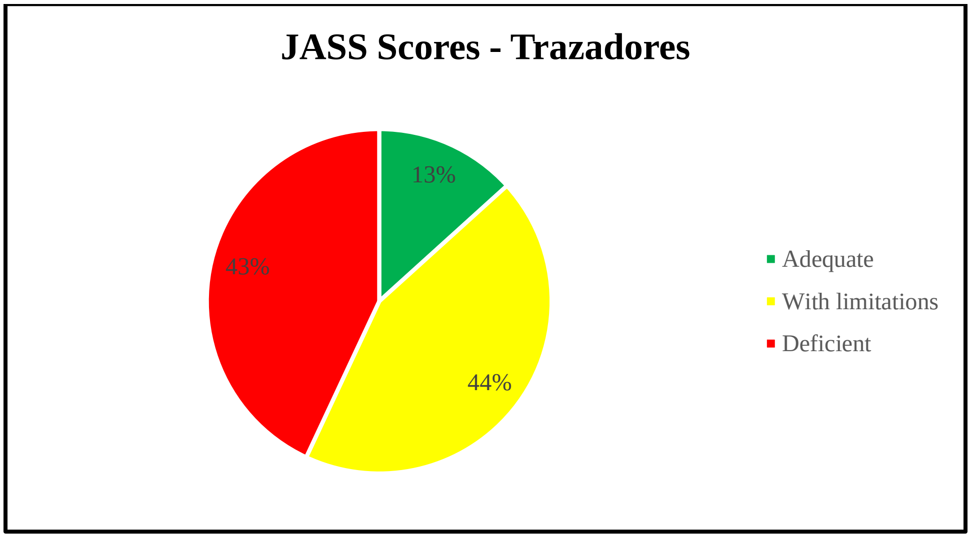

Figure 4.5: Distribution of JASS scores in Trazadores assessment tool analysis (n=158)

A more accurate snapshot of the state of community-managed rural water supply systems would include a stratified sample across all districts and provinces. These data should become available as a part of the Diagnostico data set as the MVCS Incentive Program continues.

For maps containing individual scores for each community, see Appendix G

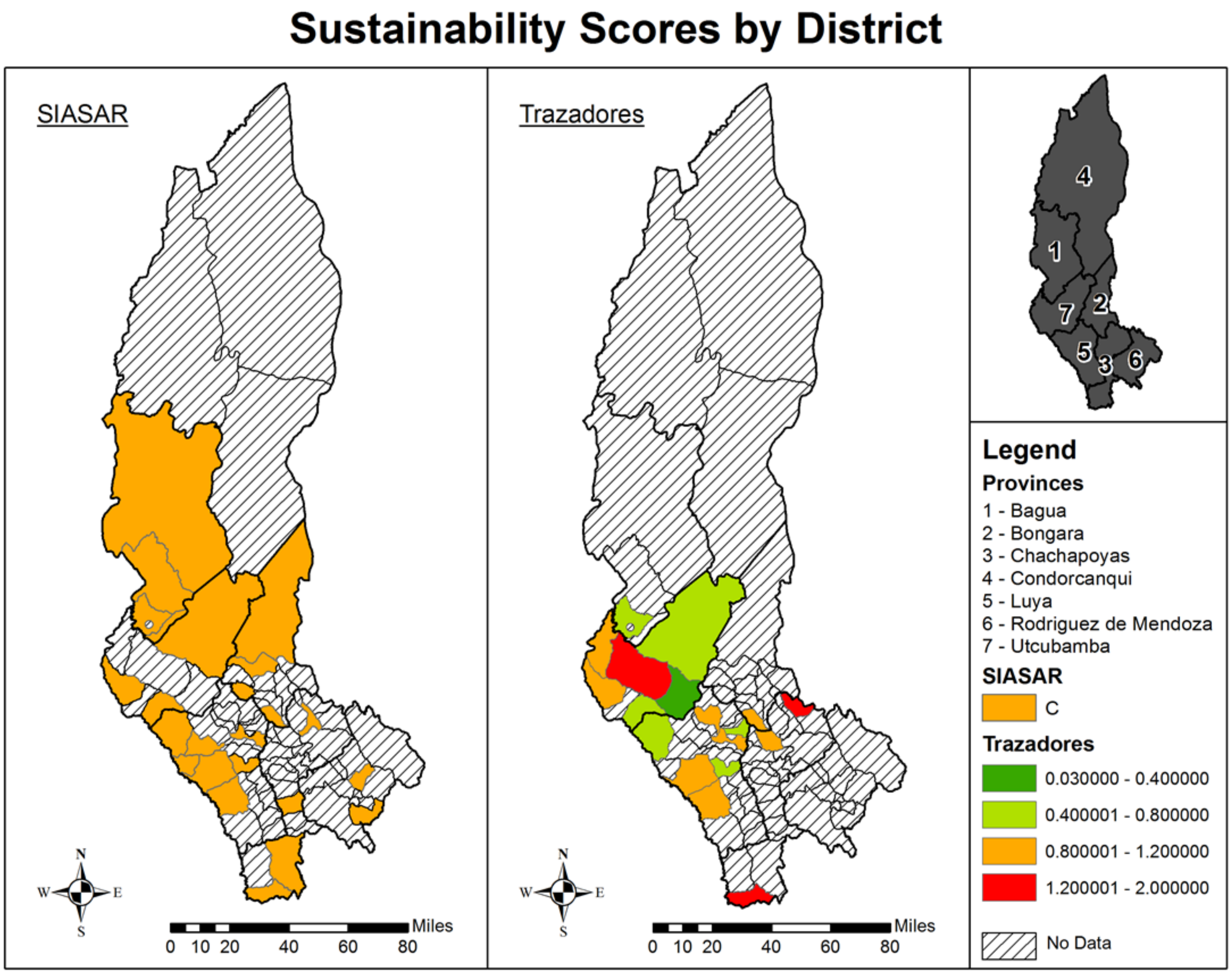

Figure 4.6: Map of aggregated sustainability scores (district average) by district: SIASAR assessment tool (system score), Trazadores assessment tool (general sustainability score). For maps containing scores of each community see Appendix G.

4.5 Comparison of Individual Community Scores from SIASAR and Trazadores

In order to provide a more in-depth analysis, the communities contained in the SIASAR and Trazadores datasets were compared to find cases of overlap between system and JASS scores. Appendix H contains the detailed comparison which includes 66 communities. The two datasets were collected at different points in time (SIASAR from July to December of 2015 and Trazadores from August 2016 to July 2017) which provides limited insight into changes over time in the communities. It also provides some validation of the results from the two tools, however this validation is not rigorous since the two tools collect different data and calculate sustainability differently. Additionally, where scores are not in concurrence it could possibly be for several different reasons:

- Completion of a new water system project (rehabilitation or improvement).
- Deterioration of the water system due to age or natural event
- Positive impact of the external support provision from the ATM
- Inconsistencies in data collection methodology
- Inconsistencies in sustainability score calculation

For each community, the change from the SIASAR score to the Trazadores score was calculated to identify change over time. As a reminder, SIASAR gives four grades of A-D, with 'A' being the highest and 'D' being the lowest for both water system and JASS. Trazadores gives four grades of 'Adequate', 'With some limitations', 'With serious deficiencies', and 'In decline' for the general score (system) and only three grades of 'Adequate', 'With some limitations', and 'Deficient' for the JASS. This difference in methodology hindered a direct comparison in the case of the JASS score but since no JASS had a grade of 'A', a grade of 'B' corresponded with 'Adequate', 'C' with 'With some limitations' and 'D' with 'Deficient'. The results of this analysis are summarized in Table 4.16. If the score went up it calculated as a ‘+’, if it went down it calculated as a ‘-‘, and a ‘0’ means it stayed the same.

Table 4.16: Differences from SIASAR scores to Trazadores scores for communities where there was overlap in system and JASS scores

Δ	**Δ System Score**	**Δ JASS Score**
+2	8	6
+1	20	36
0	14	22
-1	11	2
-2	1	0
No Data	12	0
Total	66	66

Table 4.16 shows that for the system score, 42 out of 66 systems scored better or stayed the same from the SIASAR to the Trazadores score. For the JASS score, 64 out of 66 systems scored better or stayed the same from the SIASAR to the Trazadores score. Some of this change, especially with the JASS scores, might be attributed to the way the two tools calculate sustainability. For Trazadores, the calculation of JASS score is relatively weak in that it only considers several factors whereas the SIASAR score considers multiple factors at different levels. Also, the Trazadores data are collected and reported by the ATM whereas the SIASAR data were collected by an outside source. It could be possible that the ATM are more generous with their positive scoring in an attempt to make themselves and their districts appear to be performing better.

In several cases where this thesis author has personal knowledge of the situation, the difference in score could be attributed to recent projects that were completed in those communities that would have had a positive impact on the sustainability of the systems and JASS. Definitive impact analysis to measure the impact of water improvement projects and training programs is contingent on a study that has more control over independent and dependent variables. However, in the future these sustainability assessment tools, in particular SIASAR, could be used to perform such an analysis.

4.6 Discussion of the State of Community-Managed Rural Water Supply Systems in Amazonas

Overall the results from both the SIASAR and Trazadores assessment tools point to a lack of sustainability across the region of Amazonas. For all scores across both tools, a majority of systems and service providers face significant challenges that they will not be able to overcome by themselves (i.e. grades of ‘C’ and ‘D’ ranging from 43% - 89%). To compare with systems in another Latin American country, Schweitzer & Mihelcic (2012) found that in the Dominican Republic, 18% of systems would not be able to overcome significant difficulties. While that study used a different assessment tool, the results from Amazonas are significantly worse than those from the Dominican Republic.

The results discussed in this chapter from SIASAR and Trazadores assessment tools are affirmed by this thesis author’s experience working with JASS in the region of Amazonas. At present, there is an overall lack of capacity on the part of the JASS to sufficiently guarantee sustainable service provision and, as confirmed by the cases in the SIASAR dataset, water systems are reaching the end of their design lives which only further complicates the ability of the JASS to provide a high service level.

As noted by Whittington et al. (2009), systems do function in the majority of cases, however, functionality does not equate to sustainability. Without adequate tariff collection, preventative maintenance, and sufficient water treatment, among other factors, a service cannot be considered sustainable. As shown in Figure 4.6, the data included in the SIASAR and

Trazadores data sets do not even cover half of the total number of districts in the region of Amazonas. Because the cases included were not randomly sampled, it can be assumed that they are not an accurate representation of the whole set of systems in the region of Amazonas. It is likely, due to the nature of data collection for Trazadores, those data are only available in districts where the ATM is active since they were responsible for data collection. It can be assumed then, that the districts not included do not have an active ATM (i.e. external support structure) and thus their systems are in a worse state than those included in this analysis. However, this will only be confirmed as data are collected from all of the systems throughout the region.

4.7 Assessment of the ATM Model for Direct Support Provision to JASS

Another caveat to the results from the SIASAR and Trazadores analysis is that neither fully accounts for whatever recent impact has been seen from the adoption of the ATM office as an external support provider. The initiative to create and provide support to the office of the ATM at the local district government level only started in 2015 and even then it was only initiated in 18 out of 83 districts. In 2016 that was expanded to the other 65 qualifying districts in the region. That being said, the level to which each district buys-in to the initiative is at the volition of the local district mayor. Therefore, it can be safely concluded that any systematic direct impact on water systems and JASS management will not be seen immediately.

As was explained in Chapter 3, this research sought to examine the role of the ATM as a technical assistance provider to the JASS. To do that six districts spread across five provinces of Amazonas were selected where the ATM office had been implemented since 2015. In each district a community (and corresponding water system and JASS) was identified where the ATM had a history of providing support. The surveys listed in Chapter 3 were carried out with the

JASS, operator, and the ATM and these data were scored using the SIASAR calculation matrices listed in Appendix I. Ideally, to measure impact a baseline measurement would be compared with the data collected as a part of this research. However, that data was not readily available and thus impact analysis is beyond the scope of this thesis. In lieu of this, the analysis of the field data primarily consisted of qualitative anecdotes from the interviews.

4.7.1 Results from Six Communities Included in Primary Data Collection

The detailed scores for each of the six communities are found in Appendix J. In Table 4.17 a summary of the scores and grades for each of the districts is presented. As can be seen in the table, scores are generally high among the six communities. The only score lower than a ‘B’ for any component is for the ATM of Leimebamba.

Table 4.17: Summary of scores from each of six communities visited during field research

Province	Bagua	Utcubamba	Bongara	Bongara	Luya	Chachapoyas
District	La Peca	Cajaruro	Jazan	Florida	Luya	Leimebamba
Community	**Tranquilla**	**Paraiso**	**Suyubamba**	**Carrera**	**El Molino**	**Palmira**
Community Score	3.00	2.63	3.75	3.50	3.75	4.00
Grade	**B**	**B**	**A**	**A**	**A**	**A**
System Score	29	23	25	28	28	28
Grade	**A**	**B**	**A**	**A**	**A**	**A**
JASS Score	3.00	2.60	2.60	3.40	3.00	3.60
Grade	**B**	**B**	**B**	**B**	**B**	**A**
ATM Score	3.57	3.29	3.43	3.57	3.00	2.43
Grade	**A**	**B**	**B**	**B**	**B**	**C**

While inconclusive, a bivariate correlation analysis of this data was performed to try to identify any trends between positive ATM score and positive JASS score. Because they were inconclusive they are not included here. They can be found in Appendix J.

4.8 Discussion of Field Data Results

While statistical analysis of these results would not lead to any conclusive information about the support provided by the ATM to the JASS it does not mean that the analysis and field research were entirely without merit. Useful anecdotes concerning the external support provided by the ATM to the JASS became clear as a part of the interview process. For instance, in the case of Leimebamba and Palmira, the low ATM score is largely due to lack of resources provided by the municipality and the fact that the ATM technician has responsibilities in other offices in the municipality. This is a very common occurrence, that in order to save money on human resources a municipality will assign several demanding positions to the same person. It is impossible for one person to do all of the tasks that they are given when they are expected to do the work of three people. In this particular case, the strong score of the JASS and system in Palmira is due to the strong leadership of the JASS president, the relative wealth of the community as a whole and the proximity of the community to the district capital. Those three important factors are not related at all to the involvement, or lack thereof, of the ATM.

In the case of La Peca and Tranquilla, the president of the JASS and the ATM are close relatives. This perhaps skews the amount of attention that the JASS in Tranquilla receives as compared to the other JASS in the district. From the interview with the ATM, there is no special attention given to Tranquilla over the other communities. The president of Tranquilla is also a very strong leader, like in the case of Palmira, and so the good scores in Tranquilla are also strongly affected by the leadership provided.

In the case of Cajaruro and Paraiso, Cajaruro is the district with the largest number of communities in Amazonas. This also means that the municipality is much larger and receives more money in their general fund from the central government. The impact of this can be seen in the work of the ATM office. While in every other district the ATM office consisted of only one technician, and in most cases a part-time technician, the ATM office of Cajaruro had two full-time staff members and one part-time. They also had two dedicated motorcycles where in the other cases transportation was shared with other offices in the municipality. At the time of the interview, the ATM reported that in spite of the staff and transport available it was still hard to attend to the over 100 communities in their jurisdiction. Paraiso is one of the closest communities at only 15 minutes away on motorcycle. So, it can be assumed it is easier for the JASS and the ATM to work together towards sustainable service provision.

In the case of Jazan and Suyubamba, Suyubamba was one of the only communities that the ATM was able to work with. In several of the other communities in the district the JASS did not maintain a good working relationship with the ATM. In the case of Peru, the primary responsibility for and source of external support provision is the ATM office. Therefore, if the JASS cannot turn to the municipality for assistance then there are not many other places available to look.

In the case of Florida and Carrera, Carrera had recently been the beneficiary of a government program to build water systems and install household sanitation systems. They also provide training to the JASS under the program. Because of this the JASS was newly formed and consisted of members from three communities that were connected to the water system. The ATM also received some training as a part of this and so was very active in working with the JASS in Carrera.

In the case of Luya and El Molino, the ATM reported during the interview that it was difficult to find time to provide technical support to the JASS because of the other responsibilities assigned by the municipality. The ATM is a long-time employee of the municipality and because of that maintains a great relationship with the different JASS in the district, including El Molino, however was not able to frequently visit them to provide training or to provide follow-up. In the case of El Molino, a previous Peace Corps volunteer had been very active in working on a project to build bathrooms in the community and as a part of that had provided recent trainings to the JASS.

As can be seen each case is unique, but together provide some useful information to better understand the difficulties that those that fill the ATM position encounter in the course of their work. Some of the most salient and useful conclusions from the field data will be included in the final chapter, Chapter 5: Conclusion and Recommendations.

4.9 Research Limitations

With any research it is important to understand the limitations of the results that are caused from the research and analysis design. Three of the most important limitations will be discussed here in the following paragraphs.

For the analysis of the three sustainability assessment tools, one limitation is the lack of knowledge concerning the exact data collection process of the SIASAR data in Peru as well as the long-term plans of the government of Peru both nationally and regionally. Lack of information about the data collection for SIASAR does not limit the rich analysis that was done in the question mapping or the evaluation matrix, however it does limit the interpretation of the data that was used. Not knowing the long-term intentions of the government of Peru limits the recommendations that can be made for long-term use of the assessment tools. There is no one right answer for monitoring sustainability, therefore much depends on the resource investment that the government wants to make and the commitment of stakeholders at the national, regional, and local level to buy-in to the arrangement.

For the assessment of the state of community-managed rural water systems in Amazonas, the results are limited by the incomplete data of both the SIASAR and Trazadores data sets. Because all provinces and districts in Amazonas are not represented equally in the data, the results do not paint an accurate picture of the current state throughout the region. A true understanding of trends throughout the region will be necessary in order to design regional policies to ensure that there is equitable access to a basic drinking water service level for all citizens of Amazonas and Peru.

Lastly, from the field data there are several limitations from the research design. First of all, the selection criteria that were used for choosing Amazonas have several implications. In particular, incidence of extreme poverty and lack of accessibility were two of the criteria. Two implications from this are that perhaps the situation is worse in Amazonas as compared with other regions that have less poverty and are more accessible. Thus, the results of the state of community-managed rural water systems here are not reflective of Peru as a whole. A second limitation comes from the criteria used to select districts to include in the field research. All of the districts are larger in size than many of the rural districts in Amazonas. Since budget is distributed based on the size of the district, these districts have more money than smaller districts and it is likely that that has an effect on the function of the municipality and the support provided to communities in their jurisdiction. Also, the presence of a Peace Corps volunteer in each district is a research limitation in that they have been providing extra support in these districts that other districts do not receive. A final limitation, is that because the ATM selected the community and JASS to visit during field data collection in each district it is likely that they chose their best performing JASS. Because of this the results might not be an accurate representation of the other communities.

These limitations should be taken into account in the interpretation of the results included in this research. They do not change the overall value of the results but do provide opportunities for future research to explore this topic without these limitations.

CHAPTER 5: CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

As an overall goal this thesis set out to assess the sustainability of community-managed water systems in rural areas of Amazonas, Peru. Based on a review of the literature, it was identified that two important factors for sustainable water service delivery are: 1) effective monitoring, and 2) provision of continued external support to service providers, in this case the JASS. This thesis focused on monitoring for asset management and sustainable service delivery. In this case, the sustainability of a community-managed water system was defined as the indefinite provision of water service at a predetermined quantity, quality, and continuity.

The first objective of this thesis was to describe the history of rural water systems in Peru, drawing specific attention to the implications this history has on present day service provision. This was attended to in the second chapter which began with an overview of the history of rural water service provision in Peru. Through understanding the systems and structures that have defined rural water provision over the past decades it is possible to better diagnose the current problems and prescribe corrective actions for the future. The central theme when discussing the history of rural water provision in Peru is the move from centralization to decentralization. Because this did not, and does not, happen at the same rate through all of the levels of government there remains today a lack of understanding of roles and responsibilities as they relate to water service planning, life-cycle maintenance, capital and recurrent finances, day-to-day management, and water quality monitoring. The encouraging fact is that there are people and parties at every level of government in Peru who realize what is not working and what needs to be done to improve (see MVCS, 2016). What must happen now is a greater synergy between all of these actors to clearly define responsibilities as they relate to rural water service provision. Much progress has been made in Peru to deliver and ensure the right to water for all of its citizens and this progress must continue.

The second objective was to compare and contrast three sustainability assessment tools being used by government officials in Amazonas, Peru and use these three tools to assess the state of community-managed rural water systems. While all three of the tools (Rural Water and Sanitation Information System – SIASAR, Tracers in Rural Water and Sanitation – Trazadores, and Diagnostic Survey for Water Supply and Sanitation – Diagnostico) are useful for ensuring the sustainability of community-managed rural water systems, this research identified the SIASAR assessment tool as the most appropriate of the three to ensure sustainability. The question mapping analysis in Chapter 4 showed that the Diagnostico assessment tool is the most in-depth of the three in content that it collects, however as is, its best use is as an asset management tool and a baseline data source. Both the SIASAR and Trazadores assessment tools are useful for asset management, too, however they both also provide monitoring of service delivery. Of the two, SIASAR proved the most appropriate for ensuring long-term, sustainable water service delivery due to three factors: 1) consideration of a broad, yet detailed, set of sustainability indictors at the levels of community, system, service provision, and technical assistance provision; 2) ease of data collection via the mobile application; and 3) ability to perform a variety of data analysis at different scales (i.e. community, district, province, region, country).

To address the second part of objective two, in the second part of Chapter 4, the data from SIASAR and Trazadores were used to assess the state of community-managed rural water systems. The assessment showed that 81% of systems in the SIASAR analysis and 58% of systems in the Trazadores analysis have deficiencies that are beyond the ability of the JASS to overcome. The average system age is more than 15 years, which means that these rates of system decline will only increase unless more investment is made. As discussed in Chapter 2, ROMAS (Replacement, Operation, and Maintenance of Potable Water Systems) is an initiative of FONCODES (National Social Development Compensation Fund) that seeks to rehabilitate water systems in each region of Peru while at the same time equipping the ATM office to better perform their job. The data included in this analysis were collected before this initiative was in implementation. Hopefully as monitoring of these systems continues it will reflect the positive impact of this initiative.

The third objective was to examine the role of the Área Técnica Municipal (ATM) in providing support to the direct service providers (Juntas Administradoras de los Servicios de Saneamiento - JASS) in Amazonas, Peru through the use of collected field data. While the anecdotal evidence from the research is useful, further research is needed to better understand what specific ATM support activities are statistically most effective at strengthening the function of the JASS. Further research is also needed to identify the personnel needs and financial commitment in external support necessary to ensure sustainable water service delivery.

The fourth objective was to provide feedback to the local and national government of Peru concerning: the overall sustainability of water service delivery in rural areas of Amazonas, Peru; the progress of the implementation of the ATM model for support provision; and, make recommendations concerning the future use of the sustainability assessment tools. While much of this has been addressed throughout this thesis, the most important recommendations will be summarized in section 5.2.

5.2 Recommendations

Based on the most recent recommendations in the literature and data collected for this research, it can be concluded that Peru is on the right path towards promoting sustainable water service delivery. The Municipal Incentives Program has shown to be an innovative way to encourage local municipalities to invest in support provision to the rural water systems in their districts. The recently implemented Decentralized Offices of the Ministry of Housing, Construction and Sanitation (MVCS) in each region should increase the efficiency and quality of new rural water system projects and more effectively improve, rehabilitate, and expand existing systems. However, there still remains work to be done that includes, among other tasks: 1) developing a coherent long-term monitoring plan, and 2) prioritizing the further development of the ATM model for external support provision to the JASS.

5.2.1 Monitoring

As has been stated previously, this thesis identified SIASAR as the most appropriate of the three assessment tools examined to be used to monitor long-term sustainability of rural water service provision. However, at present the government of Peru is in the process of collecting data throughout the country using the Diagnostico tool. It would be foolish at this point to abandon the successful data collection initiative using the Diagnostico tool. It is recommended however that further research be completed to determine either, 1) how to extract the necessary indicators identified in the analysis of section 4.3 from Diagnostico to be analyzed using the SIASAR framework or 2) develop a unique set of sustainability indicators and analysis frameworks within the Diagnostico tool.

In order to best continue this work, it will be important for both the central and regional governments to invest resources into analyzing the data that is being collected. The costs of employing a small team of one to two people in each region to analyze the data are small in comparison with the investment that has been made to collect the data. Research completed using this data would not only benefit Peru but would be useful abroad, as well.

Lastly, following the recommendations of Smits et al. (2013) for the institutionalization of monitoring, the government of Peru should develop a long-term monitoring plan that includes benchmarks for improvement in system performance. This should include the frequency with which data is to be collected as well as the division of costs and responsibilities. As Peru continues to grow economically it is time to focus not just on monitoring coverage but on monitoring service delivery. This will only be achieved with a concerted effort at every level of government to prioritize sustainable and equitable water service throughout the country.

5.2.2 External Support

The other central theme of this research was the importance of continued external support provision to the JASS or water committee. What has been implemented thus far is a promising start however, as evidenced through this thesis author's experience and through the interviews with six ATM technicians, there is much room for improvement. Three of the most important recommendations are discussed in greater detail in the following paragraphs.

Unlike the role of the JASS in water service provision, the role of the ATM in support provision is not well defined in Peruvian legislation. Broad terms are used to dictate that the ATM should monitor, supervise, and provide technical support to JASS; those terms however are not further developed into specific activities or standard operating procedures. In the past several years the best guide for those who fill the ATM position has been the Incentives Program list of goals and activities. However, if those incentives are discontinued a void will be created and it is likely that barring other influences the external support provision would also cease, or at least diminish in activity level. Further research should be conducted that identifies the best way to ensure the ATM position fulfills the role of external support provider even if the incentives stop.

Through the interviews with the ATM technicians for this research it also became clear that there is a lack of capacity building and training materials for the ATM. Unlike a health post nurse or an office secretary there is no professional specialization in water system management. While periodic workshops carried out by the regional governments have become a regular occurrence there is also a high rate of turnover in the ATM positions and that institutional knowledge is lost. Further development of professional training programs and training materials should be pursued in order to best support those who fill the ATM position at the local government level.

Lastly, it is recommended to prioritize the institutionalization of regional support mechanisms for local municipalities. Much of the fate of rural water service provision lies in the hands of the local district mayor. Based on the experience of this thesis author, many who are elected in the locations of this research have little to no experience in public administration much less have extensive knowledge of infrastructure development, implementation, and management. While many have good intentions for serving their jurisdiction often times being elected as a local mayor becomes a daunting task to assume, which frequently leads to severe inefficiency and corruption. However, if the local mayors are empowered to adequately encourage development in their districts the end result could be much better. This support to local mayors should include promoting an understanding of the importance of the ATM role as well as the other dynamic factors involved in ensuring sustainable water service provision. Whether this is achieved through the provincial governments or centralized at the regional government level it is vital that local district municipalities are receiving the support they need to assume the large responsibility for rural water service delivery that has been given to them through the process of decentralization.

5.2.3 Other Recommendations from Review of the Literature

Several other recommendations to ensure sustainable water service delivery were identified from a review of the literature. These recommendations include several important "building blocks" identified by Lockwood & Smits (2011): 1) analysis of life-cycle costs of water service provision, 2) promotion of the professionalization of water service delivery, and 3) creation of a framework for the regulation of rural water quality and service level. In poorer rural areas the user tariff is often insufficient to sustain a water system throughout its entire life-cycle, especially when major repairs and expansion are necessary. It is recommended that research be conducted to better understand all the costs involved in water service provision in Peru and how to cover those costs equitably among users, local municipalities, and central government. Next, whether covered by the user tariffs or by government subsidy the management and most importantly the operation and maintenance of rural water systems needs to move away from entirely voluntary arrangements and become more professional. This means the provision of adequate remuneration for those responsible for administration, operation, and maintenance. Lastly, the health sector needs to be held accountable for regulating the water quality provided by rural water systems and most importantly equipped to do so.

While too many around the globe and in Peru are still lacking access to improved drinking water sources, this research has demonstrated that Peru is on a positive path of progress in regards to the management of their rural water supply systems. As the priority shifts from provision of infrastructure to provision of a service, there must be a larger commitment to building local capacity at both the community and local government level. Functionality can no longer be the measure of success for a water system, the focus must be on water quantity, quality, and continuity for the entire life-cycle of the service. To ensure this, government offices at all levels must institutionalize monitoring for service delivery. As rural water service providers become more professional they must be held accountable to achievable goals for service level. If Peru can continue to prioritize these initiatives it is more likely than not that they will have done their part by 2030 to reach the UN’s Sustainable Development Goal 6 that includes the target to achieve universal and equitable access to safe and affordable drinking water.

REFERENCES

AguaLimpia. (2013). *Manual de organización y gestión de las Juntas Administradoras de Servicios de Saneamiento – JASS.* Retrieved from http://www.agualimpia.org/pdf/AGUALIMPIA%20Manual%20gestion%20JASS.pdf (Accessed 03 July 2017).

Annis, J. E. (2006). *Assessing progress of community managed gravity flow water systems using rapid rural appraisal in the Ikongo district, Madagascar.* Retrieved from http://usfmi.weebly.com/thesesreports.html (Accessed 24 August 2017).

Borja-Vega, C., Pena, L., & Stip, C. (2017). Sustainability of rural water systems: quantitative analysis of Nicaragua's monitoring data. *Waterlines, 36(1)*, 40-70. http://dx.doi.org/10.3362/1756-3488.2017.003

Calderon Cockburn, J. (2004). *Agua y saneamiento: El caso del Perú rural (Informe final).* Lima, Peru: ITDG. Retrieved from http://www.bvsde.paho.org/bvsacd/cd27/agua-peru.pdf (Accessed 03 July 2017).

Castillo, O., & Vera, R. (1998). *Descentralización, gobierno local y saneamiento básico rural: Estudio de caso en el Perú.* Retrieved from http://www.cepes.org.pe/pdf/OCR/Partidos/descentralizacion_saneamiento/descentralizacion_gobierno_local.pdf (Accessed 01 July 2017).

CIA. (2017). *The World Factbook*. Retrieved from https://www.cia.gov/library/publications/the-world-factbook/geos/pe.html (Accessed 19 May 2017).

Clasen, T. F., Alexander, K. T., Sinclair, D., Boisson, S., Peletz, R., Chang, H. H., … Cairncross, S. (2015). Interventions to improve water quality for preventing diarrhea. Cochrane Database of Systematic Reviews, 10. http://dx.doi.org/10.1002/14651858.CD004794.pub3

Crabtree, J. (2003). *Peru: An Oxfam country profile.* Oxford, UK: Oxfam Publishing.

Decreto Legislativo Que Aprueba la Ley Marco de la Gestión y Prestación de los Servicios de Saneamiento, D.L. No. 1280 (2016).

Decreto Supremo No. 023-2005-VIVIENDA, No. 023, (2005).

Decreto Supremo No. 031-2008-VIVIENDA, No. 031, (2008).

Decreto Supremo Que Aprueba el Plan Nacional de Saneamiento 2017-2021, D.S. No. 018-2017 (2017).

Fogelberg, K. (2013). From adopt-a-project to permanent services: The evolution of Water for People's approach to rural water supply in Bolivia. *Water Alternatives*, *6*(3), 367-383.

Freudenberger, K. S. (2008). *Rapid rural appraisal (RRA) and participatory rural appraisal (PRA): A manual for CRS field workers and partners.* Baltimore, MD: Catholic Relief Services.

Gobierno Regional Cusco. (2010). *Gestión del saneamiento ambiental básico rural: Manual para las Áreas Técnicas Municipales de Saneamiento.* Retrieved from http://proyectosaba.org/publicaciones.html (Accessed 03 July 2017).

Hutchings, P., Chan, M. Y., Cuadrado, L., Ezbakhe, F., Mesa, B., Tamekawa, C., & Franceys, R. (2015). A systematic review of success factors in the community management of rural water supplies over the past 30 years. *Water Policy, 17(5),* 963-983.

Instituto Nacional de Estadistica e Informatica. (2015). *Estado de la población peruana.* Lima, Peru: INEI.

INEI. (2016). *Nota de prensa No. 074 – 22 abril 2016.* Lima, Peru: INEI.

JMP. (2017). *Progress on drinking water, sanitation and hygiene – 2017 update and SDG baselines.* Geneva, Switzerland: WHO.

Kayser, G. L., Moomaw, W., Orellana Portillo, J. M., & Griffiths, J. K. (2014). Circuit rider post-construction support: improvements in domestic water quality and system sustainability in El Salvador. *Journal of Water, Sanitation and Hygiene for Development, 4(3),* 460-470. http://dx.doi.org/washdev.2014.136

Kleemeier, E. L. (2010). *Private operators and rural water supplies: A desk review of experience (Water papers series).* Washington, DC: World Bank.

Kusek, J. Z., & Rist, R. C. (2004). *Ten steps to a results-based monitoring and evaluation program: A handbook for development practitioners.* Washington, D. C.: World Bank.

Ley General de Servicios de Saneamiento, Ley No. 26338 (1994).

Lockwood, H., Bakalian, A., & Wakeman, W. (2003). *Assessing sustainability in rural water supply: The role of follow-up support to communities.* Retrieved from http://www.aguaconsult.co.uk/assets/Uploads/Publications/WorldBank-AssessingSustainability-2003.pdf (Accessed 16 August 2017).

Lockwood, H., & Smits, S. (2011). *Supporting rural water supply: Moving towards a service delivery approach.* Rugby, UK: Practical Action Publishing.

Manser, N., Naughton, C., Orner, K., Prouty, C., Verbyla, M., & Mihelcic, J. R. (2015). Proceedings from the American Society of Engineering Education (ASEE) National Conference: *Improving the global competency of engineers through the Peace Corps Master's International Program*. Washington Convention Center, Seattle, WA.

McConville, J. R., & Mihelcic, J. R. (2007). Adapting life-cycle thinking tools to evaluate project sustainability in international water and sanitation development work. *Environmental Engineering Science, 24(7),* 937-948. http://dx.doi.org/10.1089/ees.2006.0225

Mihelcic, J. R., Crittenden, J. C., Small, M. J., Shonnard, D. R., Hokanson, D. R., … Schnoor, J. L. (2003). Sustainability science and engineering: The emergence of a new metadiscipline. *Environmental Science & Technology*, *37*(23), 5314-5324.

Mihelcic, J. R., Fry, L. M., Myre, E. A., Philips, L. D., & Barkdoll, B. D. (2009). *Field guide to environmental engineering for development workers.* Reston, VA: ASCE Press.

Mihelcic, J.R., Phillips, L. D., & Watkins, D. W. (2006). Integrating a global perspective into education and research: Engineering international sustainable development. *Environmental Engineering Science*, *23*(3), 426-438.

Ministerio de Salud. (1997). *4.5 Metodología para el trabajo de JAAPS.* Retrieved from http://www.minsa.gob.pe/publicaciones/aprisabac/45.pdf (Accessed 03 July 2017).

Ministerio de Vivienda, Construcción y Saneamiento. (2003). *Estudios de base para la implementación de proyectos de agua y saneamiento en al área rural: Problemas, cobertura y sostenibilidad de los servicios.* Retrieved from https://www.wsp.org/sites/wsp.org/files/publications/tarea1.pdf (Accessed 08 July 2017).

Ministerio de Vivienda, Construcción y Saneamiento. (2016). *Propuesta de bases para una política nacional de saneamiento: Logros, experiencias compartidas y dialogo de política.* Retrieved from http://www3.vivienda.gob.pe/popup/Latinosan/PROPUESTA%20DE%20BASES%20PARA%20UNA%20POL%C3%8DTICA%20NACIONAL%20DE%20SANEAMIENTO.pdf (Accessed 03 July 2017).

Ministerio de Vivienda, Construcción y Saneamiento. (2017). *Manual del aplicativo informático: Sistema de diagnóstico sobre abastecimiento de agua y saneamiento en el ámbito rural.* Retrieved from http://pnsr.vivienda.gob.pe/portal/wp-content/uploads/2017/03/Manual-del-aplicativo-inform%C3%A1tico.pdf (Accessed 05 July 2017).

Moritz, M. C. (2016). *The effect of community connectivity on water and sanitation systems in rural Panama.* Retrieved from http://digitalcommons.mtu.edu/etdr/242 (Accessed 15 May 2017).

Oblitas de Ruiz, L. (2010). *Servicios de agua potable y saneamiento en el Perú: Beneficios potenciales y determinantes del éxito.* Retrieved from http://repositorio.cepal.org/bitstream/handle/11362/3819/lcw355.pdf;jsessionid=5742CF2D31C234DD4288C0D2E2EF8677?sequence=1 (Accessed 05 July 2017).

Prokopy, L. S., Thorsten, R., Bakalian, A., & Wakeman, W. (2008). Evaluating the role of postconstruction support in sustaining drinking water projects: Evidence from Peru. *Journal of Planning Education and Research, 27,* 294-305. http://dx.doi.org/10.1177/0739456X07311072

Resolución Ministerial No. 269-2009-VIVIENDA, No. 269 (2009).

Resolución Ministerial No. 205-2010-VIVIENDA, No. 205 (2010).

Resolución Ministerial No. 207-2010-VIVIENDA, No. 207 (2010).

Resolución Ministerial No. 063-2017-VIVIENDA, No. 063 (2017).

Sara, J., & Katz, T. (1997). *Making rural water supply sustainable: Report on the impact of project rules.* Retrieved from http://www.wsp.org/sites/wsp.org/files/publications/global_ruralreport.pdf (Accessed 03 July 2017).

Schouten, T., & Moriarty, P. (2003). *Community water, community management: From system to service in rural areas.* London, UK: ITDG Publishing.

Schouten, T., & Smits, S. (2015). *From infrastructure to services: Trends in monitoring sustainable water, sanitation, and hygiene services.* Rugby, UK: Practical Action Publishing.

Schweitzer, R. W. (2009). *Community managed rural water supply systems in the Dominican Republic: Assessment of sustainability of systems built by the National Institute of Potable Water and Peace Corps, Dominican Republic.* Retrieved from http://usfmi.weebly.com/thesesreports.html (Accessed 24 August 2017).

Schweitzer, R., Grayson, C., & Lockwood, H. (2014). *Mapping of water, sanitation, and hygiene sustainability tools: Triple-S working paper 10.* The Hague, The Netherlands: IRC. Retrieved from https://www.ircwash.org/resources/mapping-water-sanitation-and-hygiene-sustainability-tools (Accessed 19 May 2017).

Schweitzer, R. W., & Mihelcic, J. R. (2012). Assessing sustainability of community management of rural water systems in the developing world. *Journal of Water, Sanitation and Hygiene for Development, 2*(1), 20-30. http://dx.doi.org/10.2166/washdev.2012.056

SIASAR. (2012). *Manual usuario de SIASAR.* Retrieved from http://new.siasar.org/es/publicaciones (Accessed 03 July 2017).

SIASAR. (2016). *Conceptual model SIASAR 2.0. Version 10.1.* Retrieved from http://siasar.org/en/publications (Accessed 22 October 2017).

Smits, S., Uytewaal, E., & Sturzenegger, G. (2013). *Institutionalizing monitoring of rural water services in Latin America: Lessons from El Salvador, Honduras and Paraguay (Technical Note #IDBTN-526).* Washington, DC: Inter-American Development Bank.

Smits, S., Franceys, R., Mekala, S., & Hutchings, P. (2015). *Understanding the resource implications of the 'plus' in community management of rural water supply systems in India: concepts and research methodology.* Community Water Plus working paper. The Netherlands: IRC.

Starkl, M., Brunner, N., & Stenstrom, T. (2013). Why do water and sanitation systems for the poor still fail? Policy analysis in economically advanced developing countries. *Environmental Science & Technology, 47,* 6102-6110. http://dx.doi.org/10.1021/es3048416

Suzuki, R. (2010). *Post-project assessment and follow-up support for community managed rural water systems in Panama.* Retrieved from http://usfmi.weebly.com/thesesreports.html (Accessed 24 August 2017).

United Nations. (2015). *Transforming our world: The 2030 agenda for sustainable development.* New York, NY: United Nations.

Walters, J. P., & Jacernick-Will, A. N. (2015). Long-term functionality of rural water services in developing countries: A system dynamics approach to understanding the dynamic interaction of factors. *Environmental Science & Technology, 49,* 5035-5043. http://dx.doi.org/10.1021/es505975h

Whittington, D., Davis, J., Prokopy, L., Komives, K., Thorsten, R., Lukacs, H., … Wakeman, W. (2009). How well is the deman-driven, community management model for rural water supply systems doing? Evidence from Bolivia, Peru and Ghana. *Water Policy, 11,* 696-718. http://dx.doi.org/10.2166/wp.2009.310

World Bank. (2017). *Peru overview.* Retrieved from http://www.worldbank.org/en/country/peru/overview (Accessed 19 May 2017).

World Commission on Environment and Development. (1987). *Our Common Future.* Oxford, NY: Oxford University Press.

WHO. (2014). *The top 10 causes of death, Fact Sheet No. 310*. Retrieved from http://www.who.int/mediacentre/factsheets/fs310/en/ (Accessed 16 January 2017).

Zhang, Q., Prouty, C., Zimmerman, J. B., & Mihelcic, J. R. (2016). More than Target 6.3: A systems approach to rethinking Sustainable Development Goal in a resource-scarce world. *Engineering, 2,* 481-489. http://dx.doi.org/10.1016/J.ENG.2016.04.010

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Tampa, FL 33612

RE: **Expedited Approval for Initial Review**

IRB#: Pro00029379

Title: Community managed rural water supply systems in the department of Amazonas, Peru: An assessment of sustainability factors of the water committees using the Sustainability Assessment Tool

Study Approval Period: 2/1/2017 to 2/1/2018

Dear Mr. Mangum:

On 2/1/2017, the Institutional Review Board (IRB) reviewed and **APPROVED** the above application and all documents contained within, including those outlined below.

Approved Item(s):

Protocol Document(s):

Mangum_Protocol_v1_01_21_17.docx

Consent/Assent Document(s)*: **ALL GRANTED A WAIVER**

Verbal Informed Consent_Households_English_v1_01_21_17.docx

Verbal Informed Consent_Households_Spanish_v2_01_31_17.docx

Verbal Informed Consent_Key Informant Operator_Plumber Focus Group(JASS)_English_v2_01_31_17.docx

Verbal Informed Consent_Key Informant Operator_Plumber Focus Group(JASS)_Spanish_v2_01_31_17.docx

*Please use only the official IRB stamped informed consent/assent document(s) found under the

"Attachments" tab. Please note, these consent/assent documents are valid until the consent document is amended and approved. Waivers are not stamped.

It was the determination of the IRB that your study qualified for expedited review which includes activities that (1) present no more than minimal risk to human subjects, and (2) involve only procedures listed in one or more of the categories outlined below. The IRB may review research through the expedited review procedure authorized by 45CFR46.110. The research proposed in this study is categorized under the following expedited review category:

(6) Collection of data from voice, video, digital, or image recordings made for research purposes.

(7) Research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies.

Your study qualifies for a waiver of the requirements for the documentation of informed consent as outlined in the federal regulations at 45CFR46.117(c) which states that an IRB may waive the requirement for the investigator to obtain a signed consent form for some or all subjects if it finds either: (1) That the only record linking the subject and the research would be the consent document and the principal risk would be potential harm resulting from a breach of confidentiality. Each subject will be asked whether the subject wants documentation linking the subject with the research, and the subject's wishes will govern; or (2) That the research presents no more than minimal risk of harm to subjects and involves no procedures for which written consent is normally required outside of the research context. (Verbal consent forms).

As the principal investigator of this study, it is your responsibility to conduct this study in accordance with IRB policies and procedures and as approved by the IRB. Any changes to the approved research must be submitted to the IRB for review and approval via an amendment. Additionally, all unanticipated problems must be reported to the USF IRB within five (5) calendar days.

We appreciate your dedication to the ethical conduct of human subject research at the University of South Florida and your continued commitment to human research protections. If you have any questions regarding this matter, please call 813-974-5638.

Sincerely

Kristen Salomon, Ph.D., Vice Chairperson
USF Institutional Review Board

APPENDIX B: INSTITUTIONAL ARRANGEMENTS IN PERUVIAN WATER AND SANITATION SECTOR

Table B.1: Institutional arrangements for rural water and sanitation provision in Peru

Entity/Agency		Level	Sector	Function/Responsibilities
Ministerio de Vivienda, Construccion y Saneamiento	Ministry of Housing, Construction and Sanitation	National	Sanitation	Formulate, regulate, direct, coordinate, execute, supervise and evaluate national sanitation sector policy. Also, via programs (PNSR and PNSU) assist local government in infrastructure provision
Programa Nacional De Saneamiento Rural	National Rural Sanitation Program	National	Sanitation	Attend to marginalized populations in rural areas in helping to provide integral water and sanitation services. Develop policies and programs to implement sustainable water projects throughout Peru.
Ministerio de Salud	Ministry of Health	National	Health	Establish water quality norms for human consumption and participate in design and execution of actions related to health and hygiene.
Ministerio de Educacion	Ministry of Education	National	Education	Promote sanitary education among users and participate in design and execution of actions related to health, hygiene, and environmental responsibility.
Ministerio de Desarrollo e Inclusion Social	Ministry of Development and Social Inclusion	National	Social	Finance the elaboration of studies of pre-inversion, execution, and/or maintenance related to water and sanitation infrastructure in rural areas.

Table B.1 (continued)

Contraloria General de la Republica	General Treasury Inspector's Office of the Republic	National	Finance	Ensure the responsible fiscal management of rural water service provision and infrastructure implementation.
Superintendencia Nacional de Servicios de Saneamiento	National Superintendence for Sanitation Services	National	Sanitation	Regulate, supervise, fiscalize, and establish norms for the provision of water and sanitation services. Also, establish tariff structure for private operators.
Autoridad Nacional del Agua	National Water Authority	National	Environment	Administer, conserve, protect, and sustainably use water resources. Also promote environmental responsibility.
Gobierno Regional	Regional Government	Regional	Government	Formulate, approve, and evaluate regional sanitation policies and plans. Provide technical and financial assistance to local governments. Carry out activities related to promotion, technical assistance and training related to water service provision.
Direccion Regional de Vivienda, Construccion y Saneamiento	Regional Management Office of Housing, Construction and Sanitation	Regional	Sanitation	Provide technical assistance to local and provincial municipalities. Strengthen capacities of the ATM. Facilitate tools, strategies and instruments that lead to sustainable service provision.
Direccion Regional de Educacion	Regional Management Office of Education	Regional	Education	Implement curriculum related to sanitary and environmental education.

Table B.1 (continued)

Direccion Regional de Salud	Regional Management Office of Health	Regional	Health	Finance and implement drinking water quality monitoring programs. Advise ATM and JASS on promotion of environmental health practices.
Autoridad Local de Agua	Local Water Authority	Regional	Environment	Grant water use rights for drinking water supply systems.
Unidad de Gestion Educativa Local	Local Education Management Unit	Provincial	Education	Implement curriculum related to sanitary and environmental education.
Redes, Microredes de Salud	Health and Micro-Health Networks	Provincial	Health	Implement drinking water quality monitoring programs.
Municipalidad Provincial	Provincial Municipality	Provincial	Government	Ensure environmental health in their jurisdiction. Provide assistance to local district municipalities.
Municipalidad Distrital	District Municipality	Local	Government	Plan, promote, and in some cases finance the development of water and sanitation service in their jurisdiction. Administer service provision where necessary. Promote the creation of and provide legal standing to JASS and other communal organizations. Help subsidize service provision when possible. Provide technical assistance. Supervise management of rural services by JASS.
Centros/Puestos de Salud	Health Centers/Posts	Local	Health	Promote healthy households through trainings, hygiene campaigns, basic health promotion. Provide water quality monitoring in coordination with the ATM.

Table B.1 (continued)

Area Tecnica Municipal de Saneamiento Basico	Municipal Technical Area for Basic Sanitation	Local	Sanitation	Supervision and oversight of water and sanitation service provision. Promote the formation of communal service providers such as JASS, water committees, or others. Supervise, oversee, and provide technical support to communal organizations.
Juntas Administradoras de Servicios de Saneamiento	Administrative Boards for Sanitation Services	Local	Sanitation	Register with the local municipality. Operate, administer, and maintain water and sanitation service. Supervise construction. Collect a predetermined user tariff. Develop a life-cycle maintenance fund.

APPENDIX C: SURVEY INSTRUMENTS USED IN FIELD DATA COLLECTION

C.1 Informed Consent Form

Informed Consent to Participate in Research –

Key Informant, Operator/Plumber and Focus Group (JASS) Interviews

Information to Consider Before Taking Part in this Research Study

Pro # 00029379
Jacob Mangum
E-mail:

Researchers at the University of South Florida (USF) study many topics. To do this, we need the help of people who agree to take part in a research study. This form tells you about this research study. We are asking you to take part in a research study that is called: **Community managed rural water supply systems in the department of Amazonas, Peru: An assessment of sustainability factors of the water committees using the Sustainability Assessment Tool.**

The person who is in charge of this research study is Jacob Mangum. This person is called the Principal Investigator.

You are being asked to take part in a research study because you are involved in some form of administration, operation, maintenance of, or support to, the water system. I hope to better understand the challenges facing communities so that in the future we can improve the training and support of communities. I have a series of questions that I would like to ask you that will only take a short time.

You will be asked to complete a survey with questions about your experiences and opinions with respect to the administration, operation, and maintenance of the water system in your community. The entire process should last no more than an hour.

Participation in the study is voluntary. You can decide not to participate or can stop participating at any moment. You can choose to participate in the study and then change your decision without any punishment.

This research is considered to be minimal risk. There are no known risks to those who take part in this study.

You will not receive any direct benefits from participating in the study. You will not receive payment for participating in this study.

All records related to this study will be maintained private and confidential. Certain people may need to see or hear your study records, but by law they must keep them confidential. These individuals include:

- The research team, including the Principal Investigator, study coordinator, and all other research staff.

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- The USF Institutional Review Board (IRB) and related staff who have oversight responsibilities for this study, including staff in USF Research Integrity and Compliance.

We may publish what we learn from this study. If we do, we will not include your name. We will not publish anything that would let people know who you are.

If you have questions about your rights or have complaints about any part of the study, you can contact, anonymously if you with, the University of South Florida Institutional Review Board at 01 (813) 974-5638. If you have questions regarding the research, please contact the Principal Investigator Jacob Mangum at 961-328-154.

Would you like to participate in this study?

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C.2 JASS Focus Group Survey

Survey Form for the JASS

"Community managed rural water systems in Amazonas, Peru: An assessment using the Sustainability Assessment Tool"

JASS FORM

Community: ______________________ District: ____________________ Province: ____________________ Date: ____________ Initial: ________

1. Members of the board of directors:

Active/ Inactive	Position	Sex	Education Level	Occupation

2. Legal status of the JASS: Legal Recognized Informal
3. Date of creation of the JASS: ________________

General System Information

4. Data that the water system construction was finished (dd/mm/yyyy) __________

Financing Source	Specific program	Amount
	Total	

5. Has the JASS made any new investments since the system was constructed? NO SI
6. If yes, in what did you invest?
   (a) Repair (b) Improvement (c) Expansion (d) Training
7. Date that the water system rehabilitation or improvement was concluded (dd/mm/yyyy) ____________

Year	Type of rehabilitation or expansion	Funding Source	Program	Executing Agency	Amount
				Total	

8. Who has the original plans?
   (a) Muni (b) Comm (c) JASS (d) Doesn't exist (e) Don't know (f) Construction company
9. How many families benefit from the system? ________
10. Number of communities connected to the system? _________
11. How many household connections? _________
12. Metering? _______ With registered consumption? _________

13. Are there public taps? NO SI How many? ___________

Organization and function of the JASS

14. Frequency of meetings:

Executive Board: ____________

General Assembly: ________________

15. What is the format of the meeting?

__ Agenda

__ Moderator

__ Hand raising

__ Defined amount of time

__ Proposals/Accords

Other: _________________

16. Average attendance at the meetings:

Executive board: ________ persons

General Assembly: __________ persons

17. Dates of the last meeting:

Board- last: ________ next: __________

General Assembly- last: __________ next: ________

18. Number and dates of the last six meetings. No. _______

19. Books utilized:

Bylaws and Rules NO SI

Minutes NO SI

Tariff payment receipt NO SI

Water use right (ANA) NO SI

Register of users and payment NO SI

Accounts NO SI

Income and Expenditures NO SI

Inventory NO SI

Others

None _____

20. Received training? NO SI

21. What type of training has the board received?

Description	**Theme**			
	Cleaning, disinfection, and treatment	**Operation and system repair**	**Administrative Management**	**Other**
President				
Secretary				
Treasurer				
Vocal 1				
Vocal 2				
Fiscal				
Users				
From who:				
Where:				

22. In the last year have you received assistance from government or NGO?

Date	Person/Entity	Reason	Who solicited

23. Organizational problems:

__ Disagreements
__ Conflict resolution
__ Service equity in the community
__ Poor water management
__ Applying rules to new connections
__ Water loss/misuse
__ Drainage problems

24. Describe the decision making process: ____
____
____
____

25. When was the last time there was a disagreement? How was it resolved?
____
____

26. Problem resolution process: ____
____
____
____

27. Number of elections held?__________________

28. How often is the board changed? ______

29. Date of the last election of the board ____ month ______year

30. Do you have a water use rules and regulation?

(a) Yes, and its applied actively (b) Yes, but only partially (c) Yes, but its not used (d) No
→ Why?________________________________

31. What are the greatest challenged in AOM?

__ Charging the tariff
__ Accounting
__ Organizing meetings
__ Physical repairs
__ Training/technical knowledge
__ Division of water resource within the community
__ Otro: ________________________________
__ Otro: ________________________________
__ Otro: ________________________________
__ Otro: ________________________________

32. How are users are listed in the register? ______

Finances of the JASS

33. Connection fee (initial payment) S/.______________ % paid____________
34. Is there an established tariff?
    (a) Fixed (b) By consumption
35. How much is the tariff? ________
36. What was the process for deciding the tariff? ____

____

____

37. Do you have an annual operating plan elaborated? NO SI
38. How often do you charge the tariff? ________
39. What is the payment mechanism? ____

____

40. Who collects the tariff? _________________________
41. Salary?______________ monthly
42. Percentage of users who owe three months: ____%
43. Income covers costs? ____

____

44. If not – How is the system maintained?
    (a) It's not (b) Extraordinary payments (c) Government subsidy (d) NGO assistance
45. Economic information/expenses

Type of expense		Actual	Theoretical cost
Administration	• Salary of office staff or technicians		
	• Paper or office supplies • Travel expenses/per diems • Rentals		
Operation	• Salary of contracted staff		
	• Energy expense		
	• Treatment expenses (chlorine)		
	• Others		
Maintenance	• Repairs by non-professional • Maintenance supplies		
Environmental services and other	• Reforestation • Cleaning and maintenance • Other		
	Total		

Notes: ____

____

____

46. Give receipts? NO SI
47. Sanction users? NO SI S/. _______________
48. In the last year have you cut or suspended service? NO SI
49. How many times? _____ Reason: _______________________
50. Bank account? NO SI Balance S/. _______________________
51. How many manage the account?_________
52. Who? (titles) ____________ ____________ __________

53. Motive, date, amount of last withdrawals

Motive	Date	Amount

54. Give accounts? NO SI

55. Are there minutes? NO SI

56. How much is the daily wage plus food? ______S/. per day

Information about water service level

57. Level of coverage:

a) Public taps _______% c) interior connection_____%

b) outside connection _____% d) multiple connections ___%

58. In the last month for how many days was any part of the comm without water? _________

59. Date of last interruption in all of the system: ___________________________

60. Motive:

Maintenance Repair Source problem Other

61. Interruption time

Less than 4 hours 4 a 12 hours 1 day 2 days > 2 days

62. Did you take any measure?

No Si Advised the community Other

63 Took some measure before reconnecting the system?

No Si Disinfected the system Other

64 Is there a frequency with which the service is cut?

No Si

65.Frequency:

Monthly Bimonthly Trimester Weekly Annually Other

66. In the last 12 months how long have you had service?

(a) All day all year

(b) Hours in dry season How many_____

(c) Hours all year How many_____

(d) Only some days of the week

System Operation and Maintenance

67. N° operators: (a) None (b) 1 (c) 2 (d) +2 Salary (month): __________

68. Hours of work/week:

(a) As needed (b) <4h (c) 4-10 h (d) 10-20 h (e) +20 h

69. ¿Who does plumbing?

(a) Plumber (b) Board members (c) Users (d) No one

70. Is this person paid? Salary (month): _________

71. What is the state of function of the system?

a) Very good b) Good c) Regular d) Poor e) Very poor

Notes: ____

72. New connections in the last year?______________________

73. Is there a maintenance plan? NO SI

74. Does the system have the necessary tools and equipment to properly be maintained? Which?

____

____

75. Construction materials? Which? _____________________________

76. In the last 12 months, what type of maintenance have you given the system?
(a) Preventative (b) Corrective (c) Preventative and corrective (d) None
77. Do users participate in a maintenance plan? NO SI
78. How often is the system disinfected? ___________
79. How often to you treat the water with chlorine?
a) Always b) Regularly c) Sometimes d) Rarely e) Never
80. Problem areas in the system:
__ Intake
__ Induction line
__ Distribution network
__ Reservoir
__ Other: ____
81. Community contribution during construction:
__ Intake
__ Induction Line
__ Distribution Line
__ Reservoir
__ Other: ____
82. How was work organized?
____
83. What has been the biggest obstacle to a well running system?
____
____
____

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C.3 ATM Interview Form

"Community managed rural water systems in Amazonas, Peru: An assessment using the Sustainability Assessment Tool"

ATM Form

Community: ________________________ District: ______________________ Province: ______________________ Date: ______________ Initials: _________

1. Name of the municipality _______________________________________
2. ¿ATM formalized? SI NO
3. What type of professional training or education do you have? ____

4. Last jobs?

Job	Duration

5. Where in the municipality do you currently work? How many different responsibilities do you have? ______________ ____

6. How long have you been the ATM? __________________
7. What type of training have you received as the ATM? _______________________________ ____ ____ ____

8. In the table, indicate which activities you have done and how long you have done them

Description		No	Si	Years of experience
Water system construction				
Sewer system construction				
Latrine construction				
Water treatment plants				
Wastewater treatment plants				
Solid waste treatment facilities				
Supervision and evaluation of water projects				
Trainings	Operation and maintenance of water systems			
	Cleaning, disinfection, and chlorination			
	Administrative management			
	Sanitary education			

9. How many people work in the ATM office? ______
10. What equipment do you have at your disposal?
    - __ Theodolite
    - __ Projector
    - __ Television
    - __ Level
    - __ Scope
    - __ GPS
    - __ Computer

Logistics	Quantity	Condition

1

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Transportation		
Water quality monitoring equipment		
Computer/office machines		

Per diem expenses	SI		No		
Fuel	Si		No		
Internet access	Si		No		
Training material printed for distribution	Si		No		

11. How many communities are under your jurisdiction? __________
12. How many water systems? __________
13.How many registered and legalized JASS do you have? _______
14. In how many communities have you worked in the last 12 months? ___________
15. How have you assisted them? ____

16. Do you have an annual operating budget? How much? ________________________________
17. How much did you spend last year? ____
18. On what things? ____

19. Describe the type of support you receive from the mayor____

20. Type of assistance provided to communities

No.	Services for providers (JASS)	Number of communities
1	Verifying and supporting the formation, operation and reorganization of the JASS	
2	Supporting the JASS in obtaining legal status	
3	Reviewing and updating system finances	
4	Providing support in establishing and updating rates	
5	Providing support in establishing and legalizing operating regulations	
6	Supporting the JASS in planning and creating community accountability mechanisms	
7	Supporting the JASS in conflict analysis and resolution (e.g.: the use or abuse of the water in the systems)	
8	Collecting samples for system water quality analysis and giving assessment on sample collection, measurement, and data interpretation	
9	Supporting the JASS in measuring the static levels of wells and surface water supplies	

10	Supporting the JASS in keeping and updating a list of service providers (electricians, technicians, water quality laboratories, etc.) and of commercial suppliers (construction, water system hardware, chemicals, etc.)	
11	Supporting the service providers (including technicians) in Management, Operation, and Maintenance (MOM) issues	
12	Other:	

22. In the last year what type of assistance and with what frequency have you helped the focus community?

Date	Motive	Type of assistance	Who initiated?

23. What are the biggest difficulties that the JASS has had in AOM?

__ Charge the tariff
__ Accounting
__ Organizing meetings
__ Physical repairs
__ Technical know-how
__ Division of water resource in the community
__ Other: ______________________________

24. How have they responded?

a) They function by themselves with their own resources
b) Primarily independently with a Little outside assistance mainly financially or for big repairs
c) They require a lot of assistance: technical and financial
d) The community is completely dependent on outside help

25. As ATM, what have been the biggest challenges that you have had in providing technical assistance to the communities?

26. In your opinion, what are the biggest obstacles to having sustainable management of water and sanitation services in your district? Regionally?

27. What do you think the role and impact of the Municipal Incentives Program is?

28. How could it improve?

C.4 Plumber-Operator Survey Form

"Community managed rural water systems in Amazonas, Peru: An assessment using the Sustainability Assessment Tool"

Plumber Operator Form

Community: _______________________ District: _____________________ Province: _____________________ Date: _____________ Initials: ________

1. Sex: M F
2. Position: Plumber – Operator – Both
3. Paid? SI NO
4. How much? ________________ S/. /month
5. Payment is:
 a) Consistent and punctual b) Consistent but sometimes late c) frequent d) owed ________months
7. Which of the following have you done or know how to do?
 __ Build an intake
 __ Change or install valves
 __ Change or install floating valves
 __ Build a pressure break chamber
 __ Fix all plumbing problems
 __ Install special connections
8. How often do you realize disinfection?
 a) <month b) Monthly c) 2–3 months d) Rainy season e) Never
12. What type of source?
 (a) Spring (b) Well (c) Surface water (river/stream/brook)
13. What type of water system?
 Gravity fed Pump
29. What components?
 __ Intake: How many__________ Type_________
 __ Pre-filter:
 __ Reunion box: How many_____
 __ Pressure break chamber: How many_____
 __ Air valve:
 __ Purge valve:
 __ Conduction line:
 __ Aerial crossing:
 __ Treatment plant:
 __ Sedimentation basin:
 __ Slow sand filter:
 __ Reservoir:
 __ Adduction line:
 __ Control valve:
 __ Public tap:
9. Problem areas:
 __ Intake
 __ Treatment plant
 __ Conduction line
 __ Distribution line

__ Reservoir
__Valves
__ Pump
__ Other: ______________________________________

10. How many times have you had to ask for external help? ____ Why?
____
____
____
____
____

11. Maintenance plan? Yes NO Carry it out? SI NO

12. Maintenance expenses on average?
____________ S/. .month

14. How much time do you spend on operation and maintenance? _________hours/day

15. How much time do you spend on repairs
__________hours/day _______days/month

16. Have you attended a training for operators? Yes NO

17. In terms of operation and maintenance activities how confident are you in doing them : a) all b) most c) half d) some e) none

18. What has been the biggest challenge for system function?
____
____

C.5 Technical Data Sheet

"Community managed rural water systems in Amazonas, Peru: An assessment using the Sustainability Assessment Tool"

Community: ______________________ District: ____________________ Province: ____________________ Date: _____________ Initials: ________

General Community Information

1. Altitude: X: Y:
2. How many families: _____
3. Design population of the system__________ Actual ________
4. How many communities are connected: 1 2 3 4 5 other___________
5. How do you get to the community?

From	To	Type	Transport	Distance (km)	Time (hrs)

6. What public services does the community have? Mark with an X
   - Health center (post)
   - School
     - Initial Primary Secondary
   - Electricity
   - Landline phone
   - Cell phone
   - Internet connection
7. Economic base of the community:

   a) Agriculture b) Ranching c) Retail d) Construction e) Plantations f) Government assistance
8. Primary flooring in houses

   Finished:

   Hardwood // Laminate // Tile // Concrete/brick

   Rustic:

   Wood boards

   Natural:

   Earth/sand

   Other
9. Walls

   Masonry: Brick or cement block // Stone// Finished Adobe

   Rustic: Unfinished Adobe// Wood// Quincha// Stone and mud

   Natural/lightweight: Cane/Bamboo/Palm/Trunks // Cardboard // Plywood // no walls

   Other
10. Roofing

    Finished Concrete// Clay tile

    Rustic: Tin roof, fiber board // Wood // Cane

    Natural/lightweight: Straw or palm

    Cardboard

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No roof

Other

11. Windows

Windows //Glass // Wood// Screen // Blinds or curtains

System info

12. Source:

a) Well b) Spring c) River stream

13. (GPS) N___________ O____________

14. Service level:

a) Public taps _______% c) Inside_____%

b) Outside _____% d) multiple ___% # Faucets/house_____

15. Sanitation coverage (latrine or bathroom) __________ %

16. Source for system? How many? _____

17. Distance from source to community ____________ minutes walking

18. Flow in dry season? In liters/second _________

19. Length of waterline from source to reservoir______________________ meters

20. Capacity of reservoir______________________________ cubic meters

21. Type of reservoir: a) Concrete b) brick c) Ferro cement d) stone e) metal f) plastic

22. Sedimentation basin: SI NO

23. Slow sand: SI NO

24. Chlorination system: SI NO

25. Flow from the reservoir?

26. Type of chlorination system?

(a) Drip (b) In-line (c) Tea-bag (d) Other

27. Is there chlorine present?

28. Residual chlorine level currently?

Location of sample	Description		
	(0-0.4 mg/L)	(0.5-0.9 mg/L)	(1.0-1.5 mg/L)
First house			
Middle house			
Last house			

29. What is the water like that is consumed?

(a) Clear (b) Turbid (c) With foreign particles

30. Have you done a bacteriological test recently? NO SI

31. Who supervises water quality?

(a) Municipality (b) Health (c) JASS (d) Other (e) No one

APPENDIX D: SUSTAINABILITY TOOL EVALUATION MATRIX SUB-CRITERIA

Table D.1: Sub-criteria used for the Sustainability Tool Evaluation Matrix to define appropriateness

Criteria	Definition	Sub-Criteria
Target audience	Who are the results of this tool intended for?	Provides useful information to stakeholders on all levels, from international to local
Life cycle stage	When can this tool be used?	Applies throughout life-cycle of the system
Level of effort	What is the time and economic requirement?	Requires least time and economic investment since this is most likely to be chosen by implementing agency
Data collection level	Where is data collected?	Collects data at multiple levels for depth and triangulation
Scope of the tool	What systems and services does this tool include?	Includes various systems and services related to overall sustainability of water service provision
Content areas	What questions are asked in the tool?	Collects useful information concerning a variety of topics
Sustainability indicators	How does this tool define sustainability?	Defines sustainability according to consensus of factors (see Table 3.2)
Data collection methodology	How is data collected and documented?	Collects data in a systematic manner that is reproducible and unbiased
Data entry methodology	What is the process for adding individual data to a database?	Provides easy and straightforward platform for reporting data
Data processing capability	What level of processing and calculation is included in the tool?	Processes data to calculate sustainability scores and allows for in-depth analysis
Outputs	What are the outputs of the tool?	Presents data in an accessible manner for all stakeholders and in a variety of mediums

APPENDIX E: SUSTAINABILITY ASSESSMENT TOOL QUESTION MAPPING

Table E.1: List of questions for each sustainability assessment tool (Diagnostico, SIASAR, Trazadores), with class code corresponding to sustainability factor

Class Codes: 0 - General, 1 - Technical, 2 - Environmental, 3 - Government, 4 - External Support, 5 - Management, 6 - Operation & Maintenance, 7 - Financial, 8 - Social

Diagnostico			SIASAR			Trazadores		
Class		Geographic location	Class	1	System survey	Class		Water quality tracer
0	A_1	Department	0	A	General information and System schematic	1	1_1	Turbidity (from field test)
0	A_2	Province	0		Date	1	1_2	Taste and odor (from sample)
0	A_3	District	0		Enumerator	1	1_3	Chlorine level
0	A_4	Name of Settlement	0	A1_1	System name	2	1_4	Supply source
0	A_5	Type of Settlement	1	A1_2	Year built			Service quality tracer
1	A_6	Settlement Pattern	5	A1_3	Associated service provider	1	2_1	Type of water service
0	A_7	Settlement Code	0	A1_4	District	1	2_2	Water service coverage
0	B_1	UTM Zone	0	A1_5	Province	1	2_3	Water service continuity
0	B_2	Datum	0	A1_6	Department/Region	1	2_4	Type of sanitation service for fecal disposal
0	B_3	Easting	0	A1_7	Latitude	1	2_5	Sanitation service coverage
0	B_4	Northing	0	A1_8	Longitud			Infrastructure status tracer
1	B_5	Altitude	0	A1_9	Altitude	1	3_1	Operational level of the water system
0	C_1	Interviewer	0	A1_10	System code	1	3_2	Status of the water system components
0	C_2	Date of Interview	0	A2_1	Watershed	1	3_2_1	Catchment/intake works
0	C_3	Supervisor	0	A2_2	Area or planning zone	1	3_2_2	Conduction main
0	C_4	Date of Verification	0	A2_3	Other divisions	1	3_2_3	Other structures in the conduction line
0	D_1_A	Interviewee	3	A3_1	Initial construction financing sources	1	3_2_4	Aerial crossings in the conduction line
0	D_1_B	Position	3	A3_2	Specific program from which the funds originated	1	3_2_5	Treatment plant for drinking water
0	D_1_C	Telephone Number	3	A3_3	Amount	1	3_2_6	Storage reservoirs
		Community Information	3	A3_4	Currency	1	3_2_7	Distribution network
8	101_1	What is the primary language in the community?	3	A4_1	Year of refurbishment and/or expansion of the system	1	3_2_8	Other structure in the distribution network
8	101_2	What is the secondary language?	3	A4_2	Financing source	1	3_2_9	Household connections

Table E.1 (continued)

	102	Which of the following services does the community have?	3	A4_3	Program	1	3_3	Operational level of the sanitation system
0	102_1	Electricity	3	A4_4	Executing institution	1	3_4	Status of the components of the sanitation system
0	102_2	Internet Café	3	A4_5	Amount	1	3_4_1	Sewage collection lines
0	102_3	Radiotelephony service	3	A4_6	Currency	1	3_4_2	Catch basins
0	102_4	Cellphone service	1	A5	Type of water supply system	1	3_4_3	Wastewater treatment plant
0	102_5	Public telephone	2	A6	Is there sufficient water in the source to meet demand?	1	3_4_4	Household sanitation systems
	103	Which of the following establishments/schools does the settlement have and do they have sanitation services?	2	A6_1	In dry season?			Service management, operations and maintenance tracer
1	103_1_A	Health establishment	2	A6_2	In rainy season?	6	4_1	Operations and maintenance (operator and tools)
1	103_1_B	Water	1	A7	Water supply system sketch	7	4_2	User tariff and other activities (income>expenditure)
1	103_1_C	Sanitation		B	Source and/or catchment	5	4_3	Work of the board of directors (recognition with local government and use of management books)
1	103_2_A	Initial School	2	B1_1	Name of the source	7	4_4	Rate of default on payment
1	103_2_B	Water	2	B1_2	Source code			Sanitary behaviors tracer
1	103_2_C	Sanitation	2	B1_3	Type of source	8	5_1	Sanitary behaviors (household cleaning, use of sanitation system, solid waste management, personal hygiene)
1	103_3_A	Primary School	2	B1_4	Is it the primary source for the system?			Institutional support tracer
1	103_3_B	Water	2	B1_5	Source flow	4	6_1	The community recieves support and follow-up from the ATM (# of visits)
1	103_3_C	Sanitation	2	B1_6	Unit	4	6_2	The health sector provides attention to the community (# of visits)
1	103_4_A	Secondary School	2	B1_7	Date measured			JASS Management grade
1	103_4_B	Water	2	B1_8	Source flow in dry season	2	7_1	Water quantity
1	103_4_C	Sanitation	2	B1_9	Unit	1	7_2	Water quality
3	104_1	What is the district capital of the settlement?	2	B1_10	Date measured	1	7_3	Water service continuity
3	104_2	Distance (km)	2	B1_11	Latitude	1	7_4	Water service coverage
3	104_3	Time	2	B1_12	Longitud	6	7_5	Operations and maintenance
3	104_4	Unit of Time	2	B1_13	Altitude	7	7_6	User tariff

Table E.1 (continued)

3	104_5	Type of Road	2	B2	Status of the area near the source of system water intake	5	7_7	Legal standing of the JASS
3	104_6	Type of Transportation	2	B2_1	Green or wooded areas near the source/water intake			ATM tracer
1	105	Does the community have a water system?	2	B2_2	Eroded areas near the source/water intake	4	8_1	Formal recognition of the ATM
1	106	How is water supplied in the community?	2	B2_3	Soure/water intake protection (fenced or other access restrictions)	4	8_2	Personnel/technician assigned to fill the position
1	107	Does the community have a sanitation system?	2	B2_4	Contamination from household soild waste or by wastewater around the water intake (presence of pit latrines, animals, household trash, etc.)	4	8_3	Work plan
1	108	What type of household sanitation system do families use in this community?	2	B2_5	Signs or risks of contamination from chemicals or dump sites around the water intake, originating from industrial, agricultural, small-scale production, or other activities	4	8_4	Support and operating capacity
1	109_1	How many households have a connection to the sewer line?	1	B3_1	System water catchment infrastructure	4	8_5	# of model JASS
1	109_2	How many households have hydraulic flush toilets?	1	B3_2	Macro metering of the catchment flow installed?			
1	109_3	How many composting latrines?	1	B4	Physical condition of the water catchment infrastructure			
1	109_4	How many VIP latrines?		C	Pipiline			
1	109_5	What is the total population with sanitation coverage?	1	C1_1	Water main code			
7	110	Do those who have sewage service pay for the system?	1	C1_2	Water main length			
7	111_1	How many families pay?	1	C1_3	Unit			
7	111_2	How much is the monthly sum?	1	C1_4	Main piping average (inner) diameter			
1	112	In what year was the construction completed for the sanitation system?	1	C1_5	Unit			
3	113	Who was the (latest) entity that built the system?	1	C1_6	Does the line contain special structures?			
3	114	When was the most recent improvement, expansion, and/or rehabilitation project?	1	C2	Physical condition of the water mains			

Table E.1 (continued)

5	115	Does the community organization provide technical assistance to families on bathroom maintenance?		D	Water Treatment infrastructure
1	116	Where do people defecate?	1	D1_1	Infrastructure code
		About service provision	1	D1_2	Type of treatment
5	201	What is the entity in charge of the administration, operation, and maintenance of water and sanitation service in the locality?	1	D1_3	It works properly
5	202	What type of community organization is in charge of the AOM of water and sanitation service?	1	D1_4	Latitude
5	203_1	What is the name of the organization?	1	D1_5	Longitud
5	203_2	What is the month and year of the last election?	1	D1_6	Altitude
5	204	Is the organization in charge of the AOM of water registered with a government body?	1	D2	Physical condition of the water treatment infrastructure
5	205	Which?		E	Water Storage infrastructure
5	206_1_A	President	1	E1_1	Infrastructure code
5	206_1_B	Participates?	1	E1_2	Storage capacity
5	206_1_C	Sex	1	E1_3	Unit
5	206_1_D	Education level?	1	E1_4	How often is it cleaned?
5	206_1_E	Recieves some type of incentivo?	1	E1_5	Latitude
5	206_1_F	What type?	1	E1_6	Longitud
5	206_2_A	Treasurer	1	E1_7	Altitude
5	206_2_B	Participates?	1	E2	Physical condition of the water storage infrastructure
5	206_2_C	Sex		F	Water distribution
5	206_2_D	Education level?	1	F1_1	Network code
5	206_2_E	Recieves some type of incentivo?	1	F1_2	Hours of service per day
5	206_2_F	What type?	1	F2	Distribution network
5	206_3_A	Secretary	1	F2_1	Number of distribution network connections
5	206_3_B	Participates?	1	F2_2	Number of installed micro-meters
5	206_3_C	Sex	1	F2_3	Number of micro-meters with recorded consumption
5	206_3_D	Education level?	1	F3	Average distance from homes to public standpipes
5	206_3_E	Recieves some type of incentivo?	1	F4	Physical condition of the water distribution infrastructure

Table E.1 (continued)

5	206_3_F	What type?
5	206_4_A	Fiscal
5	206_4_B	Participates?
5	206_4_C	Sex
5	206_4_D	Education level?
5	206_4_E	Recieves some type of incentivo?
5	206_4_F	What type?
5	206_5_A	Vocal
5	206_5_B	Participates?
5	206_5_C	Sex
5	206_5_D	Education level?
5	206_5_E	Recieves some type of incentivo?
5	206_5_F	What type?
5	206_6_A	Operator/Plumber
5	206_6_B	Participates?
5	206_6_C	Sex
5	206_6_D	Education level?
5	206_6_E	Recieves some type of incentivo?
5	206_6_F	What type?
7	206_6_G	What is the monthly amount received?
5	206_7_A	Health Promoter
5	206_7_B	Participates?
5	206_7_C	Sex
5	206_7_D	Education level?
5	206_7_E	Recieves some type of incentivo?
5	206_7_F	What type?
5	207_1_A	Bylaws of the organization/JASS
5	207_1_B	Up-to-Date
5	207_2_A	Board Rules
5	207_2_B	Up-to-Date
5	207_3_A	Registry of Users
5	207_3_B	Up-to-Date
7	207_4_A	Income/Expenditures Book
7	207_4_B	Up-to-Date

	G	Drinking water quantity and quality
1	G1_1	Water flow
1	G1_2	Unit
1	G2	Disinfection using chlorine
1	G3	Household filtration
1	G4_1	Date of residual chlorine analysis
1	G4_2	Quantity
1	G4_3	Units
1	G4_4	Date of coliforms analysis
1	G4_5	Acceptable/Not acceptable
1	G4_6	Date of physical/chemical analysis
1	G4_7	Acceptable/Not acceptable
	H	Observations
	2	Service provider survey
0	A	General information
0		Application date
0		Enumerator
5	A1_1	Name of service provider
0	A1_2	District
0	A1_3	Province
0	A1_4	Department/Region
0	A1_5	Latitude
0	A1_6	Longitude
0	A1_7	Altitude
5	A1_8	Provider code
5	A2	Type of provider
	B	Community association/organization information
5	B1_1	Date of incorporation
5	B1_2	Legal status of the provider
5	B2_2	Date of last board of directors member elections
5	B2_3	Are all board of director positions filled?
5	B2_4	Number of board of director meetings in the past six months
5	B3_1_A	Name of the president

Table E.1 (continued)

7	207_5_A	Control Book for Collections
7	207_5_B	Up-to-Date
7	207_6_A	Receipts for Payment
7	207_6_B	Up-to-Date
5	207_7_A	Meeting Minutes Book
5	207_7_B	Up-to-Date
5	207_8_A	Residual Chlorine Registry
5	207_8_B	Up-to-Date
5	207_9_A	Inventory Notebook for Tools and Materials
5	207_9_B	Up-to-Date
5	207_10_A	O&M Manual
5	207_10_B	Up-to-Date
5	207_11_A	Annual Operating Plan
5	207_11_B	Up-to-Date
5	207_12_A	Annual Economic Plan
5	207_12_B	Up-to-Date
5	207_13_A	Other
5	207_13_B	Up-to-Date
6	208_1	Pick
6	208_2	Hoe
6	208_3	Stillson wrench
6	208_4	Adjustable wrench
6	208_5	Hack saw
6	208_6	Pliers
6	208_7	Screwdriver
6	208_8	Hammer
6	208_9	Brushes
6	208_10	Broom
6	208_11	Buckets
6	208_12	Chlorine Test Kit
6	209_1	Boots
6	209_2	Gas Mask
6	209_3	Safety Glasses
6	209_3	Gloves
6	209_5	Cover-alls
5	210_1	How often does the Board of Directors meet?

5	B3_1_B	Telephone
5	B3_1_C	Sex
5	B3_2_A	Name of secretary
5	B3_2_B	Telephone
5	B3_2_C	Sex
5	B3_3_A	Name of treasurer
5	B3_3_B	Telephone
5	B3_3_C	Sex
5	B3_4_A	Name of spokesperson
5	B3_4_B	Telephone
5	B3_4_C	Sex
5	B3_5_A	Name of representative
5	B3_5_B	Telephone
5	B3_5_C	Sex
5	B3_6_A	Name of operator
5	B3_6_B	Telephone
5	B3_6_C	Sex
5	B3_7_A	Name of fiscal
5	B3_7_B	Telephone
5	B3_7_C	Sex
7	B4	Does the provider have a bank account?
7	B5_1	Does the provider have an accountability mechanism in place?
7	B5_2	Are there minutes of the last accountability meeting?
	C	Financial information. Regular income
7	C1	The provider has a defined rate scheme
7	C2_1	Rate type
7	C2_2	Average monthly rate
7	C2_3	Currency
7	C3	Is the community familiar with the rate payment mechanism and is it regularly applied?
7	C4_1	Is there water metering information?
7	C4_2	Water produced
7	C4_3	Water invoiced
7	C5_1	Number of users who should pay an invoice
7	C5_2	Billing
7	C5_3	Number of users up to date with invoice payments
7	C5_4	Billing income

Table E.1 (continued)

5	210_2	How often do the users meet?
5	211	What percentage attend the meetings?
6	212	Who carries out the O&M of the system?
5	213	How many users are registered in the registry?
7	214	Does the JASS/organization in charge of AOM charge a tariff for water use?
7	215	How often is the user tariff collected?
7	216	How much is the average user tariff?
7	217	How many users are behind in tariff payment?
7	218	On average, how many missing payments do users have?
7	219	Is there a sanction for those who fall behind or don't pay?
7	220	Are there users exempt from tariff payment?
7	221	Has the tariff changed in the last three years?
7	222	How much did it vary in the last three years?
7	223	How is the user tariff determined?
7	224	Which of the following AOM costs are covered by the user tariffs? How often do these expenses occur?
7	224_1_A	Payment to Operator
7	224_1_B	Frequency
7	224_2_A	Chlorine Purchase
7	224_2_B	Frequency
7	224_3_A	Administrative costs of board of directors
7	224_3_B	Frequency

7	C6	How is the system maintained?
7	D	Financial information. Additional income
7	D1	Additional income from operations
7	D2	Have there been special contributions not directly related to water service?
7	D3	Annual average expansion rate
	E	Financial information: expenditures
7	E1_1	Management (actual exp.)
7	E1_2	Management (expected exp.)
7	E1_3	Operations (actual exp.)
7	E1_4	Operations (expected exp.)
7	E1_5	Maintenance (actual exp.)
7	E1_6	Maintenance (expected exp.)
7	E1_7	Environmental services and others (actual exp.)
7	E1_8	Environmental services and others (expected exp.)
	F	Financial information: savings
7	F1	Is the income and expenditure ledger up to date?
7	F2	Are there available funds?
7	F3	Is there a balance sheet?
	G	Operations and maintenance
6	G1	Does the provider attend to operation and maintenance of the water system?
6	G2	Does the provider have resources for carrying out maintenance activities?

Table E.1 (continued)

7	224_4_A	Energy/Power
7	224_4_B	Frequency
7	224_5_A	Fuel
7	224_5_B	Frequency
7	224_6_A	Tools
7	224_6_B	Frequency
7	224_7_A	Accessories
7	224_7_B	Frequency
7	224_8_A	Materials
7	224_8_B	Frequency
7	224_9_A	Payment to ANA or ALA
7	224_9_B	Frequency
7	225_1	Do users make extraordinary payments for operation and maintenance of the water system?
7	225_2	How much was the average contribution per user?
4	226	Does the municipality supervise the management or visit the organization/JASS?
4	227	How often do they supervise or visit?
4	228	Does the organization/JASS receive assistance from the municipality for any of the following activities?
4	228_1	Technical assistance about operation, rehabilitation or maintenance of the system?
4	228_2	Training?

6	G3	Does the provider have technicians or operators for system operations and maintenance?
6	G4	Does the provider have service provision rules and regulations?
	H	Operations and maintenance
4	H1	Does the provider receive technical support from the government/other agencies for system operations or other activities?
5	H2	Community hygiene monitoring: Does the provider promote environmental sanitation?
5	H3	Does the provider promote protection activities in the area near the water source or system intake?
5	H4_1	Promoting the prevention of pesticide use in the area near the water source or system intake
5	H4_2	Discourages wastewater discharge in residential areas
5	H4_3	Reforestation
5	H4_4	Substituting components of water intake systems (after damages)
5	H5_1	Reviewing and/or increasing legal or administrative land protection where the water resource and/or the system intake is located
5	H5_2	Security in the area near the water source or system intake
5	H5_3	Protecting the flora and fauna in the area near the water source or system intake
5	H5_4	Checking the boundaries and signs in the area near the water source or system intake
5	H5_5	Checking fencing around the water intake and/or making improvements
5	H5_6	Checking the cleanliness of the water intake and/or making improvements
5	H5_7	Checking and/or periodically replacing water intake components (before rupture or damage)
5	H5_8	Actions to promote reforestation and to prevent deforectation
5	H5_9	Soil protection

Table E.1 (continued)

4	228_3	Provision of chlorine?
4	228_4	System maintenance?
4	228_5	Expand or rehabilitate the system?
4	228_6	Subsidize the user tariff?
4	228_7	Monitor water quality (continuity, chlorination, quantity)
4	229	Are there institutions that provide assistance for the management of the board of directors?
4	230	Were the members of the organization/JASS trained in the following:
4	230_1_A	Administrative management?
4	230_1_B	Which institution provided the training in the last 2 years?
4	230_2_A	Operation and maintenance of water?
4	230_2_B	Which institution provided the training in the last 2 years?
4	230_3_A	Elaboration of work plan for management, O&M of the water system?
4	230_3_B	Which institution provided the training in the last 2 years?
4	230_4_A	Cleaning, disinfection and chlorination of the water system?
4	230_4_B	Which institution provided the training in the last 2 years?
4	230_5_A	Sanitary education?
4	230_5_B	Which institution provided the training in the last 2 years?
4	230_6_A	Plumbing?
4	230_6_B	Which institution provided the training in the last 2 years?
4	230_7_A	Watershed conservation?
4	230_7_B	Which institution provided the training in the last 2 years?
		About the water system and service quality
1	301	Does the water system supply other settlements?
1	302	What is the continuity of the water service?

5	H5_10	Reviewing and updating contingency plans
	I	Observations
	3	Community survey
0		Application date
0		Enumerator
0	A1_1	Name of the community
0	A1_2	District
0	A1_3	Province
0	A1_4	Department/Region
0	A1_5	Latitude
0	A1_6	Longitude
0	A1_7	Altitude
0	A1_8	Community code
0	A2_1	Watershed
0	A2_2	Area of planning zone
0	A2_3	Other division
1	A3_1	Total population
8	A3_2	Majority ethnic group
8	A3_3	Predominant language
8	A3_4	Observations
1	A4	Total number of households
1	A5_1	Code/System Name
1	A5_2	Code/Service Provider Name

Table E.1 (continued)

1	302_1_A	Year-round?
1	302_1_B	Days of the week?
1	302_1_C	% of families that the system supplies?
2	302_2_A	In dry season?
2	302_2_B	Days of the week?
2	302_2_C	% of families that the system supplies?
2	302_3_A	In rainy season?
2	302_3_B	Days of the week?
2	302_3_C	% of families that the system supplies?
	303	Why isn't water service continuous?
2	303_1	Because of source output?
1	303_2	Because of system expansion?
6	303_3	Because of damaged accessories?
6	303_4	Because of deteriorated infrastructure?
1	303_5	Because of incomplete construction?
6	303_6	Because of deteriorated pipes?
7	303_7	Because of ability to pay?
6	303_8	Because of water leaks?
8	303_9	Because of inappropriate water usage (irrigation, brick-making, etc.)?
1	303_10	Other?

1	A5_3	Location
1	A5_4	Households serviced by each system-provider
1	A6	Number of households without system
0	A7_1	Electricity
0	A7_2	Landline telephone service
0	A7_3	Cellphone service
0	A7_4	Internet connection
0	A7_5	Other community characteristics
	B	Sanitation and hygiene
	B1	Process used to complete this form
1	B2_1	Number of households that have their own improved type 1 sanitation infrastructure
1	B2_2	Number of households that have their own improved type 2 sanitation infrastructure
1	B2_3	Number of households that have a different unimproved type of sanitation infrastructure of their own
1	B3_1	Number of households that use their own type 1 sanitation infrastructure partially
1	B3_2	Number of households that use their own type 2 sanitation infrastructure partially
1	B3_3	Number of households that use share type 1 sanitation infrastructure partially
1	B3_4	Number of households that use shared type 2 sanitation infrastructure partially
1	B3_5	Number of households that use their own type 1 always
1	B3_6	Number of households that use their own type 2 always
1	B3_7	Number of households that use shared type 1 always

Table E.1 (continued)

1	303_11	Don't know/unsure	1	B3_8	Number of households that use shared type 2 always
5	304	Does institutional capacity exist to solve these problems?	1	B4_1	Number of household that use an unimproved type partially
6	305_1	Since when does the water system only work partially or not at all?	1	B4_2	Number of households that use an unimproved type always
6	305_2	Day/Month/Year	1	B5_1	Number of households that have a basic hand washing facility near the sanitation facility
1	306	In what year was the water system constructed?	1	B5_2	Number of households in which all members always use the hand washing facility
3	307	Who constructed the system?	1	B5_3	Number of households in which drinking water is safely stored
3	308	When was the last intervention to improve, expand and/or rehabilitate the water system?	1	B6_1	Is there any type of solid waste collection and/or disposal practice in the community?
6	309	How often is maintenance carried out on the water system?	1	B6_2	Number of households that collect or dispose of their solid waste?
	310	In this settlement, how many:	1	B6_3	What is the most common type of solid waste disposal in the community?
1	310_1	Total households exist?		C	School form
1	310_2	What is the total population?	1	C1_1	Is there a school in the community?
1	310_3	Occupied houses with connection are there?	1	C1_2	Name of the school
1	310_4	Unoccupied houses with connection are there?	1	C1_3	Location of the school
1	310_5	What is the population served?	1	C2_1	Name of the school
1	310_6	Households are served by public tap?	1	C2_2	School code
1	310_7	Households have metering?	1	C2_3	Total number of female teachers and employees
7	310_8	What is the cost per m^3?	1	C2_4	Total number of male teachers and employees
1	311	What is the water like that they consume?	1	C2_5	Total number of female students
		B. Disinfection and treatment of the water system	1	C2_6	Total number of male students
6	312	Is the system regularly cleaned and disinfected?	1	C3_1	Does the school have water system?
6	313_1	For system disinfection, is chlorine/bleach used?	1	C3_2	Capacity to meet demand?
6	313_2	How much?	1	C3_3	System code/name
6	313_3	Unit of Time	1	C3_4	Location

Table E.1 (continued)

6	314	How often are the following system components disinfected?
6	314_1	Intake:
6	314_2	Conduction line:
6	314_3	Reservoir:
6	314_4	Pressure break chamber (Type 6 and 7):
6	314_5	Distribution line:
1	315	Is the water chlorinated?
1	316	Why is it not chlorinated?
1	317	What type of chlorination system is used?
1	318	Where is the chlorination system located?
1	319_1	What form of chlorine is used?
1	319_2	What is the concentration?
4	320	Who supplies the chlorine?
5	321	How often is the chlorine supply refilled for water chlorination?
1	322_1_1	What quantity of chlorine is used per refill?
1	322_1_2	Unit
7	322_2	What is the total cost per refill?
4	323_1	What distance is traveled?
4	323_2_A	How much time is needed to obtain chlorine for the system?
4	323_2_B	Unit
1	324	Is residual chlorine measured?

1	C4_1	Improved type 1 sanitation infrastructure coverage
1	C4_2	Improved type 2 sanitation infrastructure coverage
1	C4_3	Other unimproved sanitation infrastructure coverage
1	C4_4	Basic hand washing facility less than 10 meters away from the sanitation facility
	D	Health center form
1	D1_1	Are there any health centers in the community?
1	D1_2	Name of the health center most used by the population
1	D1_3	Location of the health center
1	D2_1	Health center name
1	D2_2	Health center code
1	D2_3	Total number of female employees
1	D2_4	Total number of male employees
1	D2_5	Daily average number of female patients
1	D2_6	Daily average number of male patients
1	D3_1	Does the health center have a water system?
1	D3_2	Capacity to meet demand?
1	D3_3	System code/name
1	D3_4	Location
1	D4_1	Improved type 1 sanitation infrastructure coverage
1	D4_2	Improved type 2 sanitation infrastructure coverage
1	D4_3	Other unimproved sanitation infrastructure coverage

Table E.1 (continued)

1	325	Why is residual chlorine not measured?
1	326_1	Level of residual chlorine in the first house:
1	326_2	Level of residual chlorine in the last house:
4	327	Does the health post/center monitor water quality?
4	328	How often do they monitor water quality?
		C. Water source characteristics
2	329_1	Water source type:
2	329_2	Name of the water source:
2	330	Point of origin:
2	331_1	Total flow in dry season
2	331_2	Total flow in rainy season
2	331_3	Total flow at capacity
5	332	Do you have water use permit from ANA?
1	333_1	Distance from source to reservoir:
1	333_2	Unit
1	334	What is the type of water system used?
		D. Infrastructure
		Water system components
1	335_1_A	Water Intake
1	335_1_B	Current physical condition:
1	335_1_C	Current operational condition:
1	335_2_A	Artesian or tubular wells
1	335_2_B	Current physical condition:
1	335_2_C	Current operational condition:

1	D4_4	Basic hand washing facility less than 10 meters away from the sanitation facility
		Interventions
3	E1_1	Source/institution responsible for water system improvement
3	E1_2	Phase
3	E1_3	Source/agency responsible for new water system
3	E1_4	Phase
3	E1_5	Source/agency responsible for improved type 1 and 2 sanitation system
3	E1_6	Phase
3	E1_7	Source/agency responsible for unimproved sanitation system
3	E1_8	Phase
	F	Observations
	4	Survey of Technical Assistance Providers (TAP)
	A	General information and system overview
0		Application date
0		Enumerator
4	A1	Name of TAP
4	A2	Type of TAP
4	A3	Service area
	B	Intervention
4	B1	Total number of communities in the service area
4	B2	Number of communities serviced in the past 12 months
	C	Financial, human, and logistics resources
4	C1	Number of technicians in the area

Table E.1 (continued)

1	335_3_A	Caisson	4	C2	Does it have an annual operation budget?
1	335_3_B	Current physical condition:	4	C3	Annual operating budget amount
1	335_3_C	Current operational condition:	4	C4_1	Quantity/stock of transportation equipment
1	335_4_A	Impulsion line	4	C4_2	Status
1	335_4_B	Current physical condition:	4	C4_3	Quantity/stock of water quality measurement equipment
1	335_4_C	Current operational condition:	4	C4_4	Status
1	335_5_A	Pump equipment	4	C4_5	Quantity/stock of IT equipment
1	335_5_B	Current physical condition:	4	C4_6	Status
1	335_5_C	Current operational condition:	4	C4_7	Travel budget
1	335_6_A	Cistern	4	C4_8	Fuel budget
1	335_6_B	Current physical condition:	4	C4_9	Internet service
1	335_6_C	Current operational condition:	4	C4_10	Printed training materials for distribution
1	335_7_A	Conduction line		D	Type of support
1	335_7_B	Current physical condition:	4	D1_1	Verifying and supporting the formation, operation, and reorganization of the CWB
1	335_7_C	Current operational condition:	4	D1_2	Supporting the CWB in obtaining legal status
1	335_8_A	Pressure break chamber (Type 6):	4	D1_3	Reviewing and updating system finances
1	335_8_B	Current physical condition:	4	D1_4	Providing support in establishing and updating rates
1	335_8_C	Current operational condition:	4	D1_5	Providing support in establishing and legalizing operating regulations
1	335_9_A	Other structure in conduction line:	4	D1_6	Supporting the JASS in planning and creating community accountability mechanisms
1	335_9_B	Current physical condition:	4	D1_7	Supporting the JASS in conflict analysis and resolution
1	335_9_C	Current operational condition:	4	D1_8	Collecting samples for system water quality analysis and giving assessment on sample collection, measurement and data interpretation
1	335_10_A	Flow box	4	D1_9	Supporting the JASS in measuring static levels of wells and surface water supplies

Table E.1 (continued)

1	335_10_B	Current physical condition:
1	335_10_C	Current operational condition:
1	335_11_A	Aerial crossing in conduction line
1	335_11_B	Current physical condition:
1	335_11_C	Current operational condition:
1	335_12_A	Union box
1	335_12_B	Current physical condition:
1	335_12_C	Current operational condition:
1	335_13_A	Water treatment plant
1	335_13_B	Current physical condition:
1	335_13_C	Current operational condition:
1	335_14_A	Aduction line
1	335_14_B	Current physical condition:
1	335_14_C	Current operational condition:
1	335_15_A	Distribution line
1	335_15_B	Current physical condition:
1	335_15_C	Current operational condition:
1	335_16_A	Pressure break chamber (Type 7)
1	335_16_B	Current physical condition:
1	335_16_C	Current operational condition:
1	335_17_A	Other structure in distribution line
1	335_17_B	Current physical condition:
1	335_17_C	Current operational condition:
1	335_18_A	Aerial crossing in distribution line
1	335_18_B	Current physical condition:
1	335_18_C	Current operational condition:
1	335_19_A	Public tapstands

4	D1_10	Supporting the JASS in keeping and updating a list of service providers and of commercial suppliers
4	D1_11	Supporting the JASS in management, operations, and maintenance issues
4	D1_12	Updating and using the SIASAR for annual rural water and sanitation municipal planning
	E	Observations

Table E.1 (continued)

1	335_19_B	Current physical condition:
1	335_19_C	Current operational condition:
1	335_20_A	Household connections (inside/outside house)
1	335_20_B	Current physical condition:
1	335_20_C	Current operational condition:
1	335_21_A	Household meters
1	335_21_B	Current physical condition:
1	335_21_C	Current operational condition:
1		Reservoir
1	335_22_A	Reservoir
1	335_22_B	Current physical condition:
1	335_22_C	Current operational condition:
1	335_23_A	Entry hatch
1	335_23_B	Current physical condition:
1	335_23_C	Current operational condition:
1	335_24_A	Valve box
1	335_24_B	Current physical condition:
1	335_24_C	Current operational condition:
1	335_25_A	Access hatch for valve box
1	335_25_B	Current physical condition:
1	335_25_C	Current operational condition:
1	335_26_A	Inflow head
1	335_26_B	Current physical condition:
1	335_26_C	Current operational condition:
1	335_27_A	Cleaning and overflow line
1	335_27_B	Current physical condition:
1	335_27_C	Current operational condition:
1	335_28_A	Ventilation tube
1	335_28_B	Current physical condition:
1	335_28_C	Current operational condition:
1	335_29_A	Chlorination system
1	335_29_B	Current physical condition:

Table E.1 (continued)

1	335_29_C	Current operational condition:
1		Sewer system or other sanitation system
1	335_30_A	Sewage line
1	335_30_B	Current physical condition:
1	335_30_C	Current operational condition:
1	335_31_A	Catch basins
1	335_31_B	Current physical condition:
1	335_31_C	Current operational condition:
1	335_32_A	Wastewater treatment plant
1	335_32_B	Current physical condition:
1	335_32_C	Current operational condition:
1	335_33_A	Household sanitation system
1	335_33_B	Current physical condition:
1	335_33_C	Current operational condition:
1	336_A	East coord. For reservoir
1	336_B	North coord. For reservoir
	336_C	Elevation
		Module II.A Municipal Service provision
3	206_A	What personnel does the municipality have for AOM of the water and sanitation services?
3	208_A	Does the municipality have tools for the AOM?
7	224_A	Are the costs of the AOM covered by user tariff?
7	224_B	Do the payments for AOM have a separate accounting service from normal municipality funds?

APPENDIX F: CORRESPONDING QUESTIONS FROM DIAGNOSTICO FOR USE WITH SIASAR FRAMEWORK

Table F.1: Questions identified from Diagnostico for use with the SIASAR framework

WSL.ACC – Accessibility		
	Households without system	310
	Total number of households	310a
	Average distance to public standpipes	310f
WSL. CON – Continuity		
	Service hours per day	302a
WSL.SEA – Seasonality		
	Water flow	331
	Enough water at source level to meet demand during dry season	302b
	Enough water at source level to meet demand during rainy season	302c
	Total population	310b
	Total number of households	310a
	Number of households served by each system	310c,d
WSL.QUA – Quality		
	Data of Analysis	N/A
	Bacteriological	N/A
	Physiochemical	N/A
SHL.SSL – Sanitation Service Level		
	Total number of households	310a
	Number of households that HAVE their OWN IMPROVED sanitation infrastructure (TYPE1)	109
	Number of households that HAVE their OWN IMPROVED sanitation infrastructure (TYPE 2)	109
	Number of households that USE their OWN IMPROVED sanitation infrastructure (TYPE 1 or 2)	109
	Number of households that USE a SHARED IMPROVED sanitation infrastructure (TYPE 1 or 2)	109

Table F.1 (continued)

SHL.PER – Personal Hygiene		
	Total number of households	310a
	Number of households with a basic hand washing facility near the sanitation facility	N/A
	Number of households in which ALL members always USE the hand washing facility	N/A
	Number of households that ALL member ALWAYS USE their OWN IMPROVED sanitation infrastructure (TYPE 1 or 2)	N/A
	Number of households that ALL members ALWAYS USE a SHARED IMPROVED sanitation infrastructure (TYPE 1 or 2)	N/A
	Number of households that HAVE their OWN improved sanitation infrastructure (TYPE 1)	109
	Number of households that HAVE their OWN IMPROVED sanitation infrastructure (TYPE 2)	109
	Number of households that HAVE a DIFFERENT UNIMPROVED type of sanitation infrastructure of their OWN	109
SLH.WAT – Household Hygiene		
	Total number of households	310a
	Number of households in which drinking water is safely stored	N/A
SLH.COM – Community Hygiene		
	Total number of households	310a
	Number of households that collect of dispose their solid waste	N/A
	Number of households that ALL member ALWAYS USE their OWN IMPROVED sanitation infrastructure (TYPE 1 or 2)	N/A
	Number of households that ALL members ALWAYS USE a SHARED IMPROVED sanitation infrastructure (TYPE 1 or 2)	N/A
	Number of households that ALL members ALWAYS USE an UNIMPROVED sanitation infrastructure	N/A
EHC.SWA – Water Supply in Schools		
	Student body	N/A
	Number of schools in community	103
	Associated water system	103
EHC.HWA – Water Supply in Health Centers		
	Average number of health system users	N/A
	Number of health centers in community	103
	Associated water system	103
EHC.SSA		
	Teaching and Administrative Staff	N/A
	Student body	N/A
	Number of sanitation and hygiene infrastructures (staff)	103
	Number of sanitation and hygiene infrastructures (student body)	103

Table F.1 (continued)

EHC.HSA – Sanitation in Health Centers		
	Medical and Administrative Staff	N/A
	Average number of health system users	N/A
	Number of sanitation and hygiene infrastructures (staff)	103
	Number of sanitation and hygiene infrastructures (users)	103
WSI.AUT – System Autonomy		
	Storage infrastructure capacity	N/A
	Number of households served by each System-Provider	310e
WSI.INF		
	Water source and/or Catchment	335
	Water main	335
	Storage infrastructure	335
	Distribution	335
WSI.PRO – Water Catchment Area Protection		
	Status of the area near the source or water system intake	N/A
WSI.TRE – Treatment System		
	Type of treatment system	334
	Functionality of the treatment system	N/A
	Treatment system physical condition	335
	Disinfection using Chlorine	315-327
	Household filtration	N/A
SEP.ORG – Organization Management		
	Legal status	204
	Date of last Board of Directors member election	203b
	Board of Directors positions filled	206
	Board of Directors meetings frequency	210
	Number of women in Board of Directors	206
	Existence of last accountability meeting minutes	207
	Existence of tariff	214
	Existence of rate payment mechanism and regularly applied	215
	Existence of income and expenditure ledger up to date	207
SEP.OPM – Operation & Maintenance Management		
	Provision of maintenance	212
	Existence of resources	208, 209
	Existence of technician or operators for system operations and maintenance	212
	Existence of service provision rules and regulations	207
	Drinking water. Residual Chlorine	326
	Number of installed micro-meters	310g
	Number of micro-meters with recorded consumption	N/A
	Number of households served by each System-Provider	310e

Table F.1 (continued)

SEP.ECO – Economic Management		
	Water produced (monthly)	N/A
	Billing (monthly)	224
	Number of users who should pay an invoice	213
	Number of users up to date with invoice payments	217
	Additional income from operations (last year)	225
	Additional income from operations (expected this year)	N/A
	Special contributions not directly related to water service (expected this year)	N/A
	Actual expenditure	224
	Expected expenditure	224
	Available funds	N/A
	Total income (last year)	N/A
	Total expenditure (last year)	N/A
	Balance sheet	207
SEP.ENV – Environmental Management		
	Environmental sanitation promotion	230
	Promotion of protection activities in the area near the water source or system intake	N/A
	Corrective actions (area near the water source or system intake)	N/A
	Preventive actions (area near the water source or system intake)	N/A
TAP.ICT – Information Systems		
	IT equipment and status	111
	Internet service and status	111
TAP.INS – Institutional capacity		
	Total number of communities in service area	201
	Number of technicians	114
	Existence of annual operating budget	111
	Annual operating budget amount	111
	Transportation equipment and status	111
	Water quality measurement equipment and status	111
	Travel and fuel budget	112
TAP.COV – Community Coverage		
	Total number of communities in service area	201
	Number of communities served in the past 12 months	205
TAP.INT – Intensity of Assistance		
	Number of communities served in the past 12 months	205
	Type of support	115, 202, 203, 212

APPENDIX G: MAPS OF COMMUNITY SCORES FROM SIASAR AND TRAZADORES

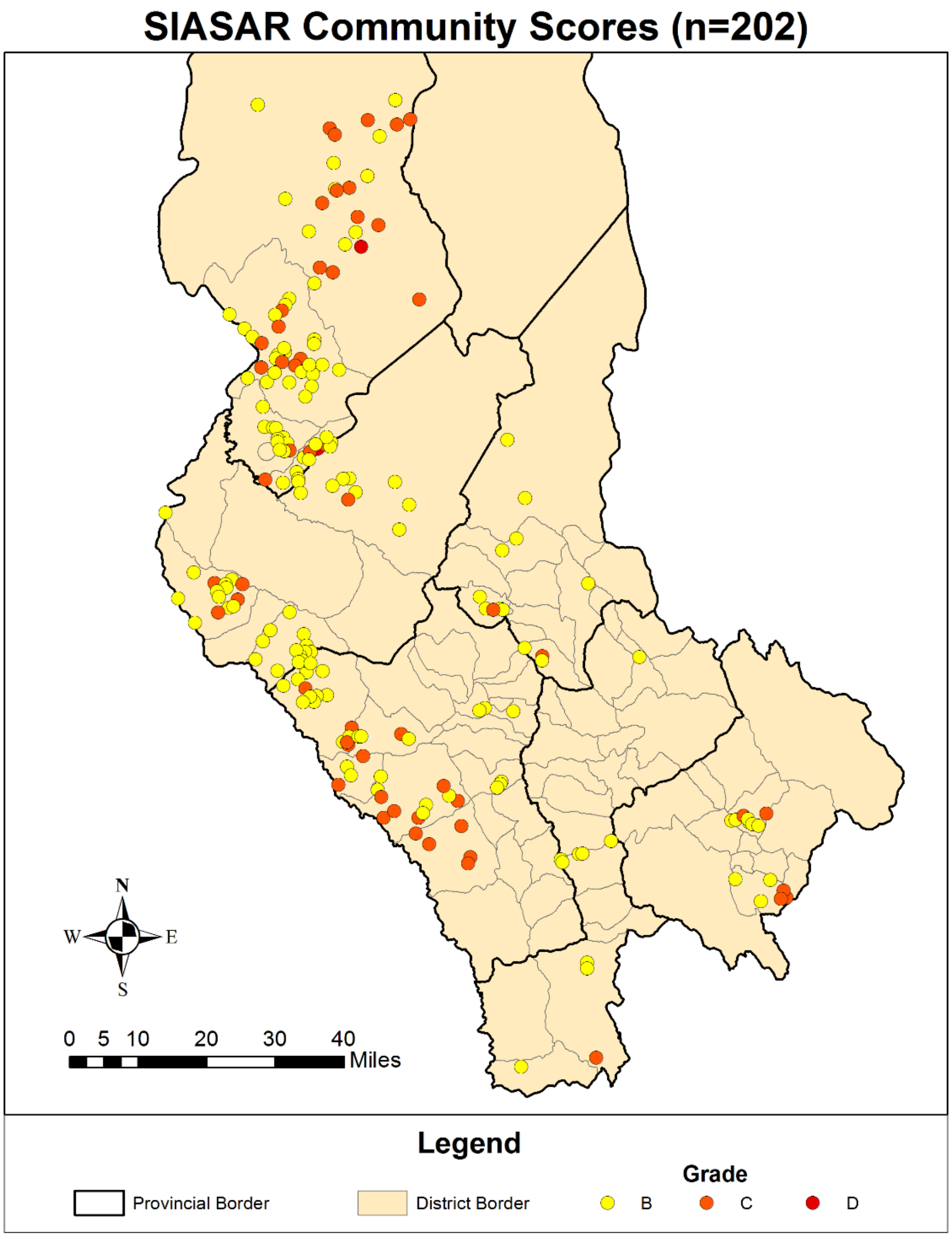

Figure G.1: Map of individual community scores from the SIASAR dataset (n = 202)

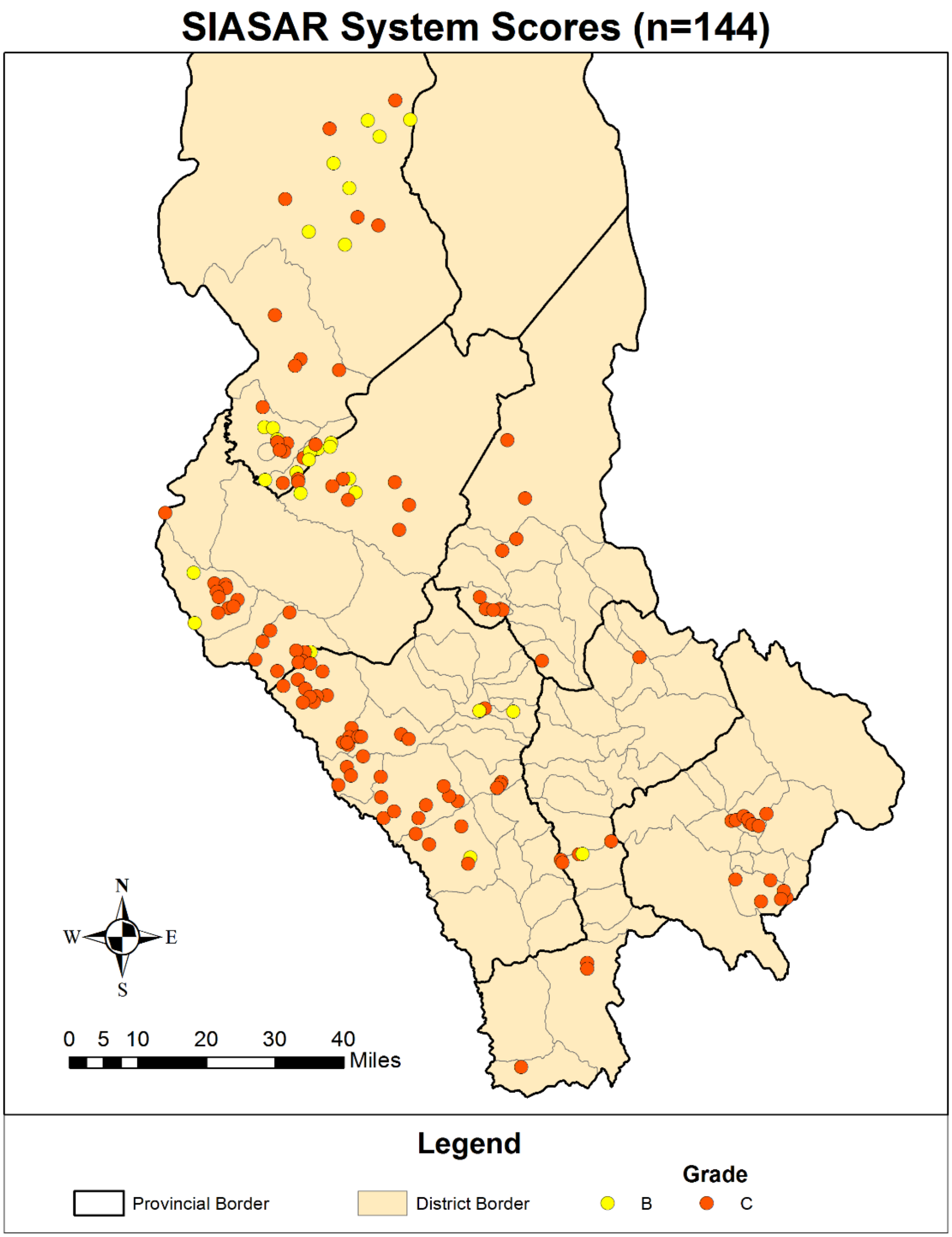

Figure G.2: Map of individual system scores from the SIASAR dataset (n = 144)

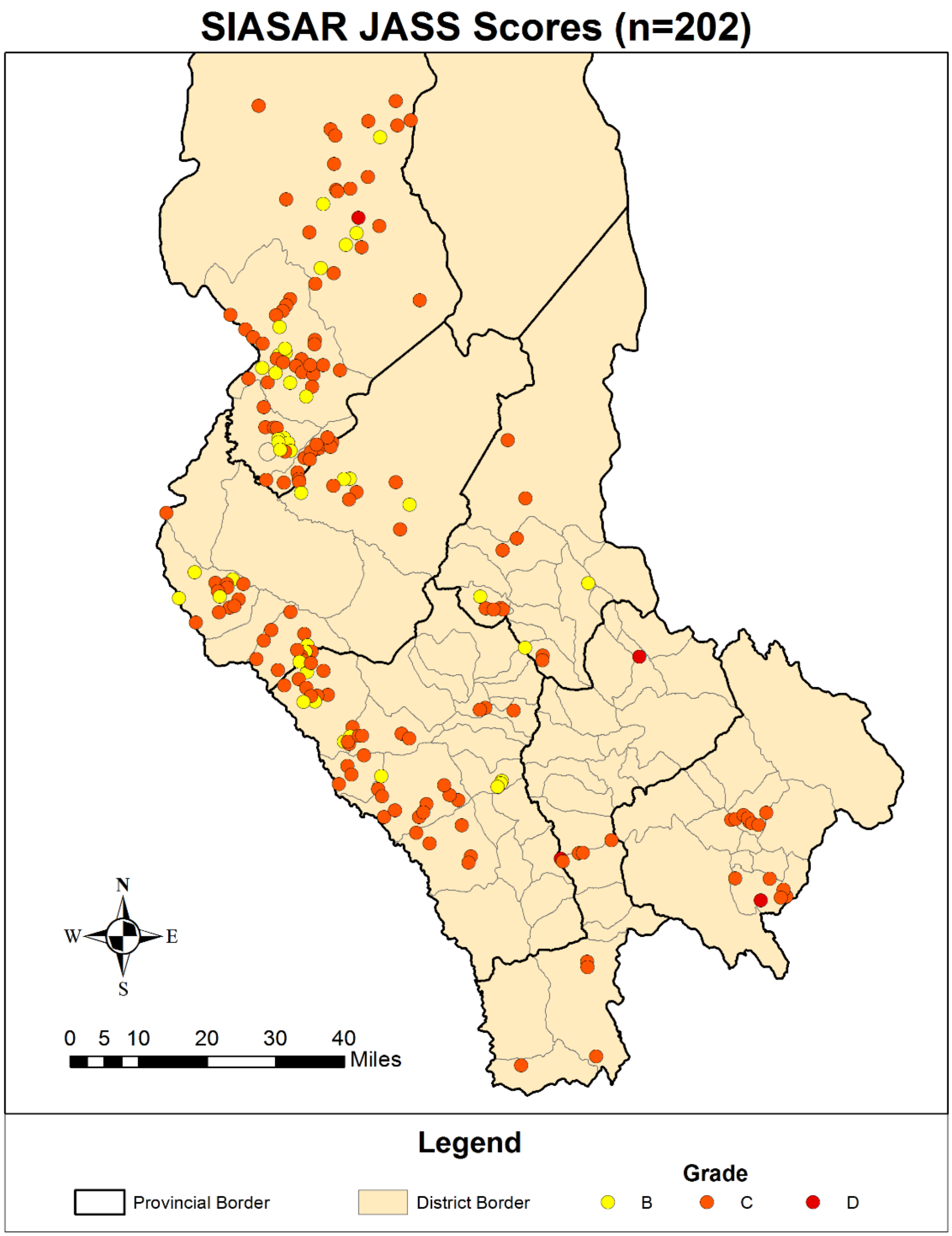

Figure G.3: Map of individual JASS scores from the SIASAR dataset (n = 202)

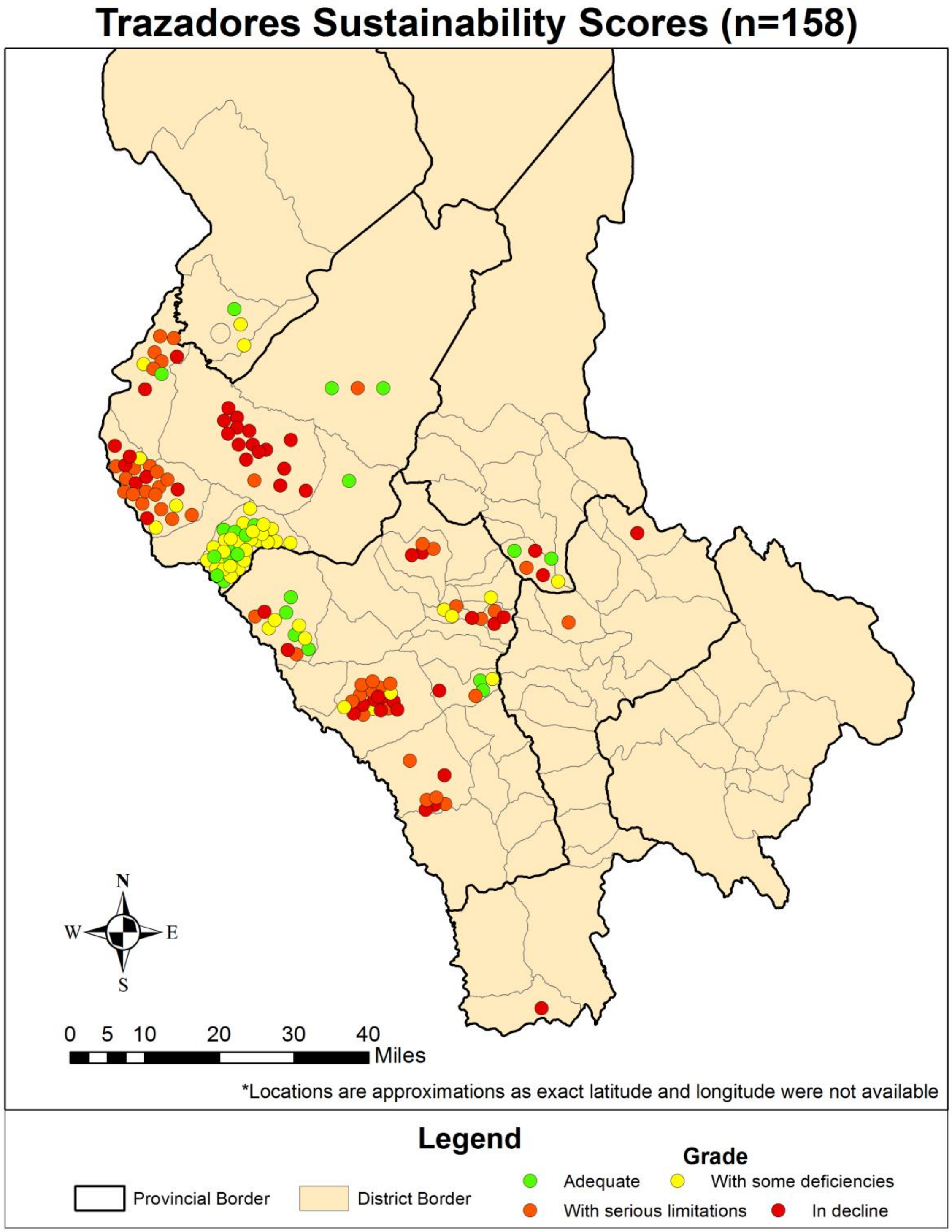

Figure G.4: Map of individual general sustainability scores from the Trazadores dataset (n = 158)

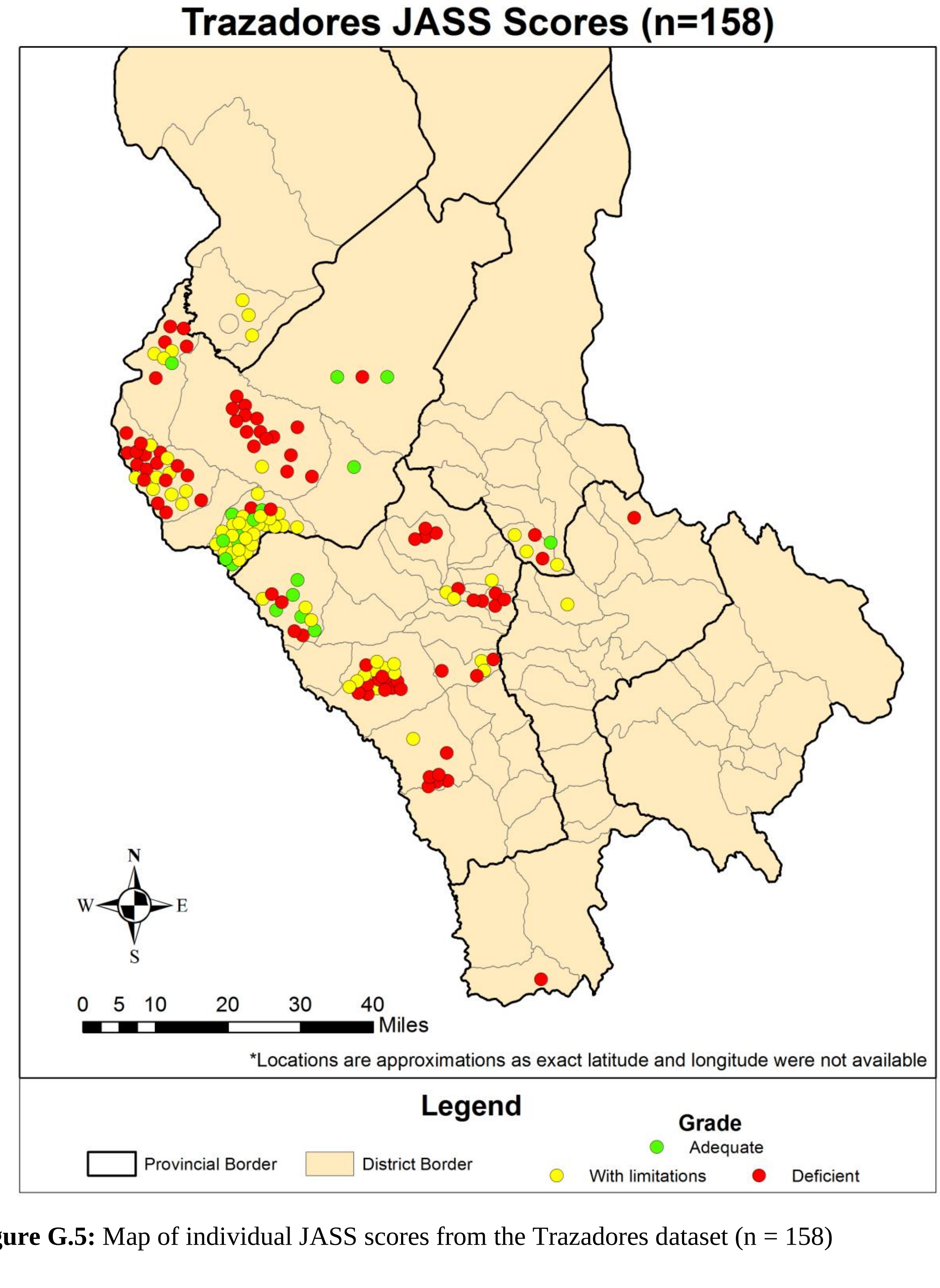

Figure G.5: Map of individual JASS scores from the Trazadores dataset (n = 158)

APPENDIX H: COMPARISON OF SCORES FROM SIASAR AND TRAZADORES

Table H.1: Comparison of scores for system and JASS from the SIASAR dataset and the Trazadores dataset where there was overlap

Province	District	Community	General_T	SIST_S	Δ_System	JASS_T	JASS_S	Δ_JASS
LUYA	CAMPORREDONDO	LA LIBERTAD	🟢 0.13	⇩ 13	2	🟢 100	🔴 2	2
LUYA	CAMPORREDONDO	SAN JOSE DEL REJO	🔴 1.25	⇩ 12	-1	🔴 35	🔴 2	0
LUYA	COLCAMAR	COCHA	🟢 0.35	⇩ 16	2	⇨ 80	⇨ 3	0
LUYA	COLCAMAR	QILLILLIC	🟢 0.35	⇩ 13	2	⇨ 80	⇨ 3	0
LUYA	COLCAMAR	TUETA	⇩ 1.2	⇩ 13	0	⇨ 50	⇨ 3	0
UTCUBAMBA	CUMBA	BANGUAR	⇩ 0.91	⇩ 15	0	⇨ 65	🔴 2	1
UTCUBAMBA	CUMBA	CHALLUAYACU	🔴 1.26	⇩ 14	-1	🔴 45	⇨ 3	-1
UTCUBAMBA	CUMBA	CORRAL QUEMADO	⇩ 1.11	⇩ 16	0	🔴 45	🔴 2	0
UTCUBAMBA	CUMBA	EL PORVENIR	🔴 1.21	⇧ 18	-2	🔴 45	⇨ 3	-1
UTCUBAMBA	CUMBA	HUALANGO	⇧ 0.8	⇩ 14	1	⇨ 55	🔴 2	1
UTCUBAMBA	CUMBA	LA FLOR	🔴 1.21			🔴 45	🔴 2	0
UTCUBAMBA	CUMBA	LA UNION	⇩ 0.89			⇨ 70	⇨ 3	0
UTCUBAMBA	CUMBA	MIRAFLORES	⇩ 0.96	⇩ 13	0	⇨ 65	🔴 2	1
UTCUBAMBA	CUMBA	NUEVA ESPERANZA	⇧ 0.79	⇩ 13	1	⇨ 50	🔴 2	1
UTCUBAMBA	CUMBA	NUEVO ORIENTE	⇩ 1.11	⇩ 16	0	🔴 45	🔴 2	0
UTCUBAMBA	CUMBA	SAN MARTIN	⇩ 0.9	⇩ 13	0	⇨ 55	🔴 2	1
UTCUBAMBA	CUMBA	VISTA FLORIDA	🔴 1.26	⇩ 13	-1	🔴 45	🔴 2	0
BAGUA	LA PECA	ARRAYAN	⇧ 0.44			🟢 85	⇨ 3	1
BAGUA	LA PECA	SAN FRANCISCO	🟢 0.28	⇩ 11	2	🟢 85	⇨ 3	1
BAGUA	LA PECA	TRANQUILLA	⇧ 0.65			⇨ 70	⇨ 3	0
UTCUBAMBA	LONYA GRANDE	CALPON	🟢 0.28	⇩ 15	2	🟢 95	⇨ 3	1
UTCUBAMBA	LONYA GRANDE	CARACHUPA	⇧ 0.72	⇩ 15	1	⇨ 60	🔴 2	1
UTCUBAMBA	LONYA GRANDE	GRACIAS A DIOS	⇧ 0.59	⇩ 15	1	⇨ 55	🔴 2	1
UTCUBAMBA	LONYA GRANDE	GRAMALOTE	⇧ 0.54	⇧ 18	0	⇨ 75	🔴 2	1
UTCUBAMBA	LONYA GRANDE	HUAMBOYA	🟢 0.22			🟢 95	🔴 2	2
UTCUBAMBA	LONYA GRANDE	HUAYLLA	⇧ 0.53	⇩ 15	1	⇨ 80	🔴 2	1
UTCUBAMBA	LONYA GRANDE	LA UNION	⇧ 0.55	⇩ 15	1	🔴 45	🔴 2	0
UTCUBAMBA	LONYA GRANDE	NUEVA YORK	⇧ 0.4	⇩ 15	1	⇨ 75	⇨ 3	0
UTCUBAMBA	LONYA GRANDE	NUEVOS AIRES	⇧ 0.55	⇩ 15	1	⇨ 55	🔴 2	1
UTCUBAMBA	LONYA GRANDE	ORTIZ ARRIETA	🟢 0.03			🟢 100	⇨ 3	1
UTCUBAMBA	LONYA GRANDE	PORTACHUELO	⇧ 0.58	⇩ 15	1	⇨ 75	🔴 2	1
UTCUBAMBA	LONYA GRANDE	PUCALLPA	⇧ 0.68	⇩ 15	1	⇨ 55	🔴 2	1
UTCUBAMBA	LONYA GRANDE	QUEROMARCA	⇧ 0.68	⇩ 15	1	⇨ 55	🔴 2	1
UTCUBAMBA	LONYA GRANDE	ROBLEPAMPA	🟢 0.09			🟢 100	🔴 2	2
UTCUBAMBA	LONYA GRANDE	RODRIGUEZ TAFUR	🟢 0.13	⇩ 13	2	🟢 100	🔴 2	2
UTCUBAMBA	LONYA GRANDE	SAN FELIPE	⇧ 0.63	⇩ 15	1	⇨ 65	🔴 2	1
UTCUBAMBA	LONYA GRANDE	SAN PEDRO	⇧ 0.68	⇩ 15	1	⇨ 55	🔴 2	1
UTCUBAMBA	LONYA GRANDE	SANTA CRUZ	⇧ 0.43	⇩ 15	1	⇨ 80	🔴 2	1
UTCUBAMBA	LONYA GRANDE	SANTA ROSA	⇧ 0.59	⇩ 15	1	⇨ 55	🔴 2	1
UTCUBAMBA	LONYA GRANDE	SANTA ROSA DE JAIPE	🟢 0.35			🟢 85	⇨ 3	1
UTCUBAMBA	LONYA GRANDE	TULLANYA	⇧ 0.68	⇩ 15	1	⇨ 50	🔴 2	1
UTCUBAMBA	LONYA GRANDE	YUNGASUYO	🟢 0.2	⇩ 15	2	🟢 100	⇨ 3	2
UTCUBAMBA	LONYA GRANDE	YUNGAY	🟢 0.04	⇩ 15	2	🟢 95	⇨ 3	2
UTCUBAMBA	LONYA GRANDE	ZAPATALGO	⇧ 0.52	⇩ 15	1	⇨ 80	🔴 2	1

Table H.1 (continued)

Province	District	Community	General_T	SIST_S	Δ_System	JASS_T	JASS_S	Δ_JASS
LUYA	LUYA	CHOCTA	⇩ 0.93	⇧ 18	-1	⇨ 50	🔴 2	1
LUYA	LUYA	EL MOLINO	⇧ 0.76	⇧ 18	0	⇨ 65	🔴 2	1
LUYA	LUYA	SHIPATA	⇧ 0.55	⇩ 13	1	⇨ 75	🔴 2	1
LUYA	OCUMAL	ALLAVIN	🔴 1.3	⇩ 11	-1	🔴 35	🔴 2	0
LUYA	OCUMAL	CALDERA	⇧ 0.78			⇨ 60	🔴 2	1
LUYA	OCUMAL	CHUQUIMAL	⇩ 1.2	⇩ 11	0	⇨ 50	🔴 2	1
LUYA	OCUMAL	COLCALON	🔴 1.29	⇩ 13	-1	🔴 35	🔴 2	0
LUYA	OCUMAL	LA UNION	⇩ 0.87			⇨ 55	🔴 2	1
LUYA	OCUMAL	LIMAPAMPA	🔴 1.45	⇩ 13	-1	🔴 45	🔴 2	0
LUYA	OCUMAL	MOTUPE	⇩ 0.83	⇩ 15	0	⇨ 55	⇨ 3	0
LUYA	OCUMAL	SALINGUERRA	⇩ 1.08	⇩ 12	0	🔴 45	🔴 2	0
LUYA	OCUMAL	SAN JUAN	⇩ 0.97	⇩ 11	0	⇨ 55	🔴 2	1
LUYA	OCUMAL	VISTA HERMOSA	⇧ 0.72	⇩ 13	1	⇨ 65	🔴 2	1
LUYA	OCUMAL	YAULICACHI	🔴 1.48	⇩ 11	-1	🔴 40	🔴 2	0
LUYA	PISUQUIA	HUARANGUILLO	🔴 1.25	⇩ 10	-1	🔴 45	🔴 2	0
LUYA	PISUQUIA	MEMBRILLO	⇩ 0.9	⇧ 18	-1	⇨ 55	🔴 2	1
LUYA	PISUQUIA	PIRCAPAMPA	⇩ 1.17	⇩ 13	0	🔴 25	🔴 2	0
LUYA	PISUQUIA	PISUQUIA	🔴 1.45	⇩ 13	-1	🔴 25	🔴 2	0
LUYA	PISUQUIA	SAN MIGUEL DE PORO PORO	⇩ 1	⇩ 15	0	🔴 45	🔴 2	0
BONGARA	VALERA	COCACHIMBA	🟢 0.35			⇨ 75	🔴 2	1
BONGARA	VALERA	LA COCA	⇧ 0.69	⇩ 15	1	⇨ 65	🔴 2	1
BONGARA	VALERA	NUEVO HORIZONTE	🟢 0.19			🟢 95	⇨ 3	1

System: General_T and SIST_S

🟢 = 'A' / 'Adequate' ⇧ = 'B' / 'With some deficiencies' ⇩ = 'C' / 'With serious limitations' 🔴 = 'D' / 'In decline'

JASS: JASS_T and JASS_S

🟢 = 'B' / 'Adequate' ⇨ = 'C' / 'With limitations' 🔴 = 'A' / 'Deficient'

APPENDIX I: SIASAR SUSTAINABILITY METRICS

Table I.1: Meaning of each component grade (A-D) from SIASAR assessment tool

SIASAR Entity	Grade			
	A	**B**	**C**	**D**
Community	The community has a healthy environment and adequate water and sanitation coverage	Water and sanitation coverage in the community is not complete	The community has serious deficits in water and sanitation coverage	The community has very serious environmental problems and coverage is extremely low
System	The system functions correctly	The system some type of malfunction that the JASS can fix	The system has a serious problem that cannot be repaired by the JASS	The system does not function
JASS	The JASS is well organized and guarantees sustainable service	The JASS is somewhat organized and maintains sustainable service	The JASS doesn't have good organization and is not sustainable	The JASS is inactive and the system is at risk of failure
ATM	The ATM is properly fulfilling their duty and/or has sufficient resources	The ATM is partially active and/or has available resources	The ATM doesn't even fulfill their role and/or lacks resources	The ATM is not functioning and/or does not have any resources

Table I.2: Community score evaluation criteria matrix, from SIASAR assessment tool

Criteria	**Score**			
	4	**3**	**2**	**1**
Potable water coverage	> 80%	65 - 80%	50 - 65%	< 50%
Improved sanitation coverage	> 80%	65 - 80%	50 - 65%	< 50%
ISSA (sustainable water coverage)	> 80%	65 - 80%	50 - 65%	< 50%
Hydraulic flush sanitation coverage	> 80%	65 - 80%	50 - 65%	< 50%
Potable water coverage in public buildings	100%	80 - 100%	50 - 80%	< 50%
Sanitation coverage in public buildings	100%	80 - 100%	50 - 80%	< 50%
Healthy environment	Good	Average	--	Poor
Good hygiene	Good	Average	--	Poor

Table I.3: System score evaluation criteria matrix, from SIASAR assessment tool

Criteria	Score			
	4	**3**	**2**	**1**
Flow	Coverage : Demand ≥ 1.5	1.5 > Coverage : Demand ≥ 1.0	1.0 > Coverage : Demand ≥ 0.8	Coverage : Demand < 0.8
Intake	Good condition	Require maintenance	Require small repairs	Requires construction
Conduction line	Good condition	Require maintenance	Require small repairs	Requires construction
Storage	Good condition	Require maintenance	Require small repairs	Requires construction
Distribution line	Good condition	Require maintenance	Require small repairs	Requires construction
Storage capacity	Capacity ≥ 1.35 Required	1.35 > Capacity ≥ 1.0	1.0 > Capacity ≥ 0.8	Capacity < 0.8
Micro-watershed	No deforestation	Minor deforestation with no impact to system	Normal deforestation with minor impact to system	Severe deforestation and affects system
Residual Chlorine (mg/L)	1.0 ≤ Residual chlorine < 1.5	0.2 ≤ Residual Chlorine	--	Residual chlorine < 0.2

Table I.4: JASS (service provider) score evaluation criteria matrix, from SIASAR assessment tool

Criteria	**Score**			
	4	**3**	**2**	**1**
JASS Management (Points for affirmative response to criteria)	Criteria 1. The JASS is legalized 2. Positions are filled 3. Meet 4 times per 6 months 4. Give accounts	3 criteria met	Two criteria met	One or no criteria met
Tariff (Points for affirmative response to criteria)	Criteria 1. Tariff exists 2. Tariff permits cost recovery 3. Collection-to-billing es greater than 80% 4. Tariff is defined (by consumption)	3 criteria met	Two criteria met	One or no criteria met
Financial durability (Points for affirmative response to criteria)	Criteria 1. Have bank account 2. Keeps financial ledger 3. Income > expenditures	Two criteria met	One criteria met	No criteria met
Attention to Operation and Maintenance (Points for affirmative response to criteria)	Criteria 1. System repair fund is sufficient for the life span of the system 2. Complete corrective and preventative maintenance 3. Have an operator for O&M	Two criteria met	One criteria met	No criteria met
Attention to watershed	Good: Source is clean, reforestation program being executed	Regular: Community is not actively reforesting or protecting the source	Poor: The community has no means of protecting the source	Failure: The community is not doing anything to recuperate source health

Table I.5: ATM (technical support provider) score evaluation criteria matrix, from SIASAR assessment tool

Criteria	Score			
	4	**3**	**2**	**1**
Availability of information	ATM with information about communities in jurisdiction and up-to-date	ATM with information but one year old	ATM with information but older than one year	ATM without information
Community visits in last 12 months	In the last 12 months visited > 90% of communities	In the last 12 months visited between 70% and 90% of communities	In the last 12 months visited between 50% and 70% of communities	In the last 12 months visited less than 50% of communities
Assistance to communities in last 12 months	In the last 12 months monitored water quality in > 90% of communities	In the last 12 months monitored water quality in between 70% and 90% of communities	In the last 12 months monitored water quality in between 50% and 70% of communities	In the last 12 months monitored water quality in less than 50% of communities
Personnel	Average communities per technician < 50	Average communities per technician between 50 and 60	Average number of communities per technician between 60 and 80	Average communities per technician > 80
Transportation capacity	Transportation capacity ≥ Number of technicians	0.5*No. of technicians ≤ Transportation capacity < No. of technicians	0 < Transportation capacity < 0.5*No. of technicians	Transportation capacity = 0
Has:	Has 4 or 3 in good condition	Has 2 of 4in good condition	Has only 1 of 4in good condition	Doesn't have any
1. Water quality monitoring equipment				
2. Computer				
3. Transportation				
4. Printed training materials				
Has:	Yes to all 3	Yes to 2 of 3	Yes to 1 of 3	Yes to 0
1. Annual budget				
2. Funds for travel				
3. Internet connection				

APPENDIX J: RESULTS AND SCORES FROM PRIMARY DATA COLLECTION

Table J.1: SIASAR scoring (community, system, JASS) for six communities included in primary data collection from field research

Criteria	Score					La Peca	Cajaruro	Jazan	Florida	Luya	Leimebamba
	4	3	2	1		Tranquilla	Paraiso	Suyubamba	Carrera	El Molino	Palmira
Potable Water Coverage	>80%	65-80%	50-65%	< 50%		4	4	4	4	4	4
Improved Sanitation Coverage	>80%	65-80%	50-65%	< 50%		1	1	4	4	4	4
ISSA	>80%	65-80%	50-65%	< 50%		3	1	3	3	3	4
Coverage with flush toilets	> 30%	20-30%	10-20%	<10%		1	1	4	4	4	4
Coverage of public buildings with potable water	100%	80-100%	50-80%	<50%		4	4	4	2	4	4
Coverage for publics buildings with improved sanitation	100%	80-100%	50-80%	<50%		4	4	4	4	4	4
Clean environment	Good	Regular		Poor		3	3	3	3	3	4
Healthy hygiene	Good	Regular		Poor		4	3	4	4	4	4
					Average	3	2.625	3.75	3.5	3.75	4
Criteria	Score				Grade	B	B	A	A	A	A
	4	3	2	1							
Flow	4	3	2	1		4	4	4	4	4	4
Intake	4	3	2	1		4	2	2	4	4	4
Conduction Line	4	3	2	1		4	4	4	4	4	4
Storage	4	3	2	1		4	2	4	4	4	4
Distribution Line	4	3	2	1		4	4	3	4	4	4
Storage capacity	4	3	2	1		4	4	4	4	4	4
Micro-watershed	4	3	2	1		2	2	3	3	3	3
Residual Chlorine	4	3	2	1		3	1	1	1	1	1
					Total	29	23	25	28	28	28
Criteria	Score				Grade	A	B	A	A	A	A
	4	3	2	1							
JASS Management	4	3	2	1		3	2	3	4	3	4
Tariff	4	3	2	1		3	2	2	3	3	3
Financial durability	3	2	1	0		3	3	3	3	3	4
Attention to Operation and Maintenance	3	2	1	0		3	4	3	4	3	4
Attention to the watershed	Good	Regular	Poor	Failure		3	2	2	3	3	3
					Average	3	2.6	2.6	3.4	3	3.6
					Grade	B	B	B	B	B	A

Table J.1 (continued)

ISSA = No. Households * System Weight * Provider Weight/Total	ISSA	0.66	0.4356	0.66	0.66	0.66	1
	JASS						
	JASS legalized	1	1	1	1	1	1
	Positions are filled	1	1	1	1	1	1
	Meet 4 times per six months	0	0	0	1	1	1
	Give accounts	1	0	1	1	0	1
	Tariff						
	Tariff exists	1	1	1	1	1	1
	Theoretical tariff covers costs	1	1	1	1	1	1
	Collection > 80%	1	0	0	1	1	1
	Tariff is defined by consumption	0	0	0	0	0	0
	Durability						
	Have bank account	0	0	0	0	0	1
	Keep accounts	1	1	1	1	1	1
	Income > Expenditure	1	1	1	1	1	1
	O&M						
	Sufficient funds to cover the lifespan	1	1	0	1	0	1
	Corrective and Preventative Maintenance	1	1	1	1	1	1
	Have operator	0	1	1	1	1	1
	No. Households	63 househol	36	233	192	35	268
	Tariff	2 soles	4 soles	2	2	4	4
	Year Built	1997	2003	1999	2016	2015	2013

J.1 Bivariate Correlation Analysis

Using IBM SPSS Statistics 23 the bivariate correlation analysis was performed to find the Pearson correlation coefficient. The correlation was found between the ATM score and the community score, system score, and JASS score using data from each of the six communities included in the field research of this thesis. The results can be found in Table H.2. Values range from +1 to -1, with a +1 indicating a total positive correlation, 0 indicating no correlation, and -1 indicating a total negative correlation. The hypothesis that was tested was that the ATM score would have a positive correlation with the other scores. On the contrary, the results show a negative relationship for each of the scores. The high significance values ($p > 0.05$) indicate that the results are not statistically significant.

Table J.2: Results from bivariate correlation analysis between ATM score and related scores for six communities from field research

	ATM Score	
	Pearson correlation	Sig. (2-tailed)
Community Score	-0.551	0.258
System Score	-0.126	0.812
JASS Score	-0.493	0.321

In order to compare with a larger sample size the data from the Trazadores tool was also analyzed using a bivariate correlation technique. In this case, the ATM score was tested with the average general score for all communities in the district, the average JASS score for all communities in the district and the maximum JASS score in each district. From this analysis the average general score shows a negative correlation with the ATM score, which was not expected. However, with both the average JASS score and maximum JASS score the ATM score had a positive, albeit insignificant, correlation.

Table J.3: Results from bivariate correlation analysis between ATM score and related scores for districts in Trazadores data

	ATM Score	
	Pearson's correlation	Sig. (2-tailed)
Avg. General Score	-0.281	0.31
Avg. JASS Score	0.258	0.353
Max. JASS Score	0.369	0.177

ABOUT THE AUTHOR

Jacob Mangum graduated from the University of Notre Dame with a Bachelor of Science degree in Civil Engineering. He simultaneously graduated from Bethel College (Indiana) with a Bachelor of Science degree in Math/Physics as part of a cooperative degree program between Bethel College and Notre Dame. After completing his coursework for his Master's degree at the University of South Florida he served for three years as a U.S. Peace Corps Volunteer in Peru before returning to USF to finish his thesis. He spent two years in the 'eyebrow of the jungle' region of Peru working as a Water, Sanitation, and Hygiene Engineer in a town of 1,500 people. After that, he spent a year in the capital, Lima, helping to train new WASH volunteers as well as consulting for a non-governmental organization based in Lima.

Originally from metro-Detroit, Michigan, Jacob is an avid Detroit sports fan. He also enjoys the outdoors and spending time in the kitchen practicing culinary skills.