Using Louis-Ostrom Comprehensive Capacity Assessment to Analyze Domestic Water Infrastructure in Nalgonda District, Andhra Pradesh, India.

A Thesis

Presented to

the faculty of the School of Engineering and Applied Science

University of Virginia

in partial fulfillment

of the requirements for the degree

Master of Science

by

Siddhartha Pailla

May

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APPROVAL SHEET

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AUTHOR

The thesis has been read and approved by the examining committee:

Garrick E. Louis

Advisor

Gerard P. Learmonth, Sr.

Timothy Beatley

Accepted for the School of Engineering and Applied Science:

Dean, School of Engineering and Applied Science

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Author:	Siddhartha Pailla (SIE)	______________________

This thesis has been read and approved by the examining Committee:

Committee Chair:	Gerard Learmonth, Jr. (SIE)	______________________
Thesis Advisor:	Garrick Louis (SIE)	______________________
Member:	Timothy Beatley (Architecture)	______________________

Accepted for the School of Engineering and Applied Science:

Dean:	James Aylor	______________________

Abstract

Access to safe domestic water supply remains a challenge in much of Rural India. The Nalgonda District in Andhra Pradesh, India has been addressing this challenge through provision of centralized water supply services (CPWSS), groundwater pumps and overhead reservoirs (PWSS), and rainwater harvesting schemes (PWS). Although Indian federal law decrees participation of the Panchayati Raj in water-related issues, there is currently no clear process for assessing and communicating local situation to District and State-level institutional leaders. As such, this limited knowledge has led decision-makers to select "shotgun"-type (generally targeted, high-cost, high-impact) solutions; specifically in Nalgonda, large-scale centralized water systems such as the Alimenti Madhava Reddy Water Irrigation Project. This approach may be appropriate for high-capacity communities; however, previous research by Hardin, Louis, Ostrom, Maton, Rogers, and other developing systems-focused researchers indicates that community-specific assessment and policy increases communal ownership and system realization.

This research introduces a participatory, comprehensive, and intra-institutional framework for considering domestic water-related technological solutions. The author first conducts a general feasibility study for Nalgonda's domestic water supply in meeting WHO's 40 lpcd requirement. Then, the author creates a hybrid framework that combines localized Capacity Factors Analysis (CFA) methodology and larger governance-specific Ostrom's framework for assessing socio-ecological systems (SESs). The Louis-Ostrom Comprehensive Capacity Assessment (LOCCA) tool is then used to consider the three major technological solutions currently being used in Nalgonda: CPWSS, PWSS, and RHS. Results indicate that CPWSS may be appropriate for a sub-section of the District, but RHS have a better likelihood of success in more rural communities of Nalgonda.

Acknowledgements

I would like to thank my parents, first and foremost, for unwavering support of what some may call a naïve but noble goal. Additionally, I would like to thank the incredible hospitality, guidance, and resources of the Chilumala family for my summer stay in Hyderabad, which made this research possible. I would also like to thank all of the families that had hosted me in their homes while I traveled across Nalgonda: your hearts are as warm as your meals, and I could not be more grateful.

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To the many engineers, social workers, health officers, media, and elected officials working to better the water services in Nalgonda, I would like to thank you for your invaluable insight and survey, without whom this research would not be possible, and for your continued service to the community. To my cousins and my driver that kept me safe through the trip and participated with me in engaging the officers and community members, thank you.

Finally, to all of my friends with your bottomless faith, I would not have had the physical or mental energy to initiate and follow through with my research without you. You believed in me when I said I can make a difference, and your vote of confidence has made that dream a reality.

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Chapter 1: Research Background and Problem Definition

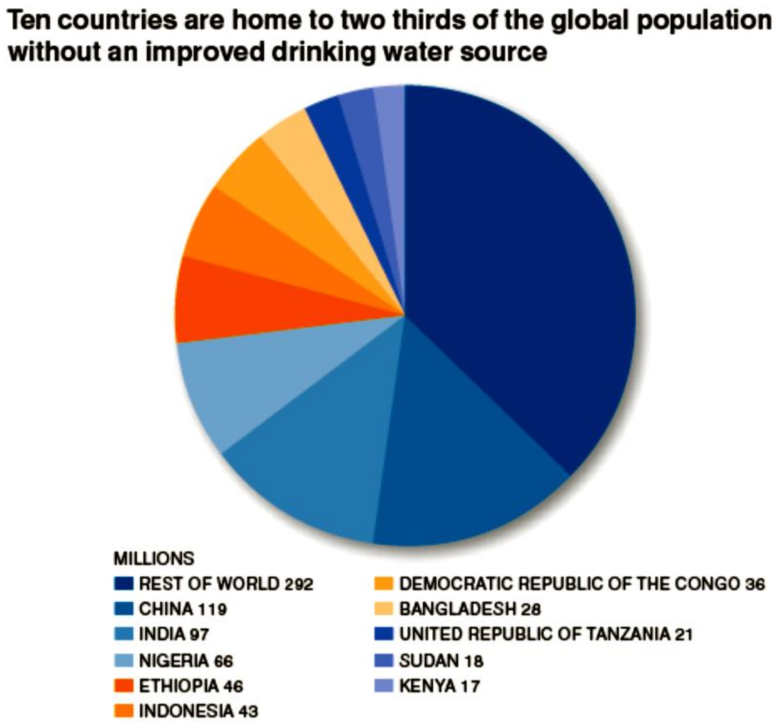

Figure 1: According the Joint Monitoring Programme (JMP) report from 2012, there are still 783 million people in the world without access to approved drinking water supply. Moreover, citizens of India and China represent over a quarter of those without access (JMP 2012).

At the turn of the millennium, leaders of the United Nations pledged to better the world and collaborated to create the Millennium Development Goals (MDG). Among the agreed upon objectives of addressing problems such as poverty, hunger, and equity, Target C of Goal 7 of the MDGs focused on ensuring environmental sustainability with an objective of "halving, by 2015, the proportion of the population without sustainable access to safe drinking water and basic sanitation" (United Nations Millennium Development Goals Report, 2009). According to the United Nations' Children Fund (UNICEF) and World Health Organization (WHO)'s Joint Monitoring Programme (JMP), approximately 783 million people in the world do not have access to improved water supply. Geographically, nearly one in three people in every continent live in an area that faces immediate and predicted water scarcity, which may be defined generally as the inability for a region's water supply to meet its demands. Even a region with vast supply of water may still fall vulnerable to poor water quality, water and wastewater management, or too much demand.

1.1 Community Assessment for Water-related Technology Solutions as Risk Assessment of Water Scarcity

Alexander Müller (2006) defines water scarcity as "the point in space, or the moment in time, at which the aggregated impact of all users impinges on the supply or quality of water, under the prevailing institutional arrangements, to the extent that the total demand by all sectors, including the environment, cannot be fully satisfied." When considering Müller's definition, one can expect that decision-makers consider the key relevant factors, including – supply, demand, institutional arrangements, quality, climate change, and ecology. However, what is not explicitly stated is the aggregated effects of these factors. For the purpose of this paper, this aggregation is considered as not just the sum of the impact by sets of users, but also impacts of interactions between subsystems. It is thus imperative that institutional leaders consider the aggregated impact in order to mitigate the risk of the event of water scarcity. Otherwise, the consequences associated with water scarcity may be significantly underestimated leading to inappropriate policies to manage their associated risks.

In that sense, one can consider that holistic assessment of communities' capabilities to adopt technological policy or solutions as risk assessment of the event of water scarcity. Several methodologies have been proposed to lower, or at least understand, the risk of failure of water-related systems, and most of these are proactive.

For example, WHO and UNICEF use the Rapid Assessment of Drinking Water Quality, which focuses specifically on source and quality, rather than quantity. The World Bank (WB) uses Demand Responsive Approach (DRA) and Methodology for Participatory Assessment (MPA). These approaches consider water demands and equip regional governments with the resources to provide appropriate supply, accounting for the regional governments' preference and WB's recommendation. Yet another evaluative methodology is the Social-Ecological System Assessment, which focuses on qualitative measurements of multiple different indicators of different subsystems in a large, complex social-ecological system (SES). Finally, Capacity Factors Analysis is another methodology that is used to match different technological solutions with the localized community's particular capabilities.

Given the availability of a variety of risk assessment and appropriate technology recommendation tools, where does the need arise? Specifically, there are three issues. First, the assessments are not comprehensive enough, as discussed earlier with regards to Müller's definition of water scarcity. Second, the assessment tools are not participatory of relevant stakeholders, as shall be discussed here. And third, the assessment tools are not designed for transfer of knowledge from one institutional level to the other; this shall also be discussed later.

What does participatory mean? While tools exist for assessment and analysis of water-related systems, they exist in a primarily consultative capacity; that is, they are framed such that a third-party meets the relevant stakeholders in order to have an idea of what a community's demand and capacity may be, and then that party recommends a solution with a matching supply. While elements of these methodologies do give some agency to any particular community, Maton (2008) suggests that the continuous and iterative participation of stakeholders throughout the development process better serves to empower and retain ownership of that community and its development. Almost all studies focused on building in developing communities signify ownership and agency as correlative indicators of a project's success or failure (Maton and Salem, 1995). As such, any design or policy methodology should try to focus on including the collective stakeholder groups throughout the process.

Thirdly, the assessment should also account for, or at the least allow for, transferability of knowledge between different institutional levels. This knowledge must transcend the typical demographic, geographic, geological, and assets data, all of which are already recorded and reported each year in the district Statistics Handbook. In order to understand why this transferability is important, one must first understand the institutional structure in the state of Andhra Pradesh (it is slightly different from other states in India). The rural governance works under the Panchayati Raj system, which has three institutional levels. At the bottom is the Gram Panchayat, which leads a small group (typically 1-4) villages or habitations. The middle level is the Mandal Praja Parishad, which leads a set (typically 10-25) of Gram Panchayats. The top level is the Zilla Parishad, which oversees all Mandals in the district. The institutional structure is displayed in the figure below.

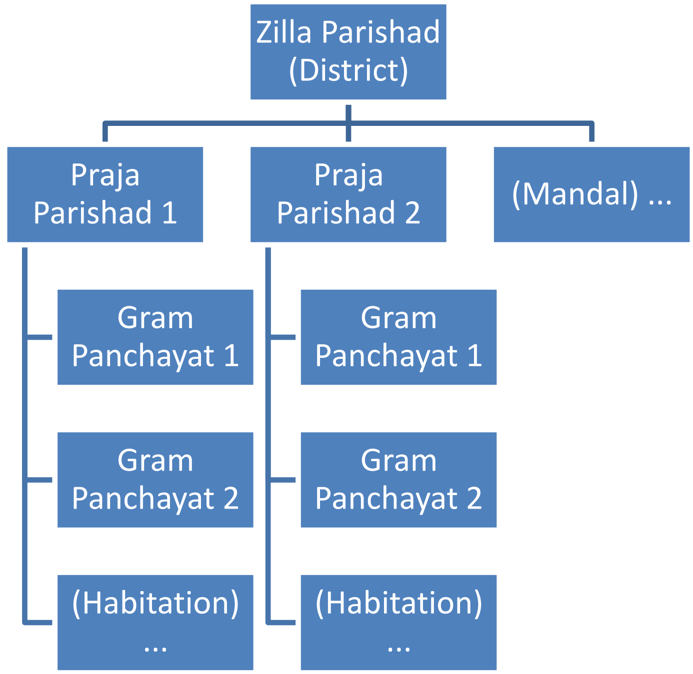

Figure 2: Panchayati Raj governance structure in Nalgonda.

Nalgonda has 3 million citizens across 59 mandals and 3,357 habitations. In an area that already faces severe physical water scarcity, the provision of 40 lpcd to over 3 million citizens becomes a difficult task. Rather than working across institutional levels or across different institutional groups to form well-informed alternatives, the current Nalgonda governance divides the goal of water supply onto the three institutional levels. **Zilla parishad**, through its **Department of Rural Water Supply (RWS) Services**, helps to design and contract out centralized water supply systems dubbed as Comprehensive Protected Water Supply (CPWS). RWS Services also designs and contracts out groundwater pump and reservoir systems dubbed Protected Water Supply (PWS) construction for individual villages. **Mandal praja parishad** oversees the maintenance of hand pumps in the respective mandal. The individual gram panchayats operate and maintain their PWS after construction, if they have one.

Two things happen during this mechanical division of labor. First, there is very little information flow, outside of the items aforementioned, between the institutional levels. Venkataswarulu, an Executive Engineer in RWS in charge of mandals in the north half of Nalgonda, notes that the department is typically only acutely aware of current construction projects and the CPWS systems. Otherwise, the status, much less the proper operation or maintenance, of PWS services or hand pumps, mechanisms that deliver water to over two-thirds of the district, is recorded bi-annually unless there is a complaint (2010). Second, decision-makers cannot make informed decision without this upwards information flow. Much like how the brain needs heat receptors to process whether a certain substance is hot or not and act accordingly, so do the different governances need equivalent receptors to assess capacity and demand to act properly. If a certain community is unable to maintain a PWS, the chances are lower that it will be able to operate and maintain a segment of CPWS.

It is clear that a more comprehensive, participatory, and intra-institutional risk assessment strategy be employed for effective management of domestic water supply services. Before proposing such a strategy, Nalgonda's current situation will be explored.

1.2 Water Issues in Nalgonda

Nalgonda is a rural district that lies east of Hyderabad, the capital city of the state of Andhra Pradesh, India. It is home to over 3 million Indians, as of 2010. Nalgonda has a range of water issues that can be broken up into three categories: water quantity, water quality, and management of water infrastructure. The district faces a seasonal water scarcity crisis; nearly two-thirds of the rainfall occurs during the monsoon season. This often leads to seasonal rivers and causes minimal reliance on surface water as a steady source for drinking water supply. Most people in the area rely on groundwater as means of drinking water supply and surface water for agricultural purposes.

Furthermore, the district's geological features of limestone and clay sediment inhibit percolation of rain into the groundwater aquifers. With the innovations in groundwater technology over the past 50 years in South India, the digging of bore wells has become economical; as a result, dependence on groundwater for both irrigational and domestic uses has risen sharply. Unfortunately, this rise in demand as demonstrated by nearly 110,000 dug wells (M.K. Rafiuddin 2007) has continually exceeded the groundwater regeneration rate, and thus is beholden to sharp drops in groundwater levels across arid regions of South India including the district of Nalgonda. Of the 59 mandals, only 27 were qualified as "safe" for development; that is, that mandal has not exceeded drawing more than 70% of its net available resource. 25 mandals were qualified as "semi-critical" (70-90% use), 4 mandals were qualified as "critical" (90-100% use), and 3 mandals were qualified as over-exploited (>100%). Furthermore, the State Ground Water Authority issued notices for restricted development to 367 villages in 2005. Rafiuddin comments in the same groundwater report that, "Ever-declining ground water levels as a result of frequent dry spells and indiscreet sinking of bore wells, the ground water resources have been depleting and pushing the ground water scenario to the point of no return" (2007).

Figure 3: 25 meter irrigation and drinking water open well in Sunkishala, Voligonda Mandal, Nalgonda District. The water level estimates have dropped from 20m bgl (below ground level) during the dry season in 1995 to more than 24m bgl in the dry season of 2010. Wet season levels were approximately 10m bgl in 1995 and 18m bgl in 2010. Source: Bal Reddy, Farm Head Caretaker in Sunkishala.

Additionally, the decline in groundwater levels has increased fluoride concentration and further aggravated the already-existing fluorosis issue in the Nalgonda region. Consider Figure 3, which demonstrates the link between lower groundwater levels and higher fluoride levels in the district of Nalgonda, particularly looking at the Deverkonda mandal area (Brindha et al, 2011). The authors suggest that heavy agriculture quickens weathering of rock, which in turn contributes to leaching of fluoride-based minerals. Furthermore, groundwater evaporation is also a contributor, as the pattern may be seen in Figure 3. High fluoride concentration raises a significant health issue—dental and skeletal fluorosis causes permanent, severe degradation and deformation of bone structures in the body. Though there is no official census figure of how many people suffer from these conditions, the most recent water report from WaterSoft (2011), in a collaborative effort between the National Informatics Centre and Rural Water Supply Sector of the Government of Andhra Pradesh, states that 80,047 (or 2.6% of the district's population) citizens do not have access to safe water. Public voice groups such as Nalgonda.org suggest that the number may be much higher.

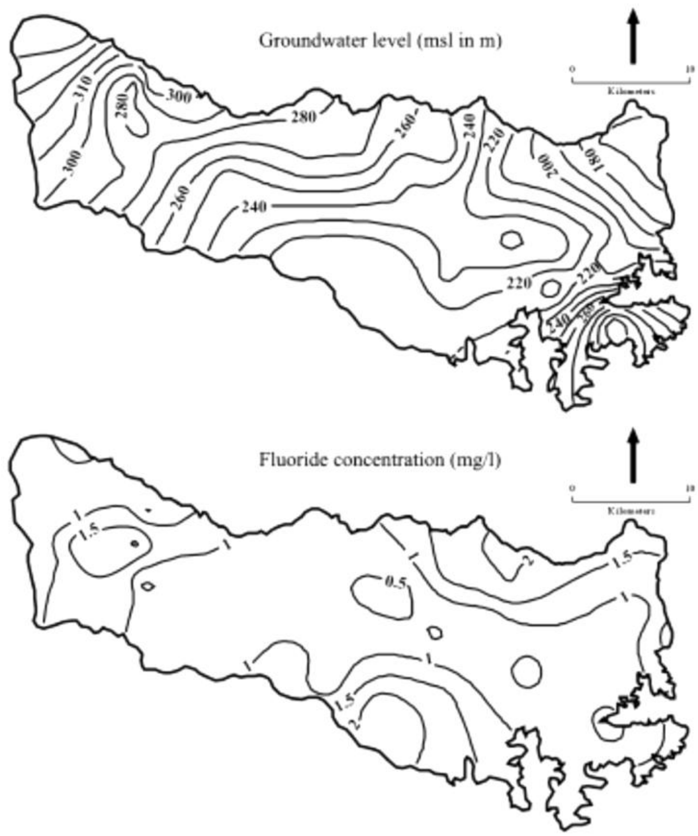

Figure 4: Link between groundwater level (above) and fluoride levels (below) in Deverkonda mandal. Notice how the topographical maps are similar. Brindha et al. (2011) suggest that the evaporation of groundwater and weathering of rock contribute to the high fluoride levels in the groundwater.

Another important public health consequence of Nalgonda's water supply to consider is the correlation between suicides and areas of lower groundwater levels, as presented in Figure 4 (Rafiuddin 2007). Brindha et al. (2011), Rafiuddin (2007), Suresh (2010), Venkataswarulu (2010), and other sources note the heavy emotional burden families feel during poor agricultural output, especially when combined with additional health problems that come with fluorosis in their children. Consider the following open letter from family and friends of victims of water-related deaths in Nalgonda written to the District and State government; the undersigned describe their troubles:

> "If you stumbled on this message that hangs in space for the next millennium, you already most likely know about our plight. Our bones are brittle, our teeth come in color, we seem to age faster and our babies do not have normal childhood - all works out to a different life style. All of this we owe it to [Fluoride]. We also owe it to several successive central and state administrations, local and other leaders that conveniently forgot about our drinking water problems… [Undersigned] – The People of Fluorine Effected Villages in Nalgonda District." - (Nalgonda.org, 2001).

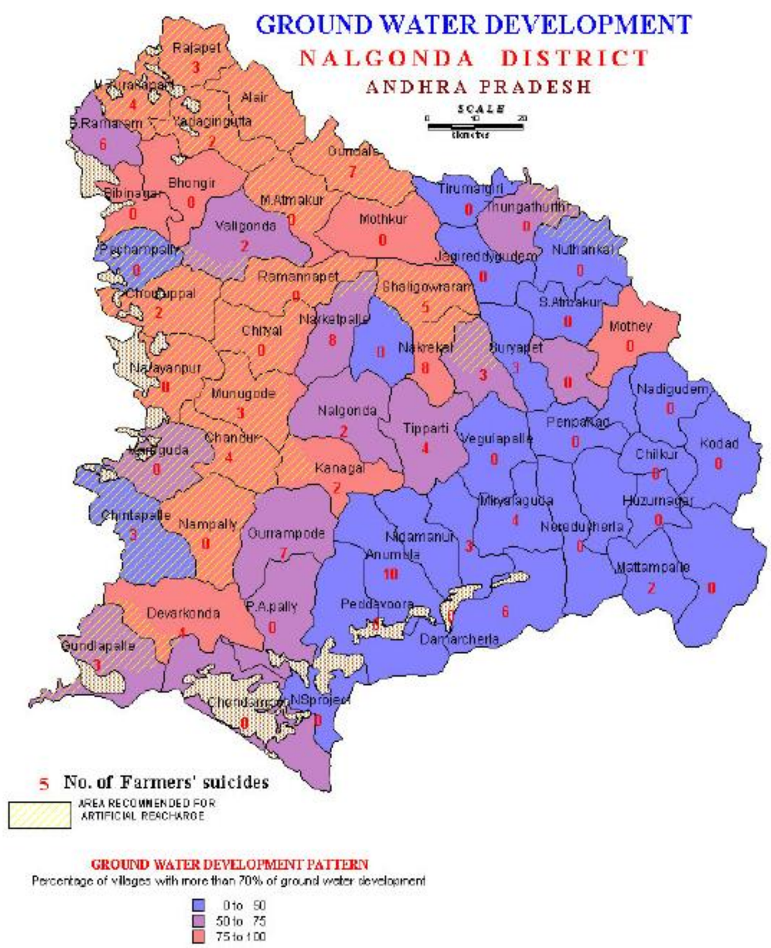

Figure 5: Number of farmers committing suicides by geographic area and ground water development.

In order to address the current water supply problems, the state and district government, with the aid of the World Bank, is attempting to tackle both domestic and agro-economic water demands on a large scale through the implementation of Alimineti Madhava Reddy (AMR) Lift Irrigation Scheme. The irrigation project, which RWS regards as a CPWS service, lifts water up 150 meters from the regional Nagarjuna Sagar Dam and feeds into a large, elevated reservoir; from there, the water travels via gravity and canal to a third of Nalgonda's habitations. Some of this water is treated at one of three water treatment facilities, and is then distributed as treated domestic water via gravity to western and central Nalgonda. Currently providing to over 900 villages, the Department of Rural Water Services hopes to expand provision to the remaining villages by 2020 (Venkataswarulu, 2010).

While these services are implemented with the intention of providing affected citizens with at least 40 lpcd of domestic water, they are currently falling short in many areas. Three main issues have inhibited this centralized framework from working. First, the long and sometimes-exposed pipelines have been subject to breakdown due to poor-quality work by the contractor or lack of coordination with other construction projects, such as sewage and electrical lines. One often finds many of the roads dug up to repair the underground clean water pipe-bursts. Second, the maintenance structure at the point-of-use has been inconsistent and unreliable due to lack of ownership and proper education. Even if members of a community are willing, socio-cultural factors such as gender, caste, and status have led to corruption. Finally, water rights and damming practices have caused severe political rift between habitations, mandals, districts, regions, and even states. Given that Nalgonda's primary economy is agricultural, the political paradigm must balance water delivery across the district, often falling susceptible to corruption. For example, Chilkamarry is a small village along the AMR CPWS pipeline that does not receive water due to political favoring of a different part of the mandal. The habitation receives less than 20 lpcd because the pipeline currently bypasses the community. This balancing act has been a leading factor in the state's political instability, causing constant revolt in the northwest region including Nalgonda to secede Andhra Pradesh to form a new state called Telangana.

The regional government has assumed that a centralized water distribution infrastructure, a "shotgun" solution, is best for supplying and maintaining quality of the domestic water to the most people. Though that assumption may be valid in other social-ecological systems, Nalgonda's current capacity limit inhibits rapid and expansive technological progress of domestic water supply (Suresh 2010, Venkataswarulu 2010). Rather than assuming and investing predominantly in a large-scale, centralized system, the decision-makers may be better served if they were to consider alternatives that have already worked in the district, such as community-led defluoridation plants or roof-based rainwater harvesting schemes. Before the consideration may even take place, the institutional structure must be aligned to receive, process, and build on collective capacity and social-ecological data. Specifically, there must be a mechanism for communication of information between institutional levels such that the district government may choose between several alternatives rather than choosing the most advanced technology available. While engineering feats such as the AMR Project are admirable, citizens may be better served by the technologies that best fit their capacity (Vollan, Ostrom 2009).

1.3 Water and Sanitation as Interrelated Issues

Figure 6: Lack of maintenance on the wastewater aqueduct in Chilkamari Gram Panchayat, P.A.Pally Mandal.

Figure 7: Drinking water tap next to the clogged wastewater aqueduct in Chilkamari Gram Panchayat, P.A.Pally Mandal.

Domestic water supply is not the only service affecting the health of citizens in Nalgonda, or India in general. Furthermore, South Asia ranks as the second lowest region by percentage in terms of sanitation coverage based on a WHO-UNICEF Report in 2006. A recent survey (2009) by the district's Rural Water and Sanitation Services unit finds that over 77% of the households in Nalgonda do not have a toilet, much less an Individual Sanitary Latrine (an improved toilet). Improper sanitation practices, such as open defecation, increases the chances of water contamination that may lead to water- and sanitation-related illnesses such as acute watery diarrhea (AWD), dysentery, and persistent diarrhea, such as giardia (Institute for One World Health, 2004). According to the UN-Water Global Annual Assessment (2010), "unsafe water, inadequate sanitation, or insufficient hygiene" account for 88% of all cases of diarrheal diseases worldwide. Further, the same report asserts, "the impact of diarrheal diseases on children is greater than the combined impact of HIV/AIDS, tuberculosis, and malaria" (2010). The report also cites a WHO study from 2008 that estimates a reduction of 2.2 million deaths of children worldwide per year given improved water and sanitation services.

Water and sanitation are interdependent issues. The primary task of domestic water unit operations is to deliver clean, i.e. without biological, heavy metal, or mineral contamination, water for drinking, cooking, and hygiene. However, if proper hygiene is not followed, the filtration and treatment of water will have been for nothing. Thus, hygiene and sanitation are equally as important in maintaining the quality of the water product for the betterment of human health. With respect to Nalgonda, even without the fluoride crisis, poor sanitation has led to several thousands of cases of diarrheal diseases and malaria. While this research does not consider paired solutions, it acknowledges the importance of sanitation-related education in rural communities as a priority in realizing a healthier society (JMP 2012).

1.4 Problem Definition – Improving Assessment for more Informed Decisions

While several institutions work hard to assess systems needs and provide appropriate services, a comprehensive, participatory, and intra-institutionally integrated assessment and decision-support tool is missing from the process. As such, policymakers are forced to take decisions from raw data, general constituent petitions, and corporate lobbyists. The results of such decisions do not necessarily meet the needs it tries to address due to a lack of specificity and lack of communication across different service providers, communities-in-need, and governance institutions.

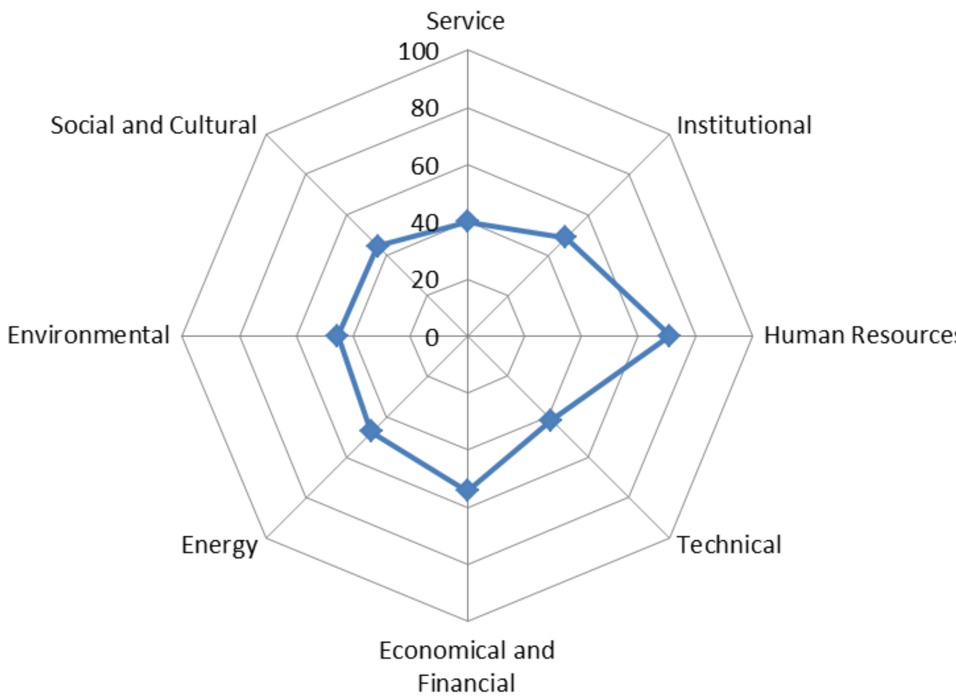

Figure 8: Initial Community Capacity Assessment of Nalgonda conducted with RWS Executive Engineer, D. Venkataswarulu (2010), and Assistant Engineer, Kandukuri Suresh (2010). Assessment in Appendix I.

It has been demonstrated that holistic information is not reason enough to invest in large-scale solutions (Vollan, Ostrom 2009). Above, a high-level Capacity Factors Analysis Methodology's Community Capacity Assessment of Nalgonda District is used to consider further the decision to implement large-scale infrastructure as supposed to localized infrastructure. Capacity Factors Analysis (CFA) decision-making methodology delivers a hierarchical holographic method of identifying areas for improvement and provides a quantitative capacity assessment of the community and used technologies. Further description of the CFA methodology itself is presented in Chapter 3. For the purpose of problem description, a preliminary community capacity assessment is conducted with the assistance of RWS engineers Kandikuri Suresh and D. Venkataswarulu (2010). As shown below in Figure 9, the preliminary results indicate that the Nalgonda district has a low-to-mid level capacity, an initial indicator that complicated alternatives, such as the AMR Project, that require high level capacity may fall outside of the district's management capacity, thereby increasing risk of system failures.

Table 1: RWS-highlighted failure events with corresponding domestic water supply service (Suresh 2010, Venkataswarulu 2010).

Events	Likelihood	Consequences
CPWS	**CPWS**	**CPWS**
1. Pipe bursts	1. Likely	1. Water service interruption (3-7 days)
2. Water contamination	2. Very Unlikely	2. Diarrheal disease outbreak (20% rise in cases)
3. Stealing/encroachment	3. Very likely	3. Pressure head loss, distribution problems
4. Alt Service interruption	4. Seldom	4. Water service interruption (1-2 months), contamination
5. Energy outage	5. Likely	5. Water service int, pressure loss
PWS	**PWS**	**PWS**
1. Energy outage	1. Likely	1. Water service int (1-4 days)
2. Groundwater contamination	2. Area-dependent	2. Fluorosis incidences
3. Reservoir contamination	3. Seldom	3. Diarrheal disease outbreak (10% rise)
4. Motor breakdown	4. Seldom	4. Water service int (1-2 weeks)
5. Operation failure	5. Likely, varied	5. Water service interruption, possible marginalization
Hand pumps	**Hand pumps**	**Hand pumps**
1. Dry well	1. Area- dependent	1. Investment in borewell drilling, possible increased distance for carrying water
2. Pump breakdown	2. Seldom	2. Water service int (2-3 weeks)
3. Groundwater contamination	3. Area-dependent	3. Fluorosis incidences

What does system failure mean in this case? With the help of the RWS Department, Table 1 was generated and shows failure events and their respective likelihoods and consequences. The events are broken into three categories, each corresponding with CPWS, PWS, or hand pumps. For the purposes of brevity, only the RWS-highlighted events are provided. Several observations may be drawn from the failure events listed in Table 1. The most dramatic consequences are water service interruption for lengthy periods, incidences of fluorosis, and incidences of diarrheal diseases. The most likely events correspond with some length of water service interruption. In addition to the above technology-specific failure events, systemic failure events are also present, such as regional drought. How well each technology responds to its respective failure event depends not just on the technology, but also the stakeholders that operate and maintain the technology. The greater the gap between a technology's required capacity and a community's current capacity, the greater the risk for a failure event such as one highlighted above. The problem, thus, is not what the technology is capable of, but what the community is capable of doing with any respective technology. It is this resonance that fosters a sustainable social-ecological-technological relationship.

The author's research considers this resonance, and hypothesizes that decision-makers are better able to meet communities' demands against the backdrop of resource limitations if they are to employ a *comprehensive, participatory, and intra-institutional assessment framework*. With such a tool, decision-makers will be able to better make informed decisions. This systemic perspective may not alter the final decision itself, but may provide a path for better risk management of failure events such as those aforementioned.

Chapter 2: Research Relevance, Motivation, and Goal

2.1 Water Scarcity around the World

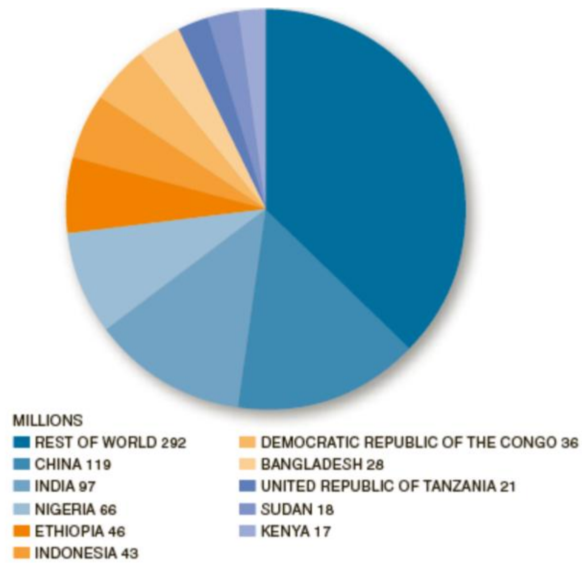

Figure 9: Breakdown of the remaining 783 million people without improved access to water by country. India ranks second with 97.1 million people with improved access to water (Joint Monitoring Programme 2012 report).

Louis (2002) defines basic human services as “those absolutely necessary for human survival,” and further identifies them as water, food, sanitation, clean air, household energy, proper shelter, and personal security. These services are interdependent and correlate positively to the standard of living in communities across the world; and several case studies (Hardin 1968; Ostrom; Louis; Bouabid 2004; Henriques 2009; Yamakoshi 2008) note that the services cannot be just provided at one instant time, but rather continuously and sustainably. As noted in Chapter 1, India ranks second highest in those with without access to improved access to water supply. The United Nations (UN) and World Health Organization (WHO), in concurrence with other non-governmental organizations (NGOs), defined guidelines (see Table 2) for acceptable access to drinking water and sanitation, dubbed “improved drinking water sources” and “improved sanitation facilities.”

Table 2: Definition of Improved Drinking Water Sources and Improved Sanitation Facilities

Drinking Water Guidelines	Sanitation Guidelines
Improved Drinking Water Sources	**Improved Sanitation Facilities** [b]

• Piped water into dwelling, plot or yard
• Public tap/standpipe
• Tubewell/borehole
• Protected dug well
• Protected spring
• Rainwater collection
	• Flush or pour-flush to:
	  • Piped sewer system
	  • Septic tank
	  • Pit latrine
	• Ventilated improved pit latrine
	• Pit latrine with lab
	• Composting toilet

Unimproved Drinking Water Sources	**Unimproved Sanitation Facilities**
• Unprotected dug well • Unprotected spring • Cart with small tank/drum • Bottled water [a] • Tanker-truck • Surface water (river, dam, lake, pond, stream, canal, irrigation channels)	• Flush or pour-flush to elsewhere • Pit latrine without slab or open pit • Bucket • Hanging toilet or hanging latrine • No facilities or bush or field

[a] Bottled water is considered improved only when the household uses water from an improved source for cooking and personal hygiene.

[b] Only facilities which are not shared or are not public are considered improved.

[c] Excreta are flushed to the street, yard or plot, open sewer, a ditch, a drainage way or other location

Even with access to improved drinking water sources, significant risks in drinking quality still exist with untreated water from protected wells, boreholes, or springs. For example, a well-covered groundwater well may still be susceptible to heavy metal or nitrogenous contaminants. Piped water supply systems are low risk in terms of exposure to poor water quality and water-borne illnesses. Diseases or illnesses that result from unsafe drinking water include, but not are limited to diarrhea, ascaris, dracunucliasis, hookworm, schistosomiasis, fluorosis, and trachoma. Consequences of illnesses include loss of productivity, paralysis, blindness, weakening of the immune system, bone and teeth decay, and even death.

As such, piped water supply ensures the most standard drinking water supply quality across the village as well as an easy venue for proper maintenance, ensuring a step towards a sustainable infrastructure. Unfortunately, only 20% of the Southern Asian population has access to a piped water system, even though 80% of the regional population has access to improved drinking water sources. This additional challenge of addressing not only general access, but also a sustainable and proper means of doing so, must also be considered. The following figure from the WHO-UNICEF report outlines the improvement in drinking water and sanitation coverage in India.

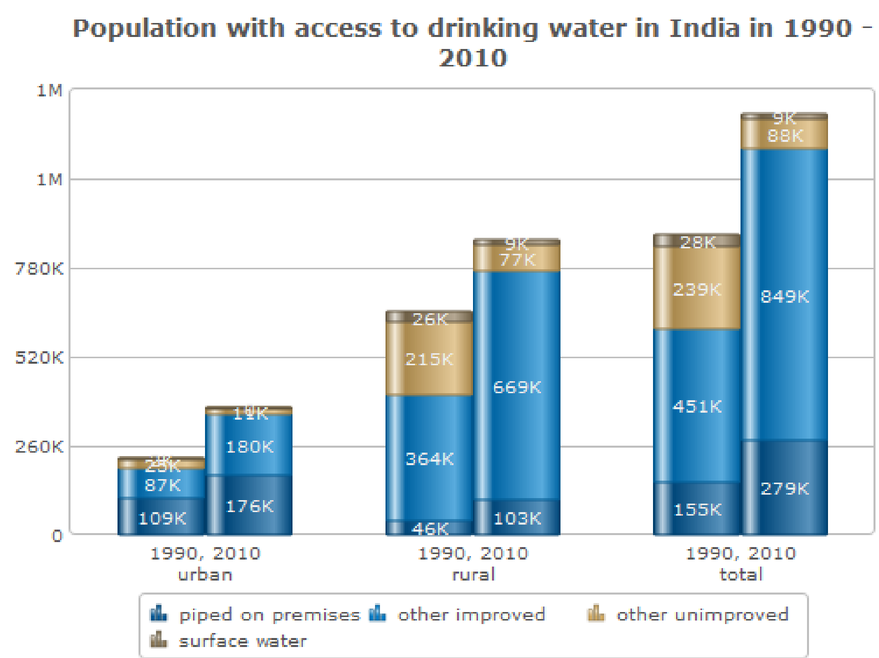

Figure 10: Drinking water coverage in India. Note that the blocks are in thousands, so a K on the bar graph denotes 1 million people. Source: JMP Report 2012

2.2 Background on Nalgonda and its Current Water Condition

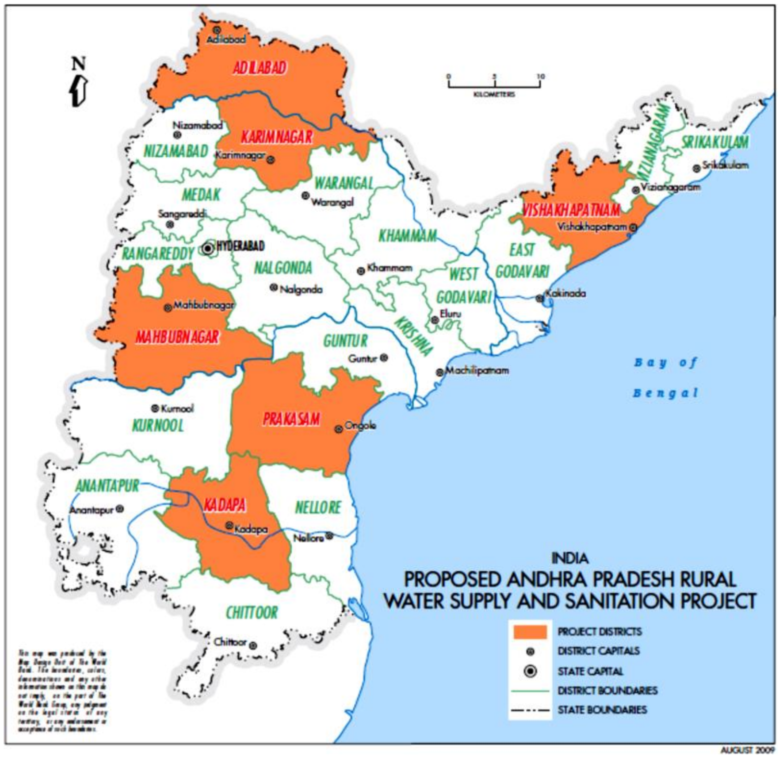

Figure 11: Map of Andhra Pradesh with World Bank's proposed rural water supply and sanitation project. Nalgonda is located next to the state capital (World Bank, 2009).

To better understand the district of Nalgonda, the general status of the state of Andhra Pradesh, shown in Figure 12, must be considered. The state itself has a rural population of 56.3 million out of a total 84.6 million people (Census of India, 2011). As per the standards described above by the UN Development Programme and WHO, a recent Andhra Pradesh Rural Water Supply report notes that 54.8% of the habitations in the state have 100% coverage, implying that all people in those villages have access to 40 liters per capita daily (lpcd) located within a 1.6 km and 100m from the center of the respective village. This also indicates that 45.2% do not have full coverage, and that breakdown is shown in Table 2. The WHO designates three statuses to villages and communities regarding their access to water: fully covered (FC) implies that the above criteria have been satisfied, partially covered (PC) implies that at least one of the criteria has been satisfied or certain water quality issues may exist, and not covered implies that the criteria have not been met at all.

Table 3: Water coverage in Andhra Pradesh by number and percent of habitations in each quartile of coverage

% of Population Coverage	# of Habitations	% of Habitations
0	1,222	1.70%
1-25	4,347	6.04%
26-50	7,802	10.84%
51-75	9,517	13.22%
76-99	9,615	13.36%
100	39,478	54.85%
Total	71,981	100.00%

About 75% of rural water comes from groundwater wells, which due to rapid population and economic growth in demand as wells as periodic droughts have become over-exploited (Rafiuddin, 2007). Over half of the mandals in Nalgonda are characterized as semi-critical, critical, or over-exploited in ground water development status. Rural villages depend on single or multiple village schemes for an organized structure to receive water. Ideal service includes piped water supply and household connections; however, the access needs to be sustainable. Over 20% of the Single Village Schemes (SVS) and Multi-Village Schemes (MVS) are currently "not fully operational and require rehabilitation or augmentation" according to an analysis recently conducted by the World Bank (World Bank 2007). The study cites lack of funds, institutional structure, and technical expertise as reasons for breakdown.

The above trends are common across the districts that constitute the State of Andhra Pradesh, but each district also has its own issues. The District of Nalgonda in

Andhra Pradesh, India is located immediately east of the state's capital, Hyderabad. The district, shown in Figure 13, has a population of above 3.48 million persons spread across 59 Mandals, 1175 Gram Panchayats, and 3,385 state-approved habitations (towns and villages). A small group of towns and villages make up a Gram Panchayat, and several tax-paying Gram Panchayats constitute a Mandal. The two prime drivers of the district's economy are its agriculture and mineral mining. Nalgonda's rural population as per the 2011 Census was approximately 86% of the total district population.

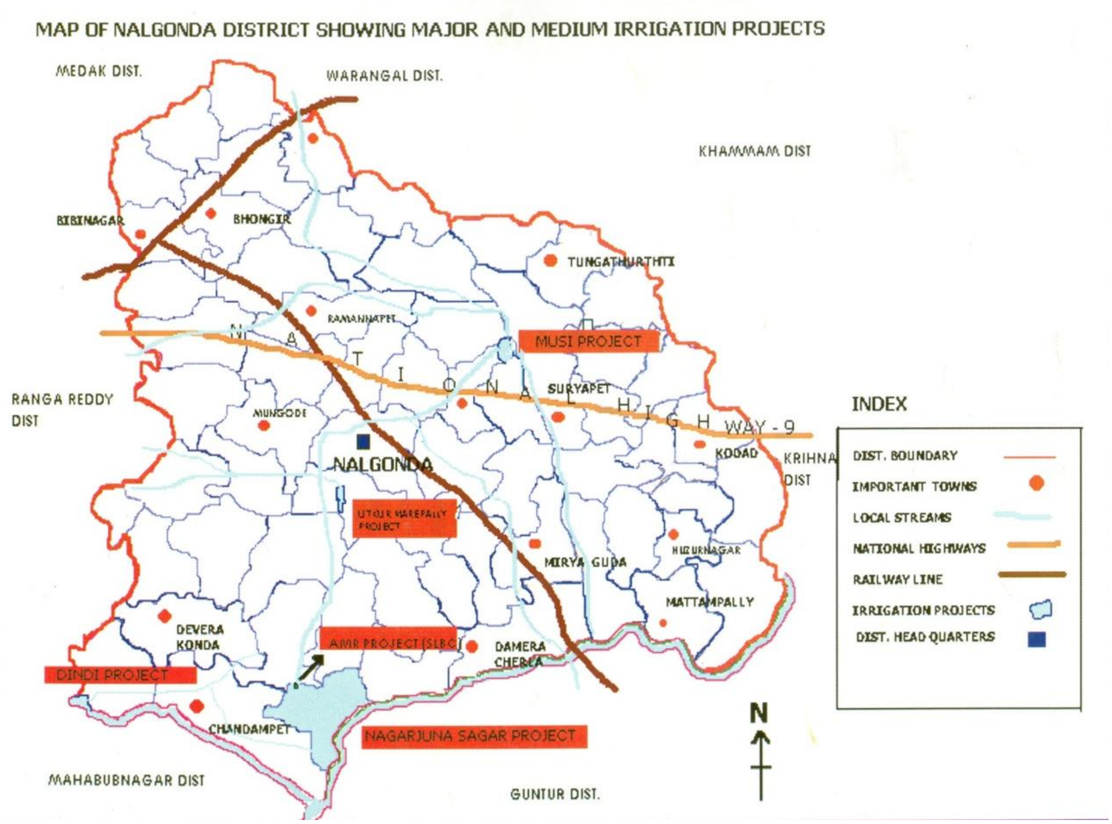

Figure 12: District map of Nalgonda including seasonal tributaries, rivers, reservoir, and Mandal headquarters. The light-blue overlay by the large reservoir at the bottom is the nearly-completed AMR project. Other proposed (some started) projects are also displayed. Source: Water Resources Information System, 2004.

Geographically, Nalgonda has an area of 14, 217 km^2, which constitutes just above 5% of the total area of Andhra Pradesh. Nalgonda receives an average rainfall of

770 mm (or about 30 inches) per year. Nearly three-quarters of this rain occurs during the monsoon season, an intense 40-45 days of rain following the summer. The summers are hot and dry, with temperatures consistently above 40 degrees Celsius (of above 100 degrees Fahrenheit). The annual rainfall is not consistent and often causes large losses in investment of the agro-economy due to uncertainty. Figures 13 and 14 show the most recent water coverage in Nalgonda by population and habitation, respectively (WaterSoft, Nalgonda Rural Water Services, 2010). The graphs show that approximately two-thirds of the district population does not meet the WHO 40 lpcd benchmark; in addition, over 80,000 people's only access is to unsafe water. Note that this does not imply that other citizens are immune from mineral contamination or unexposed to pathogens causing diarrheal health defects.

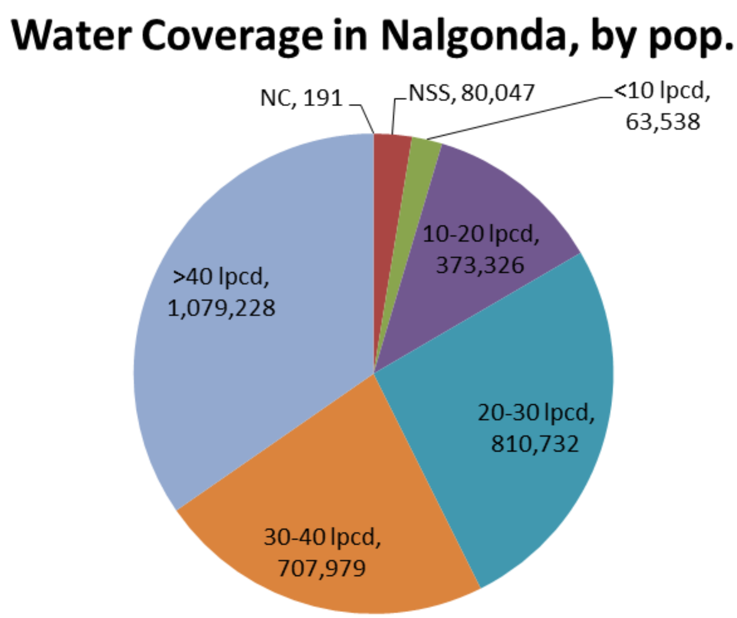

Figure 13: Domestic Water Supply Coverage in Nalgonda. NC indicates those without any water supply. NSS indicate those currently receiving known unsafe sources of water (such as excessive fluoride). (Nalgonda WaterSoft, Rural Water Supply Sector of Andhra Pradesh, 2010)

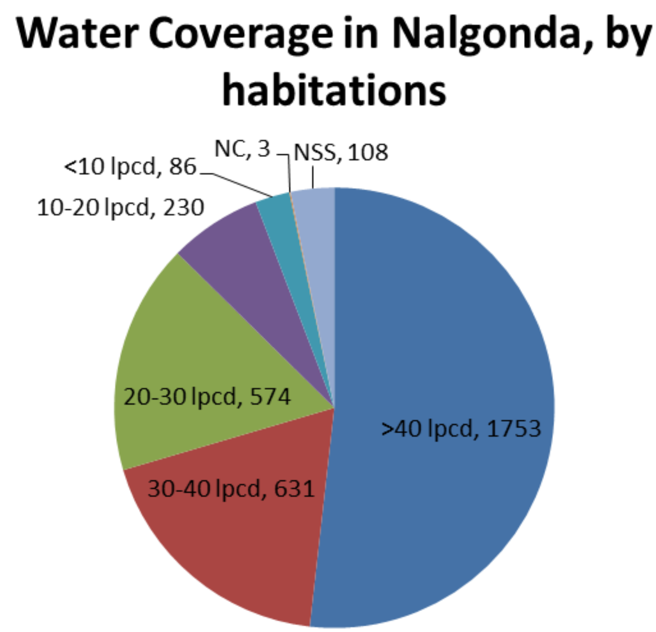

Figure 14: Domestic Water Supply Coverage by Habitation in Nalgonda. As with the previous graph, NC indicates villages without any water and NSS indicates villages with unsafe sources of water (such as excessive fluoride). (Nalgonda WaterSoft, Rural Water Supply Sector of Andhra Pradesh, 2012).

2.2.1 Fluoride in Nalgonda

In addition to the unsure annual water supply, the quality of the water is also poor. As per the WHO's 3rd edition release of drinking water quality standards, the guideline amount of fluoride in water is 1.5mg/l (WHO 2008). Parts of Nalgonda, however, far exceed the guideline amount to over 10 mg/l. Because of the excessive fluoride content, a significant portion of the population suffers from fluorosis, which leads to dental and skeletal degradation and deformation. The World Bank states that 48 of 59 Mandals have at least five villages affected by fluoride. A public interest group, Nalgonda.org, states that over 20,000 citizens of the district suffer from severe skeletal fluorosis (Figure 10), and cites a BBC article expressing that the hundreds of thousands more suffer from lower levels of fluorosis (Farooq 2003). As shown in Figure 13 from the earlier section, there are still over 80,000 people whose primary access to water is contaminated with excessive fluoride. As of 2012, 108 villages were categorized as NSS. Especially in these villages, as well as others, people suffer from symptoms of dental and skeletal fluorosis. Dental fluorosis includes yellowing, deformation, and general weakening of the teeth. Skeletal fluorosis includes deformation of the bone as shown in Figures 15 and 16.

Figure 15: A child with severe skeletal disfiguring; affected by fluoride in Nalgonda. Source: www.nalgonda.org

Figure 16: A 44-year old woman suffering from skeletal fluorosis in Narayanpur, Nalgonda. Source: Site Visit, 2011.

In response to the fluoride levels and the lack of action, several citizens sought to petition the government in addition to general open letters from public interest organizations. One such petition from P.R. Subas Chandran prompted a government response that acknowledged the fluoride condition of Nalgonda's villages:

> "In the affidavit filed in support of the writ petition, the petitioner states that out of 1178 villages in Nalgonda district, people of nearly 691 villages suffer to consumption of water containing high levels of fluoride. The consumption of such water has made many people partially disabled and crippled beyond redemption. All the residents of the said villages, suffer in some measure o the other either biologically or psychologically or sociologically. The petitioner further submits that the permissible limit of fluoride content in water, prescribed by World Health Organisation

> (WHO), is 0.5 to 0.8 PPM (Parts Per Million). However, the drinking water in the various villages of Nalgonda district has high fluoride content ranging between 1 and 13 PPM, which is 200% more than the permissible limit prescribed by WHO. The water with high fluoride content in Nalgonda district has become a silent killer and people living in the affected villages have started deserting them for want of safe drinking water."
>
> – Honourable Chief Justice S. B. Sinha and Justice V.V.S. Rao (August 24, 2001)

Thankfully, in the public interest litigation case, the High Court of Judicature in Hyderabad, Andhra Pradesh had directed that the District Collector to supply water with "optimum fluoride content through water tankers [to acute level areas initially] till the projects/schemes undertaken have been completed." Furthermore, the Government was directed to give special medical attention, work with NGOs, educate, and if necessary evacuate citizens in fluoride-affected areas (Sinha, Rao 2001). After the passing of this judgment in 2001, the results are only now starting to be realized (Venkataswarulu 2010).

2.2.2 Water distribution network in Nalgonda

After having discussed water source and water quality, it is now appropriate to consider the domestic water distribution network in Nalgonda. Much has already been introduced in the background chapter. RWS reaches habitations in three main ways: groundwater hand pumps, protected water supply schemes (PWSS) or single-village schemes (SVS), and comprehensive protected water supply schemes (CPWSS) or multiple village schemes (MVS). Hand pumps are standard for smaller villages, but over 15% have either dried up their groundwater sources or are not functional. PWSS, or just SVS if the scheme only covers one habitation, also typically uses groundwater for source and relies on electricity to pump and store in an overhead storage reservoir (OHSR) or ground level storage reservoir (GLSR). PWSSs typically serve villages of population of up to 5,000 people.

Finally, CPWSSs are large, centralized distribution water networks with a surface water body for source, large treatment plants, and gravity-fed pipes for supply lines. In this particular case, the CPWSSs derive from the AMR irrigation project from Nagarjuna Sagar. Of the 3,385 habitations in Nalgonda, hand pumps and PWSSs are the most common as shown in Table 4; however, just as supply pipelines in CPWSS fall susceptible to pipe bursts and water theft, PWSSs face more socio-cultural obstructions such as lack of empowerment leading to poor maintenance (Venkataswarulu 2010). Though the RWS department designs all local storage systems (OHSRs and GLSRs), the actual construction and first two years maintenance is handled by contractors, after which it is turned over to local Gram Panchayats (Venkataswarulu 2010).

Type of schemes	Number of Schemes	# of Habitations Served
Hand pumps	19,902	Almost everyone
PWSS	2,817	>2,000
CPWSS	13	~900 (varies)

Table 4: Water supply means for the District on Nalgonda

Chapter 3: Review of Risk and Capacity Assessment Methodologies

The goal of this research is to provide a comprehensive, participatory, and intra-institutional assessment framework that better aids decision-makers at different levels of responsibility and decision-making. First, it is important to review the leading water-related decision-aiding tools in the field.

3.1 General Frameworks for Risk and Capacity Assessment

As introduced earlier, several methodologies exist. The WHO and UNICEF created the Rapid Assessment of Drinking Water Quality (RADWQ) as a support tool for surveying water systems ("RADWQ: A Handbook for Implementation" 2008). RADWQ is primarily a sampling tool to understand water demand and quality in a certain area. While it is certainly participatory, the tool does not meet the comprehensiveness or intra-institutional objectives. World Bank employs its own tools as well. In conjunction with the World Bank's two main decision support systems: Demand Responsive Approach (DRA) and Methodology for Participatory Assessment (MPA), which serves primarily to complement DRA. The DRA approach is a participatory design framework that puts the fate of the project in the community's hands. There are several strong-suits to the DRA: first, the role of women is encouraged; second, water is treated as an economic resource, which thereby encourages private sector collaboration; and third, it is demand-driven (Parker and Skytta 2000). There are two pitfalls to this approach, however. The DRA does not account for system externalities or sub-system interactions, thereby falling short in the comprehensive and intra-institutional integration objectives. Secondly, as the

World Bank encourages the participation of DRA, the methodology only accounts for established institutional leadership rather than on-ground leaders.

UNICEF employs the Multiple Indicators Cluster Surveys (MICS), which selects test sites across a region and extrapolates the results to a larger area. The cluster sampling approach helps reduce sampling costs while using the common geographic correlations to combine sample points to achieve an affective understanding of an area. The survey tests at both the source and household level; additional influents to the water supply can thus be identified. MICS was originally conceived as a tracking tool for different projects, but quickly evolved to become a comprehensive, participatory, and iterative assessment framework used widely through UNICEF's projects. The one shortfall of MICS, as with most methodologies, is the lack of intra-institutional information sharing, which causes information silos and uninformed, and sometimes counteractive decision-making at different institutional levels.

3.2 Ostrom's Framework for Social-Ecological System Assessment

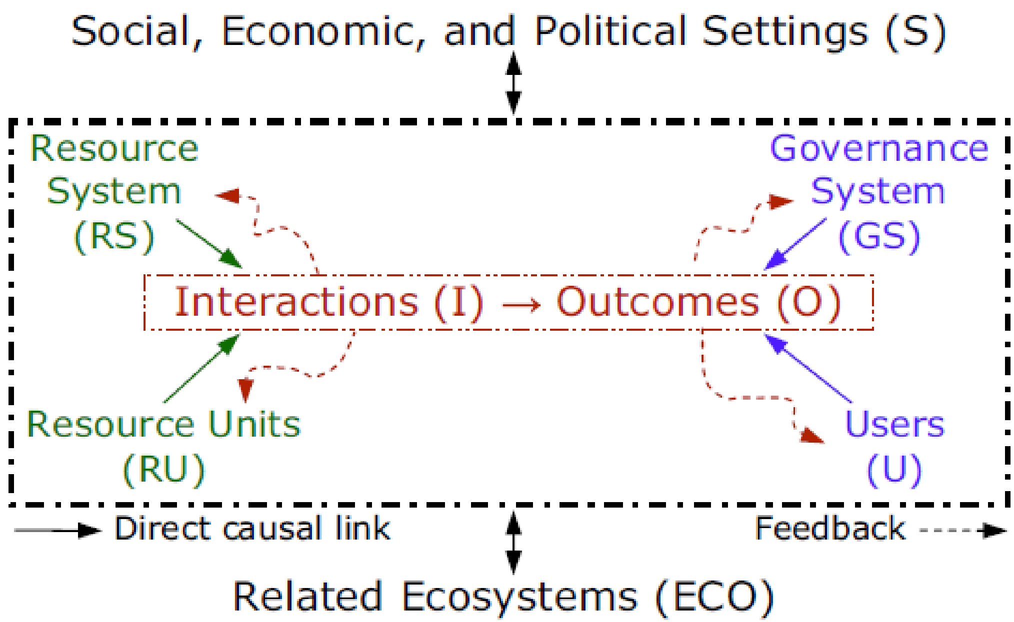

Figure 17: A multitier framework for evaluating sustainability of SESs. Source: Ostrom, 2007.

Now we consider the two methodologies that this research most heavily considers. The first is a brainchild of Elinor Ostrom, a Public Policy and Economics Professor at the University of Indiana. Recognizing the inherent complexities associated with large social-ecological systems, such as Nalgonda's domestic water supply system, Ostrom created a framework to view the said system through different perspectives. An avid follower of Garrett Hardin, Ostrom realized that there are several major players, resources, and entire sub-systems in any given system, and the model should strive to include and identify each as a part of the model.

Haimes (2004) would consider this similar to the mathematical foundation of building a state diagram of a system, shown in Figure 18, through the use of Hierarchical Holographic Modeling (something that Ostrom's framework has in common with Louis' Capacity Factors Analysis methodology). What differentiates Ostrom's model from others is the emphasis on governance and qualitative adjustment. Ostrom realized that with such complicated models of complex systems, the decision modules remained with decision-makers at the multiple governance levels.

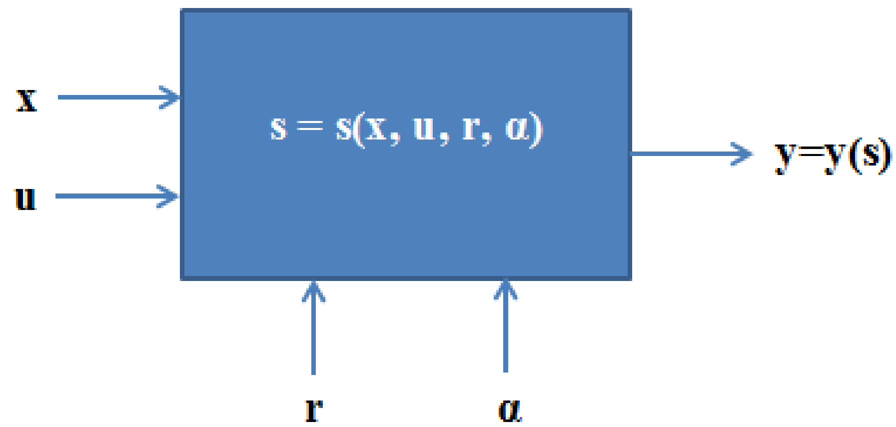

Figure 18: Haimes' mathematical model of a state diagram. The vector x represents the set of decision variables, vector u represents the set of input variables, vector r represents the set of random variables, vector α represents the set of exogenous variables, vector s represents the set of state variables (which is a function of the previous state variable, x, u, r, and α), and vector y represents the output variables (which is a function of the state variable. The box represents the system. (Haimes, 2004).

Dietz and Ostrom (2003) argued that any quantification or generalization of variables delegitimizes the correlation of models to reality. As such, Ostrom over many of her collaborations sought to define a framework for assessing Social-Ecological Systems (SES), which is what she called the complex, inter-related resource-governance systems. In a working paper, before she passed away during the summer of 2012, Ostrom and her co-author Michael McGinnis (Working paper, 2012) described the SES framework:

> "The SES framework was originally designed for application to a relatively well-defined domain of common-pool resource management situations in which *resource users* extract *resource units* from a *resource system*, and provide for the maintenance of that system, according to rules

and procedures determined by an overarching *governance system*, and in the context of *related ecological systems* and broader *social-political-economic settings*."

Continuing with the comparison to Haimes' mathematical model of a state diagram, Ostrom's framework can be seen as a method for characterizing social-ecological systems. Given such a model setup, the framework strives to address correlations rather than simple generalizations that output "panacea solutions" (2007). This sentiment is understandable – for in attempting to model complex or even complicated systems, nuances are lost in the process. She suggests drawing SES boundaries, identifying interacting subsystems or overarching classes, and comparing on a multi-tier level. Figure 15 depicts her general framework.

Table 5 shows the second-tier variables to be evaluated within each subsystem. The tier denotes not a hierarchy of systems, but rather a further clarification of the respective variables considered in the system. Viewing through the lens of Haimes' mathematical model, each second-tier variable would be considered a member of the vector set. For example, all the second-tier variables that compose the resource unit would be considered as the state variable vector.

While this model is certainly comprehensive and intra-institutional because of its emphasis on governance, it doesn't provide easy access to the relevant stakeholder groups for participation. Though it allows for qualitative feedback, that only arrives again in a consultative manner rather than participatory. Another major drawback for using this framework was that the lack of quantification of leads to subjective findings and difficulty in replication. Furthermore, it is difficult to provide recommendations with any specific technology solution for a habitation or a policy for a Mandal or District given the lack of a reverse assessment of requirements for the use of those respective alternatives.

Table 5: Second-tier variables for understanding the interactions between subsystems of a Social-Ecological System. Source: Ostrom 2007.

Social, Economic, and Political Settings (S)

S1- Economic development. S2- Demographic trends. S3- Political stability.
S4- Government settlement policies. S5- Market incentives. S6- Media organization.

Resource System (RS)	Governance System (GS)
RS1- Sector (e.g., water, forests, pasture, fish)	GS1- Government organizations
RS2- Clarity of system boundaries	GS2- Non-government organizations
RS3- Size of resource system	GS3- Network structure
RS4- Human-constructed facilities	GS4- Property-rights systems
RS5- Productivity of system	GS5- Operational rules
RS6- Equilibrium properties	GS6- Collective-choice rules
RS7- Predictability of system dynamics	GS7- Constitutional rules
RS8- Storage characteristics	GS8- Monitoring & sanctioning processes
RS9- Location	
Resource Units (RU)	**Users (U)**
RU1- Resource unit mobility	U1- Number of users
RU2- Growth or replacement rate	U2- Socioeconomic attributes of users
RU3- Interaction among resource units	U3- History of use
RU4- Economic value	U4- Location
RU5- Size	U5- Leadership/entrepreneurship
RU6- Distinctive markings	U6- Norms/social capital
RU7- Spatial & temporal distribution	U7- Knowledge of SES/mental models
	U8- Dependence on resource
	U9- Technology used
Interactions (I) →	**Outcomes (O)**
I1- Harvesting levels of diverse users	O1- Social performance measures (e.g., efficiency, equity, accountability)
I2- Information sharing among users	O2- Ecological performance measures (e.g., overharvested, resilience, diversity)
I3- Deliberation processes	O3- Externalities to other SESs
I4- Conflicts among users	
I5- Investment activities	
I6- Lobbying activities	

Related Ecosystems (ECO)

ECO1- Climate patterns. ECO2- Pollution patterns. ECO3- Flows into and out of focal SES.

3.3 Louis' Capacity Factors Analysis Methodology

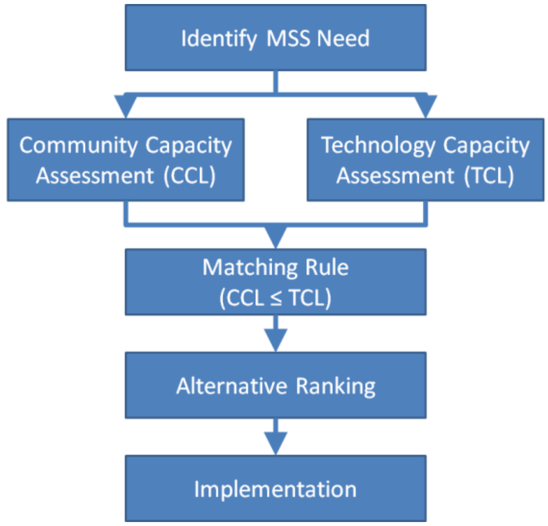

Figure 19: Louis' Capacity Factors Analysis risk methodology. Measure capacity across eight different factors and recommends the most appropriate technology for implementation. Source: Henriques 2009.

Louis (2002), Louis & Bouabid (2004, 2006), Louis et al. (2005 – Louis, Castillo, Henriques, Mardikanto, Yamakoshi, Williams – Florence Italy) suggest a slightly different holistic risk analysis module to assess community capacity and development. The Capacity Factors Analysis (CFA) approach is a decision support tool designed to help developing communities select an appropriate technology for their municipal water and sanitation services. CFA is a great design tool in curbing side effects of improper Drinking Water Supply (DWS) design and implementation.

Capacity factors are defined as characteristics that determine a community's ability to manage their MSS. The CFA approach outlines eight main capacity factors, as displayed and defined in Table 4 from Bouabid (2004) and Henriques (2008). The methodology relies on a set of weights as communicated by the stakeholders that draw importance to specific capacity factors, and thus able to calculate a Community Capacity Level (CCL) – essentially the perceived capabilities of the community. Bouabid (2004) compiled a list of technologies at their respective minimum CCLs, defined as Technology Requirement Level TRL). A matching strategy, as the one used in Henriques (2008), may then propose alternative technologies given appropriate fits between the TRL and CCL. Since the TRL may vary by region, a more standardized list is listed as the future work of Bouabid (2004).

Capacity Factor	Requirements that constitute the Capacity Factor
Service	Supply of water: Quantity, quality, accessibility (distance)
Institutional	Body of Legislation, Associated Regulation, Administrative Authority, Administrative Process, and Governance
Human Resources	Professionals, Skilled Labor, Unskilled Labor, Literate, and Illiterate
Technical	Operations, Maintenance, Adaptation, Supply Chain, Support Services
Economic/Financial	Private Sector, Bond Rating, User Fees, Budget, Asset Value, Debt
Energy Capacity	Primary Source, Back-up, Percentage of Budget, and Outage Rate
Environmental/ Natural Resources	Quality/Sensitivity; Stock of Resources: land, water, soil type, and Precipitation
Social/Cultural	Communities, Stability, Equity, Castes, and Women Participation

Table 6: Each capacity factory is essentially a risk category defined by the requirements on the right-hand side, Source: Bouabid (2004), Henriques (2008)

Appendix I shows a high-level community assessment using the CFA methodology. The data for the assessment came from the preliminary discussions with Suresh (2010) and Venkataswarulu (2010), accredited engineers in the Department of Rural Water Supply Services as a part of the 2010 Summer Research Trip to Nalgonda approved by Minister Komatireddy Venkat Reddy and District Collector S.A.M. Rizvi. Future assessments will use the same data set to expand and compare recommended alternatives. Each CF has sub-variables or requirements with respective established benchmarks. For example, outage rate is a part of assessment for the Energy CF; benchmark outage rates are used to normalize scores rather than unintentionally overweigh any single requirement or CF. Henriques (2008) compiles a set of the benchmark values that would fall into one of five scoring partitions. Though the score may vary within the partition bounds, the methodology helps normalize unrelated benchmarks quantitatively and produces a comprehendible numeric score.

Furthermore, note that the weights of requirements are not all equal; they are dependent on the engineers' perceived importance of one requirement with respect to others under the category CF. In the case study that Henriques (2008) presents for the evaluation of the Cimahi region in Indonesia, he assumes equal weights for requirements under each CF. During research, it was clear that the stakeholders valued certain requirements over others – for example, the governance requirement under the Institutional CF was more valued than others in the category because of perceived action capability. While this means that the community did not devalue administrative agencies or regulations, most agreed that the Governance produces more actionable agenda.

3.4 Strengths and Weaknesses of Louis' CFA and Ostrom's SES Assessment Frameworks

The World Bank and UNICEF frameworks make sense given their use, users, and intended implementation time of technologically-oriented solutions. However, to understand a community's capability in using those technical solutions, it is necessary to consider all interacting factors—from energy to surrounding ecosystems. Both Ostrom and Louis propose holistic frameworks that cater solutions to communities, rather than forcing intervention into communities via solutions. While these methodologies may seem similar, their respective strengths and weaknesses are different depending on implementation.

Ostrom's general framework for assessing social-ecological systems does not consider technological limitations other than resource and economic units. One may also find it difficult to understand the main takeaways from qualitative assessment. Furthermore, a framework heavily invested in assessing social/institutional/political settings might come off offensive to the current community and governance due to sociocultural differences. On the other hand, the qualitative assessment allows for a more comprehensive decomposition of the same factors across multiple different governance levels. In addition, the use of resource units provides a better grasp of feasibility and availability.

Louis' CFA methodology also has some limitations. It is difficult to validate the quantification of social concepts, such as castes. Requirements also need to be modified with context, as is encouraged by the weighting system (Henriques 2008). This makes it harder to evaluate quantitatively across different governance levels. Some strengths of

CFA include its emphasis on systematic and quantitative assessment, which is much easier to visualize. The weighting system allows for solutions catered to the specific community's needs and wants. The requirements are judged against current, research benchmarks, such as the WHO's 40 liters per capita daily (Henriques 2009). The strengths and weaknesses of both frameworks are summarized in Table 7.

Table 7: Strengths and Weaknesses of Capacity Assessment Frameworks: Louis' Capacity Factors Analysis and Ostrom's Social-Ecological System Assessment.

	Weaknesses	Strengths
Capacity Factors Analysis	• Difficult to validate quantification of social concepts, such as castes • Requirements might need to be modified for each context • Hard to translate for daily assessment use in communities by local officials • Harder to assess for larger communities	• Quantitative assessment is easier to visualize • Weight system allows for an assessment catered towards the community's needs • Requirements are judged against accepted benchmarks • Partitioned for better understanding
Ostrom's Framework	• Difficult to understand the main takeaways from qualitative assessment • Does not consider technological limitations other than in economic units • A social/institutional heavy framework might be offensive to the current community & governance	• Qualitative assessment allows for a more comprehensive decomposition of social, economic, and institutional factors • Use of resource units provides a better grasp of physical availability and feasibility

Inherent in both assessments is the consideration of adaptation-side risk associated with implementing any particular technology or policy. Both Louis and Ostrom attempt to address, though not explicitly, this psychological dimension in their respective methodologies by assessing whether the community members are willing and capable of a newly introduced alternative to that community's ecological system.

Kenneth Maton and Deborah Salem are researchers in the field of applied psychology; they would define this psychological empowerment as “the active participatory process of gaining resources or competencies needed to increase control over one’s life and accomplish important life goals” (1995).

Chapter 4: Service Mission and Research Goal

Given the author's hypothesis that a comprehensive, participatory, and intra-institutional assessment tool may better aid and inform decision-makers, this research proposes the creation of a hybrid of the SES framework and CFA methodology.

4.1 Service Mission

Given that the motivation for this thesis concerns the shortcomings of the social-ecological system of domestic water service in Nalgonda, it is appropriate to recognize a service mission: The product of this thesis proposes tangible recommendations for possible technology alternatives, where necessary, in specific areas of Nalgonda. Additionally, policy alternatives for higher governance levels are also be recommended. These recommendations have been provided to the approver and participants of the research: Minister Komatireddy Venkat Reddy and relevant departments (such as the Rural Water Services Department). A publication has already been relayed back to the investing stakeholders regarding the research components of this project. The status of these recommendations will be reflected on during the discussion section.

4.2 Research Goal and Objectives

To address the lack of assessment framework for community-specific solutions, a more comprehensive framework must be developed. In addition, policy makers at different decision-making levels or different governance levels should also be able to receive aggregated information to foster more sound investments. Ostrom's general framework for assessing the sustainability of social-ecological systems (SESs) helps establish the system boundaries, players, and interaction affects. Coupled with Louis' CFA's guiding capacity factors, the combined adaptation can dissect Nalgonda's rural domestic water distribution network and pave the way of understanding relationships between different stakeholders, governances, and resources subsystems.

> Research goal: to create a hybrid decision-aiding tool that reduces the risk of failure events associated with policy-adopted domestic water technologies.

Such a framework must be able to meet the following objectives:

1. Comprehensive – rather than focusing on demographic or physical system data, the tool should help draw a more holographic view of the system that includes random and exogenous variables.
2. Participatory – as noted by Maton, the essence of a sustainable policy starts with the retainers of the intended target of the policy, the stakeholders. A community-based and –led framework ensures that the results are adopted.

3. Intra-institutional – as delineated in Ostrom's framework, multiple governance systems drive policy implementation. As such, the framework should strive to include them.

This research addresses this problem by proposing a comprehensive risk and capacity assessment decision-support tool. The product of the application of such a methodology with respect to the case study of Nalgonda is anticipated to be a set of multi-tiered technological and policy alternatives. In order to assess whether the above objectives were achieved, certain questions are posed at the end of the study. These questions are based on the objectives, but also the respective weaknesses of the SES and CFA frameworks.

Comprehensive:

- Does the framework account for input from the following factors:
    - Service currently provided
    - Capacity of the formal institutions
    - Capacity of human resources/labor available
    - Capacity to operate, maintain, manage, and evolve technological systems
    - Capacity for economic activity and financial planning
    - Capacity of energy efficiency and reliability
    - Capacity of ecological awareness and environmental sustainability
    - Capacity of societal structure
- Does the framework allow for both quantitative and qualitative feedback?

Participatory:

- Are people for whom the system is being designed part of the process?
    - Answering questions during capacity assessment
    - Engaged in posing questions, maintaining dialogue
    - Fit Maton's description for
- Do the leaders find the process helpful for themselves?
- Do the people involved in the process feel capable of "gaining resources or competencies needed to increase control over one's life and accomplish [water supply-related goals]" if given ownership over application of the process?

Intra-institutional:

- Are leaders at different institutional levels able to communicate?
    - Are leaders of a lower institutional level able to provide feedback that is considered seriously by their corresponding superior?
    - Do leaders of higher institutional levels feel confident about making decisions on behalf of their respective constituencies?
- Is there a scale for measuring overall capacity, at different governance levels of habitation, mandal, and district?

Given the preliminary results from the CFA methodology shown in the previous chapter, it is predicted that the set may emphasize lower capacity systems such as rainwater harvesting.

4.3 Research Activities

Upon building the hybrid CFA-SES assessment tool, the author conducts a more comprehensive assessment of the water supply technologies currently employed in Nalgonda. Three specific alternatives are considered – centralized water supply systems like CPWS, groundwater systems like PWS and hand pumps, and rainwater harvesting systems. Data from 38 habitations across 20 mandals is available from the 2010 Summer Research Trip, which was sponsored by the Andhra Pradesh's Minister of Information Technology, Minister Komatireddy Venkat Reddy, and approved by the Officer of Collectorate of Nalgonda by I.A.S. Officer Rizvi. An assessment of these habitations, their corresponding mandals, and finally the district is conducted, each at its respective institutional level. Thereafter, each community is matched with the best-suited alternative. For mandal-level and district-level recommendations, corresponding water policies are considered.

Chapter 5: Louis-Ostrom Comprehensive Capacity Assessment

In order to better assess a large community's capability to successfully and sustainably adapt technological solutions, the Louis-Ostrom Comprehensive Capacity Assessment is developed The LOCCA method essentially compiles the strengths of the CFA and Ostrom's SES assessment framework. It has four main components. Figure 20 depicts a general overview.

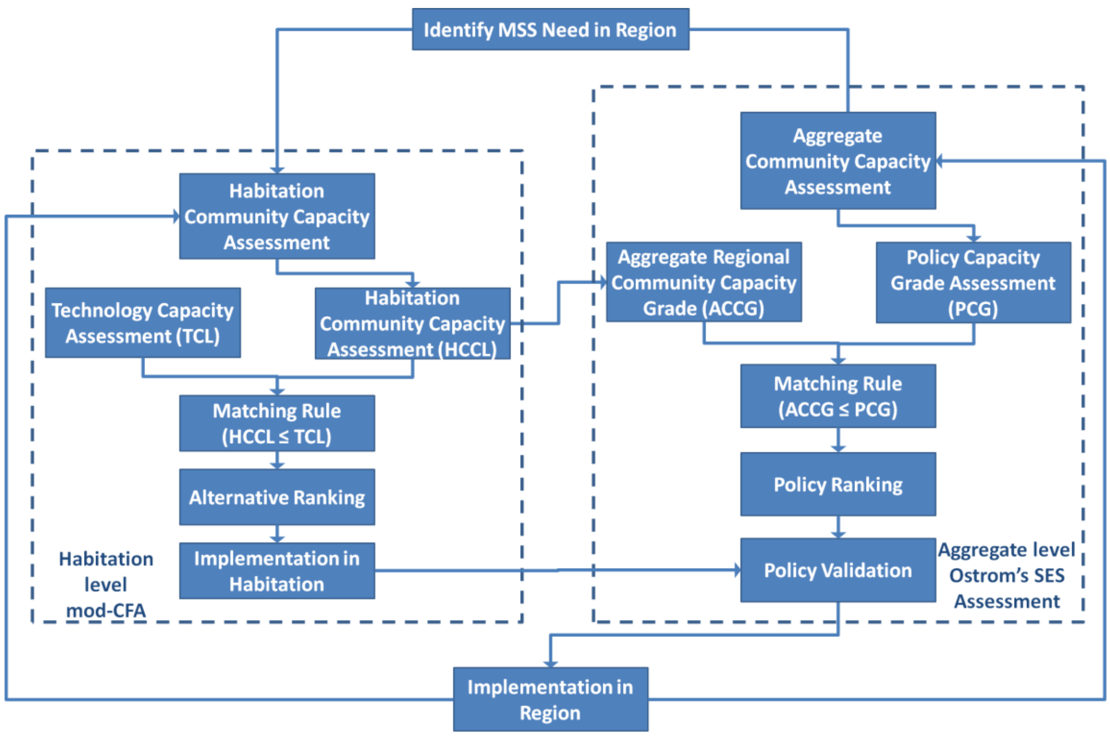

Figure 20: The Louis-Ostrom Comprehensive Capacity Assessment (LOCCA) Method. A slightly modified-CFA is used to quantitatively assess the habitation capacity and the aggregated data is used to qualitatively assign a letter grade to the respective Mandal.

First, the analyst must identify the need for improvement, such as the overview provided in Chapters 1 and 2. Note that this need does not necessarily have to be limited to water infrastructure. However, the scope of this thesis is limited to domestic water supply, and as such, the benchmarks are chosen to reflect to the water infrastructure application of the framework.

Second, the analyst performs a modified Capacity Factors Analysis (mod-CFA) at the habitation level—this involves assessing the habitation's community capacity (HCCL), checking alternative technologies that may improve the habitation's water service, matching with relevant applicable technologies, choosing the best alternative, and implementing that alternative in the respective habitation. The mod-CFA HCCL is slightly different from the CFA's CCL because of compounded requirements from Ostrom's SES assessment second-tier variables. For example, "Loss to Corruption" was one of the benchmarks added under the Economic/Financial Capacity Factor in lieu of a corresponding variable in Ostrom's SES assessment.

Third, the LOCCA method uses the data from the individual habitation assessments, compiles them, and employs Ostrom's SES assessment to assign letter grades for the aggregate communities. In India, the aggregate communities are composed of Mandals, Districts, Regions, States, and the National government. The letter grades represent partitioned levels for the Mandal's collective capability. The letter grade system was chosen to emphasize the qualitative nature of Ostrom's SES framework as well as to differentiate capacities between local habitation and higher governance levels. After the Aggregate Community Capacity Grade (ACCG) is issued, corresponding policies are considered. Similar to the CFA procedure, if policies seem "too advanced" for the aggregate community, they are eliminated via a matching rule. Then, the policies are ranked and chosen given alternative considerations.

Finally, if the corresponding technological alternatives seem successful, the respective policy extends the implementation of the alternatives to the rest of the Mandal. For the purpose of this thesis, only three locally-available technology-related policies are considered: 1) installation of comprehensive protected water supply scheme (CPWSS), 2) proliferation of protected water supply scheme (PWSS), and 3) rainwater harvesting schemes, of which roof-based and Oorani are considered. The associated capacity levels for each scheme are discussed in the next chapter.

Much of the LOCCA method may seem new, but the framework is very much based on the integration of Louis' CFA and Ostrom's SES assessment. A couple things that stand out immediately include the Aggregate Community Capacity Grade (ACCG) and the Policy Capacity Grade (PCG). The CCL assessment from CFA uses partitions in calculating the weighted requirements. Similarily, the ACCG may easily be assigned by normalizing the requirements across each capacity factor and choosing the minimum (or worst capacity factor grade) to represent the ACCG. However, a corresponding weighting system might be necessary in capturing the holistic capacity of the respective Mandal or District. Thus, Ostrom's framework is more heavily used for the higher governance levels.

Furthermore, Bouabid (2004) provides a large database of existing technology alternatives as well as pre-assessed TCLs specifically for MSS; Henriques (2008) expands this database in his Thesis. However, similar work is yet to be done with widely accepted water policies and their corresponding Policy Capacity Grade (PCG). The PCG is a qualitative measure of a certain technology-related policy's level of difficulty and system considerations in adoption, operation, maintenance, and Maton's sense of ownership. For example, consider a technology-related policy to equip every rural habitation with a hand pump for every 500 people. For such a policy to be effective, each habitation must know how to operate and not abuse the handpump, a mechanic must be available either in the habitation or the respective Mandal that is able to maintain and repair the handpump, parts should be available for repair, groundwater should be available for access, and bore-well diggers can construct handpumps in each community. Considering these requirements against an aggregate community's capacity, one can say that this is a relatively easy water policy to adopt. The PCG thus is an indicator of how well a certain policy may be realized. As mentioned earlier, it falls beyond the scope of this thesis to categorize every domestic water-related policy available. However, three locally-accepted policies will be considered and discussed more in the concluding chapter.

5.1 Requirements for the Modified-CFA at the Habitation Level

This section briefly discusses each of the requirements in the modified-CFA (mod-CFA) that is employed at the habitation level. The mod-CFA adopts all of the original eight capacity factors. However, the requirements under each capacity factor are not necessarily the same. This section explores the impetus for deleting or adding the respective requirement in addition to providing general commentary on all of the requirements.

Note that each requirement is broken down into five partitions for scoring purposes. Given equal weight across all requirements within a CF, the CF's score is calculated. Much of the formulation is borrowed from Bouabid (2004) and Henriques (2008) in their expansion of the CFA methodology initially proposed by Louis and Bouabid (2004). In the below formulation, notice that the capacity score is represented by C_{ij} (with two subscripts). The first subscript (i) refers to the CF—from 1 through 8, in no particular order of importance. The second subscript (j) refers to the requirement under the i^{th} CF. Following the C_{ij} is w_j, which signifies the weight of that specific requirement. For the purpose of this thesis, it is assumed that the weights are equal (while this was discussed with the assisting engineers while scoring, it was decided that equal best to proceed with scoring first and that changing weights later on should be considered for sensitivity analysis purposes). However, it is important to note that the weight of a specific requirement must reflect the stakeholders' collective perceived rank respective to other requirements within a CF. As is the case with the nature of weights, they must all equal to 1. Finally the CF score is evaluated as shown in Eq.1.

$$f_i = \sum_{j=1}^{n} C_{ij} w_j \; for \; n = 8, \qquad Eq. 1$$

Just as Bouabid (2004) and Henriques (2008) had followed the conservative rule for capacity matching, the HCCL score is determnined to be the minimum of all of the community's respective CFs. However, all CFs will be compared against the technology's counterpart for evaluation of alternatives.

$$HCCL = \min(f_i), \qquad Eq. 2$$

5.1.1 Service capacity factor

The Service CF reflects on the current amount of service that the community is receiving. This serves as a benchmark for improvement such that any proposed alternative must at least meet the current service level, or is otherwise eliminated from recommendation. The current benchmark for service is split up into five partitions. Note that the partitions are based on the research from Henriques (2009).

Table 8: Service Capacity Factor requirement – effective service level is the amount of water the community is currently receiving per head per day.

1	Service Capacity						w_j
C_{11}	Effective service level	< 20 l/p/d	20 - 40 l/p/d	40 - 60 l/p/d	60 - 80 l/p/d	> 80 l/p/d	1
f_1	*Score Service Capacity*					$\sum C_{ij} w_j$	*1*

5.1.2 Institutional capacity factor

The Institutional CF reflects the organizational component of water service. In water distribtion failure within a small habitation, there may be several causes that fall under the responsibility of an overseeing set of institutional bodies. The Institutional CF score addresses possible areas where institutional bodies may possibly fail, which may further lead to greater system failure. In our case, our system of interest is domestic water supply. As such the following requirements were identified under the Institutional CF.

Table 9: Institutional Capacity Factor Requirements with particular perspective of Indian governmental structure, such that it may be used for Nalgonda.

2	Institutional Capacity						w_j
C_{21}	Body of legislation	None	Basic	Intermediate	Complete	Advanced	0.1667
C_{22}	Operational rules	None	Basic	Intermediate	Complete	Advanced	0.1667
C_{23}	Administrative agencies	None	State	District	Mandal	Habitatio-nal	0.1667
C_{24}	Administrative processes	None	Basic	Intermediate	Complete	Advanced	0.1667
C_{25}	Governance	None	State	District	Mandal	Habitatio-nal	0.1667
C_{26}	Presence of NGOs	None	Low	Medium	High	Very High	0.1667
f_2	*Score Institutional Capacity*					$\sum C_{2j}w_j$	*1*

The "Body of Legislation" refers to the officially recognized standards for drinking and domestic water supply in the area of interest. "Operational Rules" is a borrowed requirement from Ostrom's framework that reflects the institution's ability to meet system needs while controlling other subsystems, such as electricity. "Administrative agencies" refer to existing institutional bodies whose purpose is to meet the system's domestic water supply, quality, and management needs. "Administrative processes" is similar to "Operational Rules," except concerns inter-organizational collaboration. "Presence of NGOs" was another added requirement because of the prevalence of communication and investment between NGOs and existing institutional infrastructure. "Associated Regulation" was a requirement in the original CFA; however, it was removed for the purpose of decomposition into the existing and added requirements—it made sense that the regulation itself was delineated rather than be subjectively assessed.

5.1.3 Human Resources capacity factor

Human Resources CF reflects the social capital of the area of interest. Assessment of human resources is especially important because it concerns the turnover ability and general maintenance of its respective infrastructure. Further, beyond maintenance, the CF accounts for the existing population's own sense of the system. The proposed modified requirements for the Human Resources CF are presented in Table 10.

Table 10: Human Resources Capacity Factors Requirements.

3	**Human Resources Capacity (service provider)**						w_j
C_{31}	Professionals	None	None	Administrative supervisor	Administrative manager	Administrative manager	0.2
				Health Scientist	Health Scientist Engineer	Health Scientist Engineer Lawyer	
						Public relations manager	
C_{32}	Skilled Labor	None	Mechanic	Maintenance technician Laboratory technician Water systems operator	Maintenance technician Laboratory technician Water systems operator Health inspector	Maintenance technician Laboratory technician Water systems operator Health inspector	0.2

					Administrative assistant Water meter leader	Administrative assistant Water meter leader IT technician	
C_{33}	Unskilled Labor	Craftsman	Clerk Mechanic assistant	Clerk Water meter reader Water systems worker			0.2
C_{34}	Illiterate	Caretaker	Caretaker				0.2
C_{35}	Access to Higher Education	None	State	Regional	District	Mandal	0.2
f_3	*Score Human Resources Capacity*					$\sum C_{3j}w_j$	1

Almost all of the requirements are from Henriques (2008) expansion of CFA. The "Access to Higher Education" requirement was added on upon commentary by community and institutional leaders—many felt that access to schools, libraries, or even professionals is equally as important as the existence of those respective resources themselves. An element of this is also presented in Ostrom's framework through the first-tier variables "Resource Units" and "Users", and the second-tier variables "Resource Mobility" and "Location." The requirement is partitioned by how far they would have to go in order to receive the benefits of resources available in higher educational institutions, with within the Mandal being the best possible scenario.

5.1.4 Technical Capacity Factor

When some of the stakeholders asked to define what technology may be, the answers were very interesting—nearly all of them were copied from a recent motivational movie called "3 Idiots." The professor prompts a student to answer the question, "what is a machine?" The protagonist of the film defines a machine as anything that human work easier, comically talking about turning a tap or switching on fan. The professor in the class was rather looking for a more dictionary-oriented explanation. Ultimately, the protagonist's definition wins over the audience over the course of film. The response from the interviewed stakeholders turned out to be more towards the protagonist's, perhaps because they had seen the film. The Technology CF considers currently implemented technological solutions and whether they are achieving their purpose. Again borrowed from Bouabid, Henriques (2008) and supplemented by Ostrom (2007), the following requirements are proposed on the next page in Table 11.

Two important aspects of Technical Capacity become immediately obvious—the level of "Operations" and "Maintenance" that is required in order for sustainable use. Operations and maintenance requirements with respect to community assessment reflects a habitation's capability to fulfill the technological interactions necessary for the system to function and to maintain its critical components. Some communities might not be familiar with maintaining water storage reservoirs, while others may be fully versed in the remote control of water treatment and distribution plants.

Table 11: Technical Capacity Factor Requirements.

4	**Technical Capacity**						w_j
C_{41}	Operations	Water Use	Pumping Water	Pumping Water Control Water Quality	Monitor water systems Control Water Quality Control Pipes	Monitor water systems Control Water Quality Monitor pipes network Monitor Treatment	0.2
C_{42}	Maintenance	None	Clean water systems Minor repair	Check water systems Major repair	Check/maintain water systems Major repair	Check/maintain water systems Check/maintain network	0.2

					Maintain pipes	Check/maintain meter Maintain IT systems	
C_{43}	Adaptation	None	Rarely	Occasionally	Usually	Frequently	0.2
C_{45}	Maintenance network	None	State	District	Mandal	Habitational	0.2
C_{45}	Distribution network	None	Regional Supplier	District Supplier	Mandal Supplier District Approved	Habitational Supplier District Approved	0.2
f_4	*Score Technical Capacity*					$\sum C_{4j}w_j$	*1*

The two added requirements from Ostrom's framework are the respective networks for maintenance and water supply operations. In interviewing the Rural Water Services department in Nalgonda and its employees, it was deemed necessary that proximity to the habitation is exceedingly important for sustained functionality. In some cases, the water supply for a habitation came from over a 100km away and their awareness of possible water shortage was never communicated. In others, maintenance complaints regarding an improperly functioning groundwater pump motor went unanswered indefinitely—the habitation's citizens were forced to pool together to buy their own, effectively double taxing themselves for a single service.

5.1.5 Economic and Financial capacity factor

Economic and Financial CF reflects the community's economic capability of sustaining its own water infrastructural system. For many rural communities, this is very low—much of Nalgonda's primary economy is dependent on agriculture and mining, both are inherently dependent factor on water supply. In fact, as mentioned in Chapters 1 and 2, the government's primary method of solving the domestic water problem is through a large, centralized water distribution system with the primary objective of delivering water for agriculture. Private investment, self-start ups, budgeting, etc. all make a big impact on how communities are able to access and receive water.

Table 12: Economic and Financial Capacity Factor Requirements.

5	**Economic and Financial Capacity**						w_j
C_{51}	Private sector investment	None	State	Regional	District	Mandal	0.14
C_{52}	Market incentives	None	Low	Medium	High	Very high	0.14
C_{53}	User fees	None	Uniform flat rate	Single block rate	Increasing block rate	Increasing block rate	0.14
C_{54}	Budget	None	Basic accounting	Annual	Tracked bi-annually	Tracked quarterly	0.14
C_{55}	Asset values	None	Real Estate	Real estate Equipment	Real estate Equipment Cash	Real estate Equipment Cash - Stocks	0.14
C_{56}	Investment activities	None	Low	Medium	High	Very High	0.14
C_{57}	Loss to corruption	Very High	High	Medium	Low	None	0.14
f_5	*Score Economic and Financial Capacity*					$\sum C_{5j} w_j$	*1*

This CF was one of the more modified CFs from the original due to several overlapping second-tier variables from Ostrom's framework. "Private sector investments" refer to large private-side investment at different governance levels. Since such investment has increased water service capacity historically by area, the partitions were broken down by region. Examples of private sector investment include agricultural bond for farms in any given area. Direct investments made by NGOs also constitute private sector investment. However, since such investment loses value due to bureaucracy, preference is given to localized investment. "Market incentives" and "investment activities" consider the idea of entrepreneurship and private market intervention. As such activities rise, so will the community's ability to afford and attract better personnel to maintain their infrastructure.

The financial requirements essentially indicate a community's capability to balance and take ownership of their respective budget and assets. "User fees" is a great requirement for understanding how communities value water while ensuring reinvestment for the future. A lack of fees encourages water abuse, while increasing block rates discourage water abuse and demonstrate the community's ability to monitor water usage. Finally, "corruption" was added due to the infamous amount of corruption not only in Nalgonda, but in general South Asia. Corruption disrupts the predictability of the functionality of any given system; thus, investment does not necessarily translate to results.

5.1.6 Energy capacity factor

The Energy CF is one of the most important measures for evaluating a community's capability to adapt to higher-level technological solutions. Given the type of "primary source," many electricity-orientated water technology-policy solutions may be eliminated. For example, in order to power a pump that extracts groundwater, a "3-phase" electricity line needs to service community. Some communities have this capability, others only have "2-phase" or "1-phase", all of which are levels of power being serviced on the line. Furthermore, given the nature of energy in the area, alternative sources or "alternative energy" is important to maintain service. The area is prone to outages; in fact, almost all areas expect no more than four to six hours of three-phase electricity, which is what is required for groundwater drawing. Thus, the "outage rate" is crucial in assessing alternatives for increasing water service. Additionally, several areas do not have such electricity daily, or at all. The "Dependence" requirement evaluates whether the community's relies on external service to operate or maintain its respective energy infrastructure. For example, is there someone in the Mandal that may fix a blown fuse? The requirements chosen for evaluation are as follows in Table 13.

Table 13: Energy Capacity Factor Requirements.

6	Energy Capacity						w_j
C_{61}	Primary source	None	Non-conventional	Conventional electricity	Electricity mid-voltage	Electricity high voltage	0.25
C_{62}	Alternative source	None	None	Generator < 10 HP	Generator < 50 HP	Generator > 50 HP	0.25
C_{63}	Dependence for service	Very low	Low	Medium	High	Very High	0.25
C_{64}	Outage rate	Very High	High	Medium	Low	Very low	0.25
f_6	*Score Energy Capacity*					$\sum C_{6j}w_j$	*1*

5.1.7 Environmental and Ecological capacity factor

The Environmental and Ecological CF saw significant change from the original CFA, including from its original name "Environmental and Natural Resources" (Henriques 2008). Much of Ostrom's framework investigates how people interact when confronted limited resources. Though the Social-Cultural CF addresses general sociological and anthropological question, none of the other CFs particularly take on Ostrom's particular research question. As such, the mod-CFA recognized this need and expanded the Environmental and Ecological CF to include multiple requirements, such as the stakeholders' general awareness of their ecological system, the size of the natural resource system itself, and the predictability of those resources over the future. It made sense that when one drafts technology alternatives to improve water supply, the natural resources are thoroughly investigated. While part of this may be captured in the Service CF, there is an inherent assumption that the ecological capacity is infinite. In an area with a large groundwater level decay rate as well as seasonal unpredictability, that assumption cannot be made. As such the following requirements in Table 12 must be evaluated.

Table 14: Environmental and Ecological Capacity Factor Requirements.

7	Environmental and Ecological Capacity						w_j
C_{71}	Environment quality	Very low	Low	Medium	High	Very high	0.2
C_{72}	Size of resource system	Very low	Low	Medium	High	Very high	0.2
C_{73}	Predictability of resource dynamics	Very low	Low	Medium	High	Very high	0.2
C_{74}	Growth or replacement rate	Very Negative	Negative	Stable	Positive	Very Positive	0.2
C_{74}	Resource sensibility	Very low	Low	Medium	High	Very High	0.2
f_7	*Score Environmental Capacity*					$\sum C_{7j}w_j$	*1*

"Environment quality" evaluates the natural water quality as well as processed water quality. As mentioned earlier Chapter 1, water and sanitation are interrelated. The quality of water is function of the natural environment (such as the heavy abundance of fluoride mineral) and the processed environment (such as what people put back into or take out of the environment). "Size of resource system" addresses the upper limit of the expected amount water that can be drawn out of water sources—everything from rain to groundwater. While the rating is partitioned in levels of very low to very high, the selection of this dependent upon a combination of the physical levels of groundwater, surface water, and rain water availability.

"Predictability" is important because leaders need to be able to strategize short-falls from any one source by relying on other sources. "Replacement rate" accounts for the heavy dependence on groundwater. Many habitations rely on groundwater for drinking water while others overuse it for irrigation purposes. Such activities need to be balanced for long-term usage. Finally, the "sensibility" requirement accounts for how much stakeholders may know about the finite amount of water—either by Müeller's definition of water scarcity (Müeller 2006) or just conventional usage relative to their partners. Per Ostrom's concern on a population's competitiveness becoming overbearing for the area's natural resources (2009), an evaluation of a community's sensibility of using water resources is important.

5.1.8 Social-Cultural Capacity

The Social-Cultural CF is incredibly relevant in assessing a community's capacity for a technology solution. While it may be easy to model institutional or technical resources, the social-cultural CF accounts for the heritage and current mood of the community. The following Table 13 shows the requirements for this CF.

Table 15: Social and Cultural Capacity Factor Requirements.

8	**Social and Cultural Capacity**						w_j
C_{81}	Communal ownership	Very low	Low	Intermediate	High	Very high	0.2
C_{82}	Political stability	Very low	Low	Intermediate	High	Very high	0.2
C_{83}	Equity	Very low	Low	Intermediate	High	Very high	0.2
C_{84}	Leadership/entrepreneurship	Very low	Low	Intermediate	High	Very high	0.2
C_{85}	Participation of women	Very low	Low	Intermediate	High	Very high	0.2
f_8	*Score Social-Cultural Capacity*					$\sum C_{ij} w_j$	1

"Communal ownership" evaluates an individual sense of shared resource and responsibility. While many feel entitled to the service, not everyone feels equally responsible for operating and maintaining that service. A shared feeling is essential for not abusing one's entitlement to a shared resource while giving, either financially or through personal work, towards the betterment of that resource. "Political stability" gauges the vulnerability of the provision of service to any specific community depending on that community's political beliefs or opponent's political beliefs. In Nalgonda, this is especially prevalent due to the attempted secession of the northwestern region of the state, called Telangana, from the rest of the state. This will be discussed more in a later section.

"Equity" is similar to communal ownership in the sense of shared resources; however, it additionally concerns a culture's treatment of an individual or family given their heritage. The Indian government introduced the idea of Scheduled Castes and Scheduled Tribes—essentially officially recognized lower castes and tribes of India—in order to address culturally imposed disadvantages. While the spirit of the practice is admirable, such economic and political disambiguation only intensifies segregation. In the end, such segregation becomes clear through corruption of services provided.

"Leadership and entrepreneurship" is an essential social-cultural requirement. Each habitation elects a Sarpanch, essentially a mayor. The mayor is the final authority on almost every single aspect in that habitation or Gram Panchayat. The Panchayati Raj, a council or senate of the Gram Panchayat may sway the Sarpanch's opinion, but functionally almost all progress depends on the Sarpanch's word. As such, a community's capability to take on projects usually falls to the leadership that it is under. Furthermore, entrepreneurial citizens or leaders are essential for dispatching heavy demands with limited resources. Finally, "women participation" is an accepted criterion worldwide for the level of social-cultural capacity.

5.2 Technology Capacity Level and Matching Rule

Assessing a community's capability to use a technology is not enough. It is imperative that the reverse is also performed. The Technology Capacity Level addresses this idea—in order for a community to use a technology effectively, there is minimum score of the capacity factors that the community must first meet. Just like a community, a technology is evaluated against each requirement to determine the minimal partition level that must be met in order for the technology to function appropriately. As mentioned earlier, Bouabid (2004) and Henriques (2008) use the conservative matching rule to ensure technologies that are catered to the communities' respective capabilities; as such the risk of system failure will be low. The rule is as follows:

$$HCCL \geq TCL \quad Eq.3a$$

$$HCCL = \min(f_i) \;\; and \;\; TCL = \max(f_i) \quad Eq.3b$$

One may note that the rule may unnecessarily remove alternatives and is inconsiderate of the gradient in difference of values between the HCCL and TCL. Consider a hypothetical example where the HCCL of Community A is 55 and the HCCL of Community B is 40. Now consider Technology Alternative X with a TCL score of 56 and Technology Alternative Y with a TCL score of 70. It is difficult to ascertain that Alternative X is not a suitable or sustainable recommendation for Community A. However, it is possible to compare relatively; that is, the following statement is truer—Technology Alternative X has a lower chance of system failure if it were in implemented in Community A than Community B. Similarly, Technology Alternative X would be a better recommendation than Technology Alternative Y for Community A, even though both alternatives do not meet the above matching rule. Such comparisons become valuable given the complexity of the model. Furthermore, such comparative analysis provides a better foundation of trust in following through with the recommendation of an alternative. In the original context, Bouabid (2004) used this matching rule eliminate in the respective quintile partitions rather than a strict score. That is another method to perceive this model.

Therefore, given the variability of the model, it makes sense to consider a set of practical technologies by each CF and thereby evaluate overall relative risk of system failure. The original intention of the rule was to act as a filter for the large array of technology alternatives that were compiled by Bouabid (2004). However, for the purpose of this thesis and verification of the established model, only a small set of technology alternatives (who fit the broad categories of different TCL partitions) were evaluated. Once a technology's TCL score has been evaluated, which is done in the next chapter, the set of technology alternatives' scores are compared against the HCCL in radar graph. The graph provides a visual measure of understanding possible shortcomings of an alternative if it were implemented in a community.

5.3 Aggregate Community Capacity Assessment

Once a habitation is assessed for its ability to use a technology solution, it becomes imperative to aggregate and extrapolate such information to policy makers at higher governance levels. However, averages, modes, or medians of the HCCLs do not suffice or qualify as fulfilling proper assessment of an entire Mandal or District. Since Ostrom's framework is strong in providing comprehensive and qualitative analysis given initial low-level assessment, the LOCCA method emphasizes Ostrom's 1st-tier general variables to complement the HCCL data. As shown in Figure 17, Ostrom essentially outlines major subsystems' interactions. She outlines two main variables, Governance System and Users, where policies may impact the outcome of an integrated system. Ostrom also delineates the Resource System and the Resource Units as the states of the system, prone to change per policy actions and interactions with other systems. Furthermore, Ostrom assumes that the Social, Economic, and Political Settings as well as Related Ecosystems (such as the Agro economy) influence the state variables and policies, yet they are outside of decision control.

In order to assess a Mandal's or District's Aggregate Community Capacity Grade (ACCG), which is defined as the community's ability to adapt to that policy, one must combine the HCCL data and Ostrom's general assessment. In doing so, one must first establish standards for each ACCG level such that they may directly translate to policy. The following ACCG letter grades and their corresponding characteristics across Louis' CFs are proposed. The ACCG for that entire Mandal or District is then assessed by considering the qualitative grade that best represents all of that Mandal or District's lower ACCGs.

Table 16: Aggregate Community Capacity Grade Characteristics across Risk Factors.

Grade	Institutional	Human Resources	Technical	Economic and Financial	Energy	Environmental and Ecological	Social and Cultural
A	• Strong local, Mandal, and District level regulation • Local governance, minimal supervision • Integrated government agencies • High legislative standards for water quality	• Heavy social capital • Several higher educational institutions • Training or mentoring facilities and programs • Illiterates trained as operators or caretakers	• Capable of complex water unit operations • Experts with tech maintenance • Reliance network is close to point of use • Source is nearby point of use	• Strong market • Maintains accurate budget • Very little corruption • Users pay towards system use	• Primary source powers groundwater pumps and filters • Alternative source capable of drawing groundwater • Low dependence • Very low outage	• No natural or manmade pollutants in water • High groundwater level, rainfall • High resource conscience • Waste and wastewater curbing plans	• Sense of communal ownership exists • Low political rift • No segregation or affirmative action necessary • Women are leaders, not just participators
B	• Strong Mandal & District level regulation • Local governance, Mandal supervision • Legislative standards • Communication between institutional agencies • NGO presence	• Medium Social capital • Few higher educational institutions • Illiterates trained as operators or caretakers	• Capable of operating medium-level water technology • Familiar with tech maintenance • Reliance network is in neighboring Mandal • Source is far from point of use	• Strong market • Maintains annual budget • Some corruption • Users pay towards system use, but collection rate is not high	• Primary source varies over course of day • Alternative source capable of drawing groundwater • Medium dependence • Outage no more than 8 hours per day	• Some natural pollutants • No manmade pollutants in water • Resource supply > demand • Resource conscience • Some waste curbing plans	• Sense of communal ownership exists • Some political rift • Some segregation or affirmative action • Women participate in central activities • Motivated leaders
C	• District-level regulation • Little governance structure, relies on District officers • No standards or legislation • No communication between agencies	• Low social capital • Basic schools exist • Apprenticeship in water management comes from agriculture experience	• Capable of operating low-level water technology • Maintains system without familiarity • Reliance network is farther than immediate neighbor	• Market exists • Maintains annual budget • Frequent corruption • Users pay towards system use, but collection rate is very low	• Primary source varies over course of day • Alternative source can only power lights • High dependence • Outage no more than 16 hours/day, predictable	• Some natural pollutants & manmade pollutants in water • Resource supply = demand • No resource conscience • No waste cleanup	• Little sense of communal ownership • High political rift • Heavy segregation or affirmative action • Women participate in menial activities • Leaders participate sometimes
D	• Little or no regulation • Little or no governance, relies on District intervention • No standards or legislation • NGO intervention seen as necessary	• Low social capital • Basic schools exist, but no teachers • Apprenticeship in water management comes from agriculture experience	• Operates low-level water technology without background • No system maintenance • Reliance network is farther than immediate neighbor	• No market • Uncertain budget • Frequent corruption • No collection of user fees • Low asset values • Investors wary, little entrepreneurship	• Primary source no more than 6 hours a day • No alternative • Very high outage, inconsistent and unpredictable	• High natural pollutants & manmade pollutants in water • Resource supply < demand • No resource conscience • No waste cleanup	• No sense of communal ownership • High political rift • Heavy segregation or affirmative action • Women do not participate • Poor leadership

5.4 Policy Capacity Grade and Matching Communities with Policies

Similar to the Technology Capacity Level (TCL), a Policy Capacity Grade (PCG) is assessed for each policy that is considered for recommendation. While the policies vary from educational to infrastructural to technological to institutional, the ACCG characteristics chart shown in Table 16 provide a comprehensive assessment of an aggregate's community to be able to adapt to such policies. For example, consider recommending a water-related policy that serves to provide Comprehensive Protected Water Supply Service, which has certain requirements as low energy outage and high maintenance, to a rural Mandal without proper energy infrastructure or human resources. Without proper resources, such a policy is doomed to failure and will have heavy financial and political repercussions.

As with the TCL, different policies will be compared against a community's ACCG across the risk factors highlighted in Table 16. Unlike the TCL, however, the PCG is not evaluated as the minimum grade from the set of all CF grades, but rather a qualitative average. The primary impetus behind this assertion is to allow for the qualitative assessment to supplement the quantitative assessment provided by mod-CFA; secondarily, the PCG comparison is intended to act as an information-sharing activity that meets the participatory and intra-institutional requirements. Thus, a minimizing function on partitions would not make sense. It is suggested in the concluding chapter that in the future, the foundation for how such a qualitative score may be further investigated. However, for the purposes of this thesis, the characteristic groundwork outlined in Table 16 provides enough means for policy matching. Furthermore, it should be noted that only a few policies that reflected current capability were selected for consideration. The PCGs of the policies are calculated in a subsequent chapter.

Finally, Henriques' (2008) matching policy for CFA can be modified for generality purposes and be adapted to policy matching in the following manner:

$$ACCG \gtrsim PCG \quad Eq. 4$$

This rule ensures that any recommended policies are capable for immediate implementation. During the site visit, several stakeholders commented on officials that sought unrealistic goals and were essentially voted for their sensationalism rather than practicality. While it is important to have a long-term vision, inability to follow through short-term measures inhibits future performance. Furthermore, adopting a better policy alternative that is catered to the Mandal or District is hypothesized to subsequently increase the respective ACCG of the Mandal or District. To prove this hypothesis, however, requires a long-term longitudinal study and is listed as an item for future work.

5.5 Ranking Strategies for Technologies and Policies

After deriving a set of acceptable technologies and policies, they are ranked for recommendation to the stakeholders for implementation. The primary product of this thesis is an assessment of a community's capacity to adopt a technological solution, and it is assumed that any set of alternatives that meets the community's capacity level is appropriate for implementation. Given that a set of alternatives is eligible for implementation, they are ranked by estimated Service benefit that they will provide to the community. Cost is another major player for choosing among the alternatives; however, several existing frameworks address how cost evaluation should impact alternative recommendation.

5.6 Implementation Timeline of Chosen Alternatives

This section provides a brief commentary on the implementation timeline of the chosen alternatives. Upon assessment of lower-level communities, such as individual habitations and Gram Panchayats, the turnaround time for technological alternative recommendation may vary from one to three months. However, assessment at higher governance levels takes a much longer time. From Figure 20, it is easy to see that much of policy approval depends on the success of implementation of lower governance levels. While the policy matching process may start immediately after constituent HCCLs are evaluated, the implementation of a policy depends on the success on recommended alternatives. As such, the implementation timeline for policies varies from one to three years, depending on how quickly constituent habitations show results. The validation timeline for this framework falls to a longitudinal study that may befit a doctoral dissertation.

Chapter 6: Technology and Policy Alternative Capacity Assessment

Chapter 6 investigates a set of technology and policy alternatives and their minimal requirements necessary for implementation into a community. As aforementioned, the technology alternatives are chosen from the set of existing technology solutions in the region and the policy alternatives are chosen correspondingly from the District and State's activities. Expert feedback from department heads in Nalgonda is the primary information used to calculate the TCLs and evaluate the PCGs. Specifically, after receiving permission from District Collectorate Indian Administrative Service (IAS) Officer S.A.M. Rizvi and Superintending Engineer (SE), B. Jagadishwar Reddy, Personal Assistant to SE Kandikuri Suresh and Executive Engineer (EE) D. Venkataswarulu. Additional information from on-site engineers and mechanics were used to modify the scores as reflected.

6.1 Technology Alternative Capacity Level Assessment

The set of technology alternatives that were chosen for evaluation are outlined here:

1. Comprehensive Protected Water Supply Scheme (CPWSS) – a surface water-sourced, centralized filtration and distribution system aimed to service large areas at once.
2. Protected Water Supply Scheme (PWSS) – a groundwater-sourced, defluoridation optional, distribution system aimed to service a Gram Panchayat.

3. Rainwater Harvesting Schemes (RHS) – roof-based or man-made rainwater collection-based sourcing, carbon-based filtration, aimed to service from a family scale to a small village.

6.1.1 Comprehensive protected water supply scheme TCL

Figure 21: Portion of the AMR Project model. Note that the water is provided via canal from the main surface water source at the Nagarjuna Sagar Dam. That water is transported via canal for irrigation projects and via pipe for drinking water supply.

CPWSS is a modern, centralized water treatment and distribution service. In context with Nalgonda, CPWS is provided through one main water source—the Nagarjuna Sagar Dam of the Krishna River. Water is taken in from an entry point in the southwestern tip of Nalgonda in Puthangadi and lifted 150 meters via pump to a balancing reservoir in Akkampally. From there, the water is transported via canal for both irrigation and domestic usage. The domestic water intakes along the North-South canal lead to large-scale water treatment facilities. Water is treated for bio-contaminants, pathogens, minerals, and general suspended solids. The treated water is then distributed to storage reservoirs in surrounding Mandals and Gram Panchayats. The distribution channel to the storage reservoirs is gravity-fed; however, the distribution channel pipes are not always secured underground or the contractors may not always build to design requirements. The CPWSS system is reviewed primarily by the AMR scheme, an overview of which is shown in Figure 21. The TCL and PCG of CPWSS were conducted together. Since it is a large scale implementation costing crores of rupees, it acts as a policy initiative by the government. The evaluation was primarily conducted with Kandukuri Suresh and respective visits to branch offices of RWS in different Mandals. The summary is presented below in Figure 22. The full evaluation is presented in Appendix II.

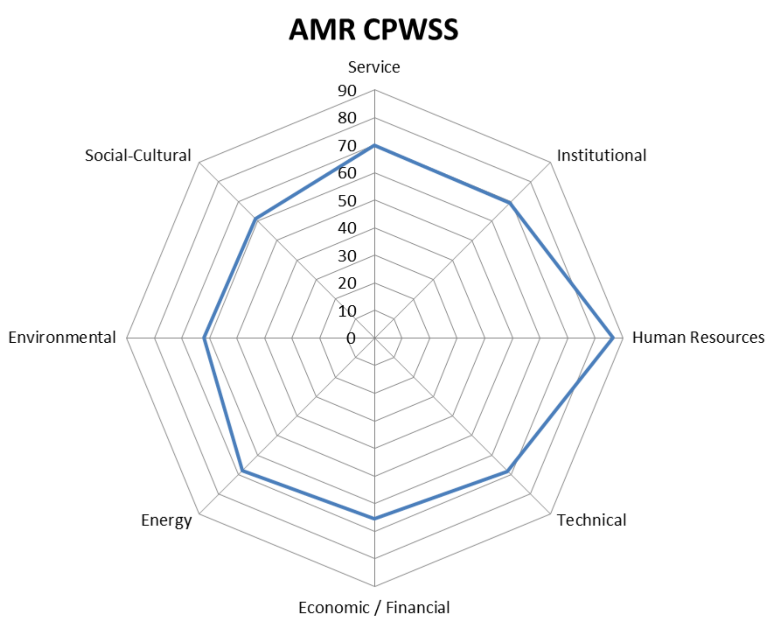

Figure 22: Graph of AMR CPWSS' Technology Capacity Level.

6.1.2 Protected water supply scheme TCL

Figure 23: A PWSS in construction nearby Mothkur. Almost all PWSS pump water up to an overhead reservoir to supply water via gravity to nearby households, or villages if the PWSS is a larger variety.

PWSS serve either a portion of a large village, a medium-sized village, or a pair of small villages. It pumps groundwater to an overhead reservoir either daily or every other day depending on availability of electricity. It is up to the community to clean the tanks every other week via bleach or chlorination to prevent pathogen growth; however, this is not usually done. The main advantage of this technology is that it is easily replicable; however it depends heavily on groundwater and electricity. Thus, fluoride becomes a problem, as well as access to high-voltage electricity without many outages. The TCL associated with PWSS is perceived as the technology uptake associated with installing a new PWSS in a community. A picture of a typical PWSS is presented in

Figure 23. The summary of its TCL is presented below in Figure 24, the full scores available in Appendix II.

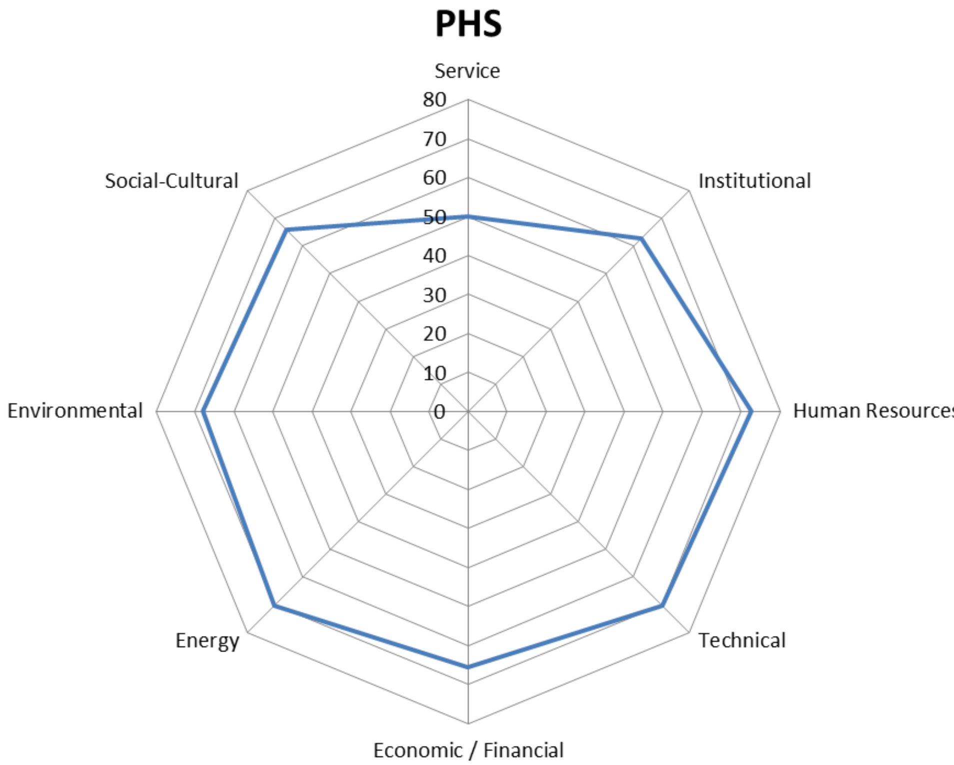

Figure 24: Technology Capacity Level of PWSS.

6.1.3 Rainwater harvesting scheme (RHS) TCL

RHS serves families in a village. Typical rainwater harvesting systems are roof-based, meaning that the rain falling upon the roof of house is collected in a separate tank, then filtered before use. Other systems in the area include groundwater collection schemes within an household and at a communal level. Outside the house and within a family's plot, the family may lay stone flooring instead of keeping a dirt lawn to collect the water towards a ground-level water storage reservoir. The water is kept inside over the course of the year and used as needed for primarily domestic purposes. A typical 8mx8m house is able to generate an average of over 100 liter per day in the region.

Other schemes that are more communal based also exist, such as the Oorani scheme. The Oorani scheme creates a man-made open reservoir between a small set of villages and creates pathways for water collection. Its natural dip collects water over the course of the year more easily than at a household level as it takes advantage of a greater geographic expanse. Nearby villagers than collect the water through hand pump set up by the reservoir that contains a filtration system within them. While these schemes can collect more water, they are also susceptible to greater evaporation rates. However, these schemes have filled the gap for localized water supply infrastructure for incredibly rural areas in place of centralized water supply solutions such as the AMR project.

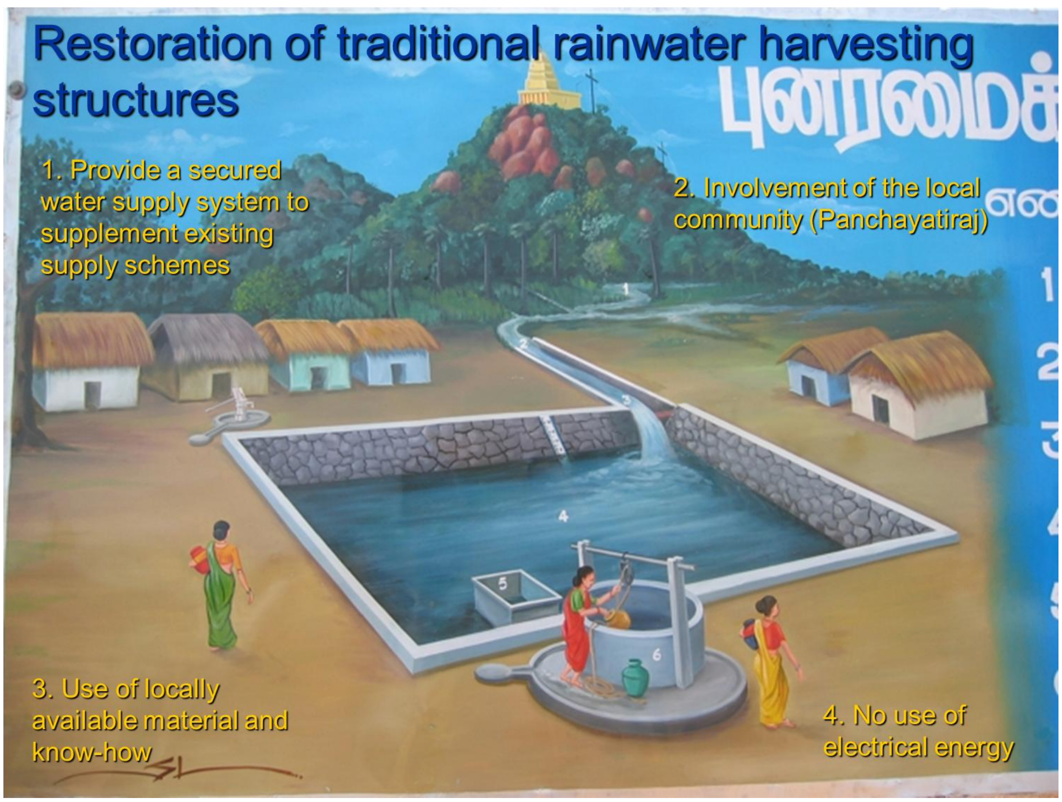

Figure 25: Oorani Scheme as presented by visiting faculty from Anna University (Walther 2009).

The Oorani schemes are still very new and thus the engineers were hesitant about guessing at its TCL. However, they were able to provide feedback on rainwater harvesting schemes at large. With the help of NGOs, four villages implemented roof-based rainwater harvesting schemes. Furthermore, one Oorani schemes is already seeing water being collected in its respective ecosystem. Given this set of experiences, the TCL of rainwater harvesting systems is calculated, and Figure 26 below presents a summary.

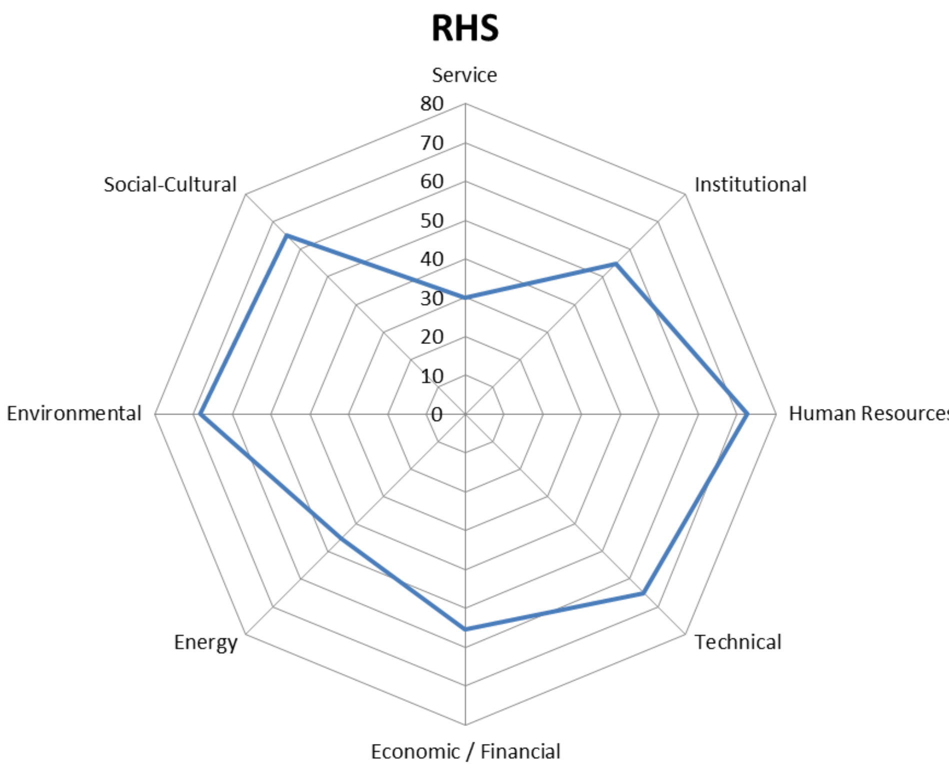

Figure 26: Technology Capacity Level of RHS.

6.2 Policy Capacity Grade Level Assessment

After considering the local technology options, three associated "water policies" were also investigated. The first policy is the expansion of and installation of additional CPWSS. By far, this is the costliest policy; however, this is also a policy to which the World Bank could lend. The second policy is the proliferation of PWSS. Proliferation of these facilities includes building these sites in areas without any, or with limited water supply as well as providing the operation and maintenance infrastructure associated with the technology. This policy includes the smaller governance levels in contributing to operational costs, but requires financial injection from the State or District levels. Finally, the third policy is the proliferation of RHS. Though these schemes are new, they are comparatively cheap to support. Furthermore, tax-breaks could be provided to local businesses that lend their support to the construction and contribution of RHS in their respective communities. However, these schemes are very difficult to regulate and may fail if not followed through with properly. The details of these policies are discussed below.

Before speaking specifically of each of the below policies, the current policies of building, operation, and maintenance of rural water supply systems should be reviewed. In 2007, the Government of Andhra Pradesh issued Government Order Ms. No. 569 (GO. 569) to further specify responsibilities and allocate funds to the Panchayat Raj institutions, which were officially state-recognized through Indian Constitution's 73rd Amendment. Formally, GO. 569 references that:

> “73rd Amendments Act has provided for the devolution of powers and responsibilities to Panchayat Raj Institutions to enable them to function as Institutions of Self-government with respect to:
>
> a) The preparation of plans for economic development and social justice.
> b) The implementation of schemes for economic development and social justice as may be entrusted to them including those in relation to the matters listed in the Eleventh Schedule.”
>
> - Andhra Pradesh GO. 569 in reference to 73rd Amendments Act of India

The Eleventh Schedule that is referred to in the above excerpt includes responsibility over multiple services that span from water, sanitation, education, animal husbandry, agriculture, rural housing, etc. Amongst them is the delineated item of “drinking water.” In referencing the federal constitutional amendment, this government order is essentially placing the massive responsibility of managing the rural water supply to the Panchayat Raj institutions. Furthermore, GO. 569 decrees that:

> “The Government after careful consideration of recommendations of the Task Force hereby devolve the following functions to Panchayat Raj Institutions in respect of Rural Water Supply Department:
>
> - Maintenance of Rural Water Supply Schemes with assistance of Rural Water Supply Engineering Department.
> - Participation of planning for new drinking water schemes.
> - Promotion of Household Connections.
> - Creating awareness through Training Programs, Seminars and IEC activities on Health Hygiene and Safe Drinking Water.
> - Review the water testing reports and Monitor the Quality of Drinking Water.
> - Planning, Implementation, and Monitoring of Total Sanitation Programme.”

Table 17: Annexure to GO. 569 Issued on December 22, 2007 describing the responsibilities of each institutional level.

Activity	Distribution of Functions and funds		
	Zilla [District] Parishad	**Mandal Parishad**	**Gram Panchayat**
Development of water supply system (Annual allocation Rs. 132 Crores [$24M])	1. Participation in planning of CPWS scheme. 2. Maintenance of CPWS Schemes/Multi-Village Schemes (MVS) (Annual allocation of Rs. 55 crores [~$10M] 3. Review the water testing reports and Monitor the Quality of Drinking Water. 4. Arrange Training Programmes, Seminars and IEC activities on Health, Hygiene and Safe Drinking Water 5. Review the activities of District Water and Sanitation Mission	1. Participation in planning of water supply schemes covering more than one Gram Panchayat. 2. Review and Monitor the maintenance of Hand pumps, PWS Schemes, and distribution of grant as per planning (Annual allocation of Rs. 14 crores [$2.6M]) 3. Providing and entrustment of Transportation and hiring of wells for Drinking Water. 4. Review the water testing reports and Monitor the Quality of Drinking Water.	1. Identify schemes and locations, through the involvement of Gram Sabha and GP. 2. Operation and Maintenance of single-village schemes (Annual allocation of Rs. 63 crores [$11.5M]) 3. Regular chlorination of open wells and treat water and cleaning of OHSR. 4. Ensure proper distribution of water to all locations of households in its villages. 5. Monitoring and surveillance of quality of water 6. Take up the works relating to laying of pipelines for drinking water supply in the village 7. Promote Household connections. 8. Formation of Water and Sanitation Committee and levy and collect the user charges.
Rural Sanitation	1. Planning, entrustment, monitoring and coordination of Rural Sanitation Programmes. 2. Approve the action plans on Total Sanitation submitted by the MPS. (annual allocation Rs. 178 crores [$32.4M]) 3. Providing Technical support for implementation of Total Sanitation	1. Organizing awareness campaigns on Total Sanitation in the villages. 2. Consolidate the action plans of the Gram Panchayats and integrate with Mandal Parishad plans and submit to the ZP. 3. Coordination and supervision of implementation of Total Sanitation Programme 4. Providing Technical support for implementation of Total Sanitation to GPs.	1. Prepare an action plan for Total Sanitation of the Gram Panchayat and submit to the MP 2. Implement the Total Sanitation in the GP 3. Undertake Sweeping of the Streets, construction and Cleaning of drains, disposal of solid-waste, Construction of ISLs, Waste Water disposals, Construction and maintenance of flat forms for DW sources and soakage puts, Providing dumping yards, creation of awareness on Health and Hygiene among the villages.

All monetary allocations in Table 17 are updated by new legislation. While the scope of this thesis is on domestic water (primarily drinking water), both water and sanitation were included in the table to present a picture of dual responsibility of the District, Mandal leadership, and Gram Sabha.

6.2.1 Comprehensive protected water supply scheme PCG

CPWSS is typically a State-level policy since it impacts multiple Districts in a watershed. Even with the AMR Project, the scheme impacts the District of Nalgonda and the capital city of Hyderabad, where five million citizens are predicted to be serviced. The treated drinking water supply primarily goes to the city, excepting the treated water from three distribution facilities. The AMR project is predicted to cost Rs. 1260 crores, or nearly $230M, as shown by the Government of Andhra Pradesh's Water Resource Information System. While GO. 569 states that Zillas (or Districts) must participate in the planning of CPWS schemes like the AMR project, their participation typically ends up being an afterthought. Engineers at the state level draw up the design of the CPWSS and the design is then submitted to RWS in Nalgonda for inspection and sign-off. This is not a participatory process, much rather an intra-institutional collaboration as the spirit of the GO. 569 dictates.

Furthermore, the human resources necessary to operate and maintain a CPWSS is just as one notch above PWSS, in the sense that operators must be constantly aware that their respective portion of the system is a node in a larger network. This systemic methodology is not easy to come by, especially in rural areas where the water has both domestic and agro-economic value. Suresh comments that the RWS department typically finds "water hijackers" along the pipeline routes; these breaks in line cause severe loss in water head and thus poorer supply down the line (2010). Thus, workers different at nodes in the CPWSS should be knowledgeable of how to operate and maintain their respective pipelines to address these issues as they arise.

Venkataswarulu and Suresh both acknowledge that in general any community being serviced by a CPWSS system “does not need to be perfect, but know what they have” (2010). As such they recommend a higher-level threshold on the rest of the factors. Given this commentary, corresponding research, and the qualitative metrics shown in Table 16, the PCG is deduced and summarized in Table 18 at the end of this section.

6.2.2 Proliferation of protected water supply schemes PCG

While fluoride and groundwater depletion remain significant challenges with regards to PWSS, both Suresh and Venkataswarulu comment that this may be one of the easier options to follow. Since the installation of a PWSS is a one-time investment with minimal operational cost (assuming the pump does not breakdown), the PWSS is one of a cheaper option as well. Otherwise, the responsibilities of operation and maintenance, which includes cleaning the tank every other week, remains with the Gram Panchayat. The success of these systems typically depends on the leadership, as will be demonstrated during the case study. PWS schemes also pair well with local entrepreneurs that build defluoridation plants to remove the mineral from the water. However, this entrepreneurship is not systemic.

Finally, this option is easily replicable in terms of ease of adoption of policy since construction plans and construction partners already exist. However, its impact on groundwater cannot be easily ignored. The PCG for PWSS is summarized in Table 18.

6.2.3 Proliferation of rainwater harvesting schemes PCG

Finally, the proliferation of RHS is another option. This is the cheapest option to the state and the district because it places the burden of financial start-up typically on a family or village. Maton (2008) speaks about the order of empowerment; he suggests that the individual is an easier starting point rather than an automatic installation of culture. With this in mind, the RHS falls more along the lines of individual operation and maintenance. The biggest challenge with RHS remains its replicability; there have been many different implementations of RHS across Nalgonda, with systemic success in a few habitations. Otherwise, some households were found to have implemented their own catchment system, seemingly by preference rather than a communal push. The variations include roof-based systems and open-well catchment. For the purposes of scope, the Suresh and Venkataswarulu suggested considering roof-based systems and the Oorani system. They noted that the policies were similar, excepting a greater investment from either the Mandal or District level to create an Oorani system that may end up acting as a MVS. Roof-based systems were considered for the PCG and the results are summarized in Table 18 below.

Table 18: Policy Capacity Grade Summary Table of CPWSS, Proliferation of PWSS, Proliferation of RHS.

	Policy Capacity Grade		
Factor	**CPWSS**	**Pro PWSS**	**Pro RHS**
Institutional	A	B	B
Human Resources	A	B	C
Technical	B	B	C
Economic and Financial	B	C	B
Energy	B	B	D
Environmental and Ecological	B	B	B
Social and Cultural	B	B	B
~PCG	A/B	B	B/C

Chapter 7: Results of Capacity Assessment in Nalgonda

Thus far, the overview of LOCCA methodology and its respective assessment of three technologies and their associated policies were considered. This chapter presents the results of capacity assessment from multiple habitations, corresponding Gram Panchayats, and corresponding Mandals in Nalgonda. Much of the technology-side capacity assessment was performed in the main RWS office in Nalgonda; however, it is impossible to assess individual communities from looking at numbers on a desk. As such, the author pursued an on-site study with the accompaniment of Suresh on majority of site visits or with a local leader, either an officer or hand pump mechanic that may be more familiar with the particular community, of the RWS department.

The site visits originally included visiting 38 Gram Panchayats (GP) across 20 Mandals. However, not all GP visits produced enough information necessary to conduct a reliable capacity assessment of the area. Thus, the assessment was only conducted for the 33 Gram Panchayats, including four officially designated as “municipalities”, an institutional grouping of the less rural GPs, across 16 Mandals. The summary of each GP visited, their corresponding Mandal, and the RWS or Panchayati Raj leaders that accompanied the visit are listed in Table 19. A summary graph of the visited areas is also provided in Figure 27.

The site visits were conducted Monday through Saturday while officers of different RWS offices, GP leadership, and Mandal leadership were available. A typical visit consisted of meeting with the respective Sarpanch of the GP as well as fellow leaders in the GP, surveying their primary source of domestic water supply, whether it was a CPWSS, PWSS, or RHS, and asking questions about current means of operation and maintenance. In addition, general questions about the village dynamics, habits, and plans were also asked. Much of these visits were videotaped with consent for the purpose of retaining information since writing in front of others and not looking at others' eyes during a conversation is considered cultural taboo. Though the author led in asking most of the questions, he was helped by the RWS department co-visitor. Finally, in certain cases the author was asked to help in terms of basic engineering knowledge (a complaint of a broken pump and a complaint of a corrupt Sarpanch); however, no physical or monetary aid was provided beyond relaying the complaint to RWS.

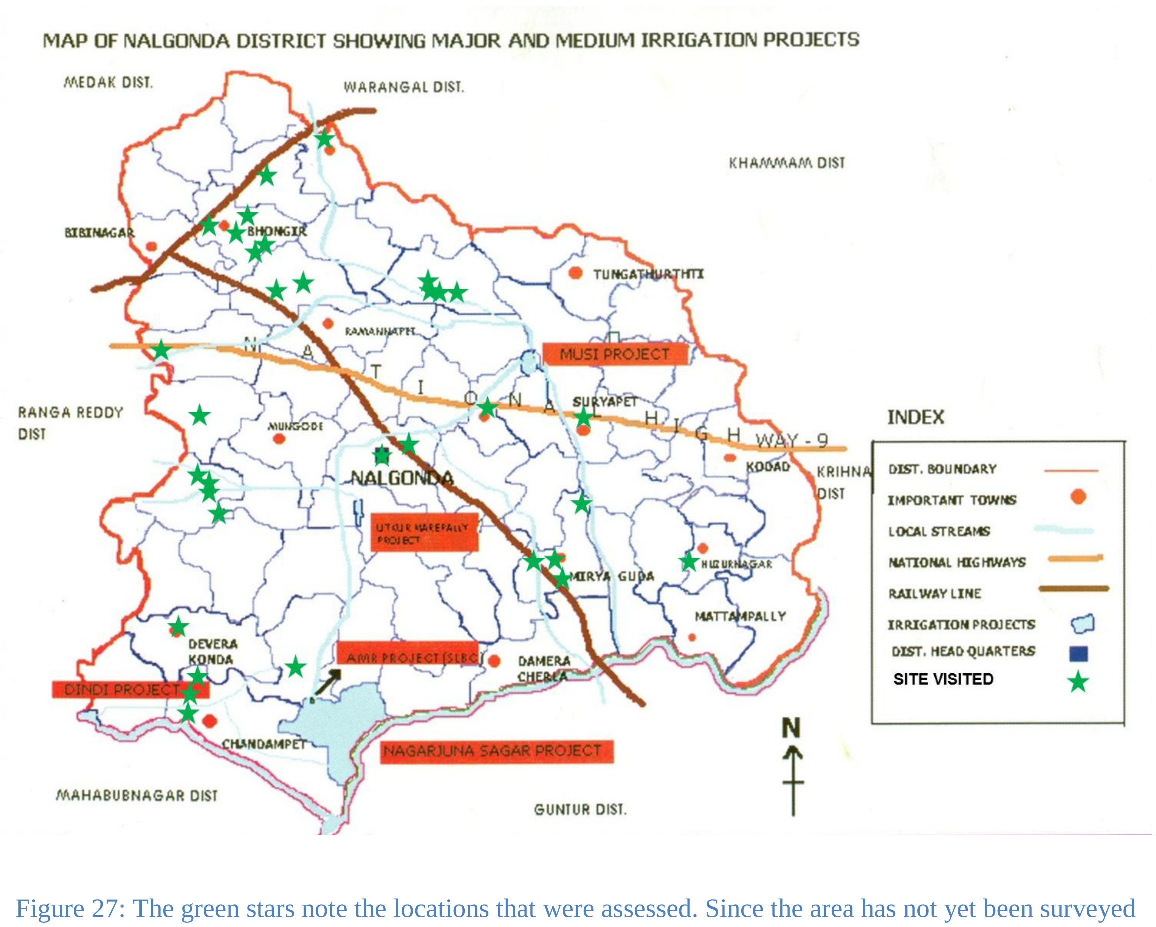

Figure 27: The green stars note the locations that were assessed. Since the area has not yet been surveyed and recorded with GIS, the locations are overlaid by an available map. While more sites were visited, only sites that were assessed are displayed here. Map provided by the Water Resource Information System (2004).

Table 19: Gram Panchayats visited, corresponding Mandal, and name and title of primary contact. DE denotes Deputy (Executive) Engineer, AEE denotes Assistant Executive Engineer, VDO denotes Village Development Officer.

Mandal	Gram Panchayats	Contact name
Bhongir	Bhongir M, Banda Somaram, Kesaram, Raigir, Ramachandrapur	DE Dasyam Laxman
Chandempet	Neradugommu, Polepally, Timmapuram	Timmapuram Sarpanch: Pappayya, Narsimha (Handpump mechanic)
Choutuppal	Choutuppal	AEE G. Indrasena Reddy
Devarkonda	Deverkonda	DE K. Hamsaram Rao, Lakshmachari (Pump Mechanic)
Huzurnagar	Huzurnagar	DE Venkat Reddy, AE K. Brahmam Babu
Marriguda	Batlapally (Vattipally), Marriguda, Shivannaguda, Anthampeta	A. Sathya, Yaddaya (Hand pump mechanics); Dikshapathi, Vothi Kata Yellaya, Dabha Narsimha; VDO Laxman Nayak
Miryalaguda	Miryalaguda M, Venkatadripallam, Zapthiveeragudem, Chinthapally	Municipal Engineer: Venkataswarulu, Town Planning Officer: Rahul R, Municipal Chairman: Rosaiah; Pump Mechanic Ch. Venkatashwarlu, Constable/Filter Plant owner Sudhaker Reddy
Mothkur	Anjipuram, Bujalipuram, Dharmapur, Mothkur	Guram Lakshmi Narshimha Reddy
Nakrekal	Nakrekal	Madhushudharn (Section Officer)
Nalgonda	Nalgonda M, Panagal	AEE Kandukuri Suresh
Narayanpur	Vaillapally	DE Seetha Ram Reddy
P.A.Pally	Chilkamarry	Venkatasham (Hand pump mechanic)
Suryapet	Suryapet M	Municipal Chairman: Meela Satyanarayana (also Founder and Managing Director of Sudhaker Group of Companies)
Valigonda	Valigonda, Sunkishala	Mandal Parishad Development Officer: K. Janaki Reddy
Yadagirigutta	Yadagirigutta	GP Secretary M.A. Salim
Alair	Alair	AEE Sreedhar Reddy

In the next section, a summary of the capacity assessment is conducted for each GP in a Mandal and an aggregate capacity grade is then issued to that respective Mandal. The full capacity assessment of each GP is provided in Appendix IV and the tables for the ACCG for each Mandal are provided in Appendix V.

7.1 Capacity Assessment by Mandal

7.1.1 Bhongir Mandal

Bhongir is one of the more populated Mandals in Nalgonda. It is a major commercial center due to its location along two major highways. The most recent surveys indicate that Bhongir is fully covered, that is that it meets the minimum 40 lpcd requirement for all of its respective villages that add up to a total population of nearly 50,000. Despite these statistics, the subjective feedback from the RWS department and local people indicate that it still struggles due to high reliance on groundwater. Deputy Engineer (DE) Laxman notes 80% of the Bhongir Subdivision of RWS is covered by defluoridation plants to remove the fluoride mineral from the groundwater. While supply and quality is not an issue due to the technology currently in place, the demand has risen dramatically from the originally anticipated amount of 40 lpcd to around 80 lpcd. He attributes this to use of water beyond domestic uses, such as diverting water for cattle.

Figure 28: Speaking with Laxman in Bhongir RWS Office.

Figure 29: Failed rainwater harvesting scheme in Raigiri Primary School.

According to Laxman, the biggest problem is socio-cultural. The ownership level of most communities is “zero. A big zero” (2010), specifying the monetary commitment that each household should pat but isn’t, and noting that the funds are barely enough to cover salaries of the operator. He infers that this is what causes the very slow turnaround on repairs of any system breakdown, even though the Mandal is technically fully covered. Furthermore, he highlights the reliance on electricity and defluoridation plants, which he says are a “terrible waste of water,” with over 60% removed as sludge. Laxman said that there could be hope with rain water, and referred to a failed experiment with rainwater harvesting in a primary school in Raigiri shown in Figure 29. The summary graph of GP Capacity in Bhongir Mandal is shown in Figure 30. As can be anticipated, the Bhongir municipality itself fares better than the more rurally distributed GPs. The most varying factors seems to be Human Resources, Institutional, and Technical, while the most commonly scored factors seem to be Social-cultural and Environmental.

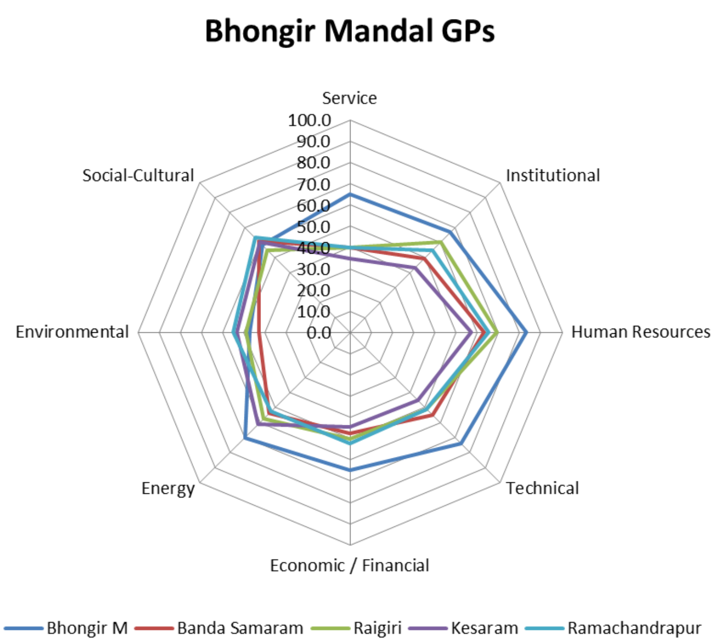

Figure 30: Capacity levels of GPS visited in the Bhongir Mandal.

With this information, it is possible to arrive at a general aggregate capacity score for Bhongir. The comments from the interview and the notes from the visit point to the fact that social-cultural and technical may be the two of the more limiting factors.

Moreover, the institutional setting is also generalized over the Mandal typically. Considering the additional factors from Ostrom's framework, the Bhongir Mandal receives an ACCG of B, indicating that it is substantial enough to receive higher capacity system like PWSS, which the area currently relies on, but may struggle with managing a centralized distribution system like CPWSS. The summary is shown in Table x.

Table 20: Aggregate Community Capacity Grade for Bhongir Mandal.

Factor	Bhongir
Institutional	B
Human Resources	C
Technical	B
Economic / Financial	B
Energy	B
Environmental	C
Social-Cultural	B
~ACCG	**B**

7.1.2 Alair Mandal

The Alair Mandal is located north of Bhongir. AEE Sreedhar Reddy provided the guided site visit to the GP of Alair in the Alair Mandal, commenting that much of the Mandal is like the GP of Alair. Alair is small and monotonous. It currently uses PWSS, and in most cases the area uses defluoridation plants much like Bhongir. Of the 34 habitations in Alair, only 12 are fully covered; 7 are anticipated to be fully covered in 2015. Alair is one of the few Mandals with a large number of habitations (6) categorized as receiving non-safe sources of water. This indicates the presence of above safe levels of fluoride in the groundwater and the lack of a defluoridation plant to remove the mineral in those respective villages.

To curb the fluoride problem in the Mandal, there is a current proposal to expand the CPWSS from Nalgonda Mandal to Alair Mandal through Mothkur Mandal. The project costs Rs. 50 crores, or roughly $9.2M. This would bring great relief of drinking water supply to the area. Reddy comments, however, that the drawback of such a system may not necessarily be the supply within the Mandal, but the lack of predictability associated with supply line failures. Additionally, if Alair follows suit with other Mandals that have received CPWSS, there will be a rise in water demand, further aggravating the water scarcity situation in the area. The summary graph and table are provided below.

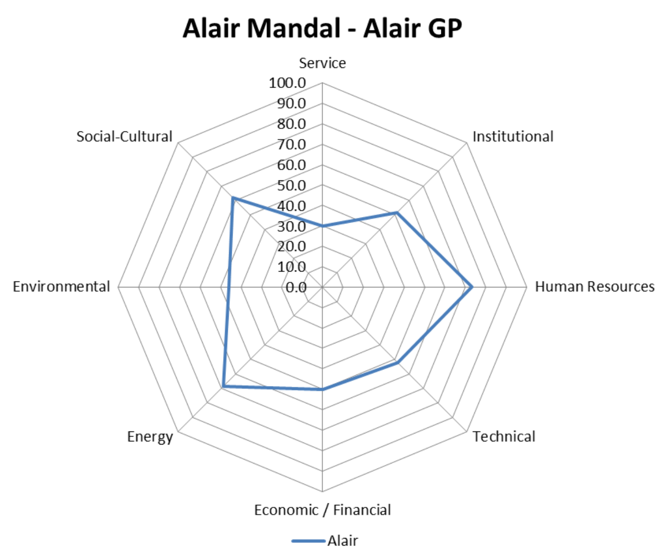

Figure 31: Community capacity assessment of Alair GP.

The three most limiting factors in Alair are institutional, social-cultural, and technical. Furthermore, the service itself is much lower than the minimum of 40 lpcd. As such, solutions should be introduced that attempt to raise this service level while accounting for the risk factors, such as poor predictability, operation and management of resources, and operational rules. Table 21 summarizes the aggregate capacity grade.

Table 21: Aggregate community capacity grade of Alair Mandal.

Factor	Alair
Institutional	C
Human Resources	C
Technical	C
Economic / Financial	B
Energy	B
Environmental	C
Social-Cultural	B
~ACCG	**C**

7.1.3 Yadagirigutta Mandal

Figure 32: Approaching Sri Lakshiminarasimha Swamy Temple in Yadagirigutta. This major religious destination helps to local economy as well as provides for self-investment for water and sanitation services.

The Gram Panchayat Secretary, M. A. Salim, of Yadagirigutta of Yadagirigutta Mandal, was the primary contact during the site visit. It is located east of Alair. This Mandal has 17 habitations with access to non-safe sources of domestic water supply, the most of any Mandal in Nalgonda. According to Salim, the water supply itself is not the problem; rather water quality is the challenge. The Mandal uses reverse osmosis to extract the water from the mineral and then supplies it via household connections to as many villages as possible. The carbon filters of the filters are replaced by local personnel every 15 days. Each such RO plant costs Rs. 4.5 lakhs or about $83,000, with an additional Rs.30,000 per month or $550 for maintenance. While these costs can add up quickly, the area has become an economic hot spot due to a major religious temple in the Yadagirigutta GP. The Sri Lakshminarayana Swamy draws people from the entire State of Andhra Pradesh, helping the local economy. Households pay towards cans of water and are thus able to contribute to nearly two-thirds of the operational costs. At the same time, these fluctuations in current population in Yadagirigutta present a challenge in drinking water demand and management.

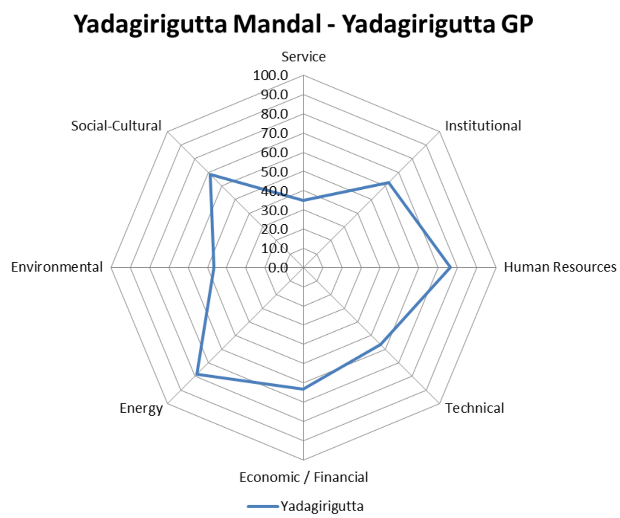

Figure 33: Community capacity assessment of Yadagirigutta GP.

The Sri Lakshminarayana Swamy Temple helped draw political support to the area, which aided with a slightly better energy infrastructure than typical rural Mandals. Tourists typically hail from urban areas, and the Mandal and District leadership works hard to accommodate them accordingly with electricity almost all day. However, one byproduct of the heavy demand in the area is the environmental impact. According to

Salim, NGOs have started cropping to address this and related problems in the area. Figure 33 shows the community capacity assessment of Yadagirigutta. Lastly, it should be noted that the GP Secretary is Muslim in predominantly Hindu area, and this can be taken as a sign of perceived equity.

As with Alair, Yadagirigutta Mandal is scheduled to receive CPWSS water. Meanwhile, the benefits afforded to Yadagirigutta because of the presence of the temple are extended across the Mandal. While some of these villages still suffer, as demonstrated by the 17 without access to safe sources of drinking water, the greater economy has been undercutting the problem by means of physical water transportation. The residual benefits of the better economy are thus wide. Its aggregate capacity is summarized below.

Table 22: Aggregate community capacity demand of Yadagirigutta Mandal.

Factor	Yadagirigutta
Institutional	B
Human Resources	B
Technical	C
Economic / Financial	B
Energy	A
Environmental	B
Social-Cultural	B
~ACCG	**B**

7.1.4 Voligonda Mandal

Next, the Mandal from where the author had originally hailed from is considered. Voligonda Mandal is south of Bhongir and is home to nearly 70,000 people. The Mandal is almost all fully covered; 67 habitations are fully covered and the remaining 25 are expected to be fully covered by 2015. The water for Voligonda comes from a mixture of borewells and an extended pipe from the Musi CPWSS. The Musi CPWSS is a newer

CPWSS similar to the AMR Project. It pumps water from the nearby Musi River, which passes south of Voligonda, to a reservoir where it is treated and then distributed via gravity to nearby habitations. This CPWSS has been a half-way system between extending the AMR Project lines and installing more PWSSs.

Figure 34: View from the hill that houses the water tower that provides water to Voligonda GP and further. The town shown surrounded by agricultural farms is Voligonda.

Voligonda has started coming into the spotlight recently after the building of a temple, an engineering college, and a secondary school by the same person that originally sponsored this summer research trip, Dr. Pailla Malla Reddy. With provision of defluoridation plants nearby these areas, access to drinking water has been drastically improved. Groundwater is still used heavily for agricultural purposes. The main restriction on further growth of the district is a better road infrastructure, which would lead to better energy and water infrastructure as well. While access to education and communal empowerment has increased, the area still suffers from seasonal droughts and outbreaks of cholera, diarrhea, and malaria, indicating poor sanitation practices.

Voligonda Mandal Parishad Officer Janaki Reddy says that this may be due to treating the Musi River as a waste site (note that the same acts as a water source). For villages that are being reached by pipeline, water tankers are currently deployed by contract. Figure 35 shows the community capacity assessment of the GPs in Voligonda Mandal.

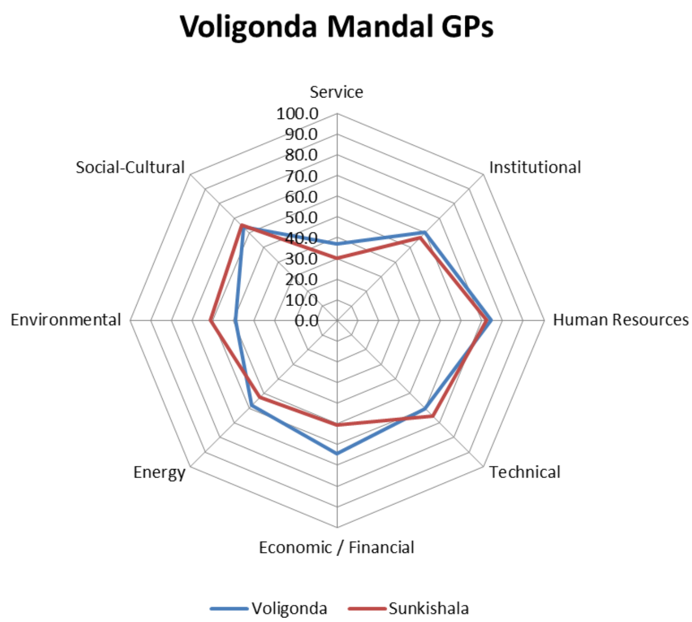

Figure 35: Community capacity assessment of GPs visited in Voligonda Mandal.

The aggregate community capacity grade includes the notes from Voligonda and Sunkishala GPs and is summarized in Table 23.

Table 23: Aggregate community capacity grade for Voligonda Mandal.

Factor	Voligonda
Institutional	B
Human Resources	B
Technical	B
Economic / Financial	B
Energy	B
Environmental	B
Social-Cultural	B
~ACCG	**B**

7.1.5 Mothkur Mandal

Mothkur Mandal is located east of Voligonda Mandal and southeast of Yadagirigutta Mandal. Atmakur(M) Mandal is located in between and was also visited, but not enough information was collected for an adequate community capacity assessment. Mothkur is more barren than the agriculturally heavy Voligonda, but recent irrigation projects nearby have spurred farming to start up in the area. The Mandal headquarters is already receiving CPWSS AMR Project water that is coming all the way in from Nalgonda Mandal's Panagal Reservoir. From the perspective of the contractors working on the project to provide access to the AMR Project water to the area, people were excited for new water but were struggling in building the appropriate infrastructure. Furthermore, the contractors were worried that the community would not be willing or would not take the initiative in maintaining the sumps and water towers that were being built to support the AMR Project water supply.

Figure 36: Contractors laying down pipe to bring domestic water supply from the AMR Project to the Mothkur area.

Guram Lakshmi Narasimha Reddy, a Doctor that runs clinics for the blind and general clinics in the Mothkur area, and Assistant Engineer P. Damodhar assisted in the site visits and helped explain the current activity in Mothkur. The construction of the

AMR Project expansion into Mothkur provided a unique opportunity to grasp community members perspective on the development. Surprisingly, many were ambivalent and despaired that the water would never come. Others showed excitement about the work bringing a few extra jobs to the area but were uncertain of how the system itself would be installed, indicating institutional weakness. The capacity summaries are below.

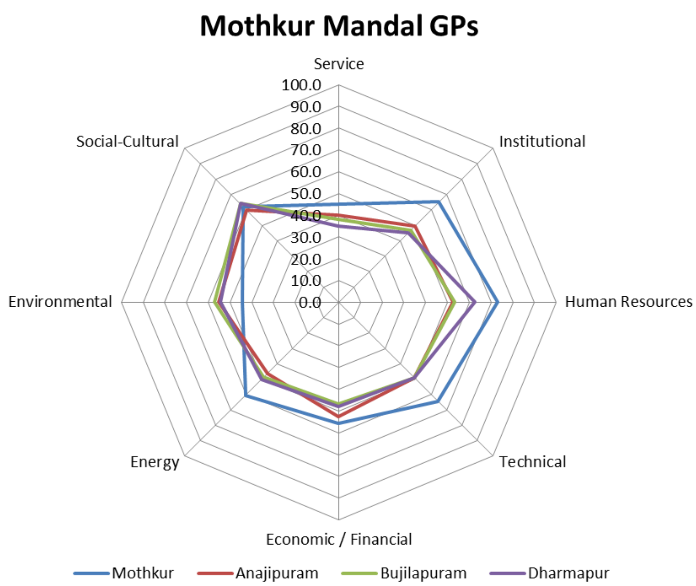

Figure 37:Capacity assessment for GPs visited in Mothkur Mandal.

The aggregate capacity of Mothkur Mandal reflects the institutional limitations, with other factors being not too bad or great.

Table 24: Aggregate community capacity of Mothkur Mandal.

Factor	Mothkur
Institutional	C
Human Resources	B
Technical	B
Economic / Financial	B
Energy	B
Environmental	B
Social-Cultural	B
~ACCG	**B**

7.1.6 Chouttupal Mandal

Chouttupal is primarily a trade town at the T-end intersection of some major highways and it is also the first major rural area outside of the Hyderabad city limits. While this gives the area an economic boost, it also creates a heavy demand of basic necessities like water and energy. Chouttupal currently faces difficulties in meeting this water demand by borewells alone. The groundwater levels have dropped severely and the Indrasena Reddy says that the area contracts water tankers to Chouttupal and area GPs on a regular basis. Due to its reliance on groundwater, Chottupal also has a small set of habitations that are vulnerable to non-safe sources of drinking water; these villages and those that are not fully covered are the primary targets of the water tankers.

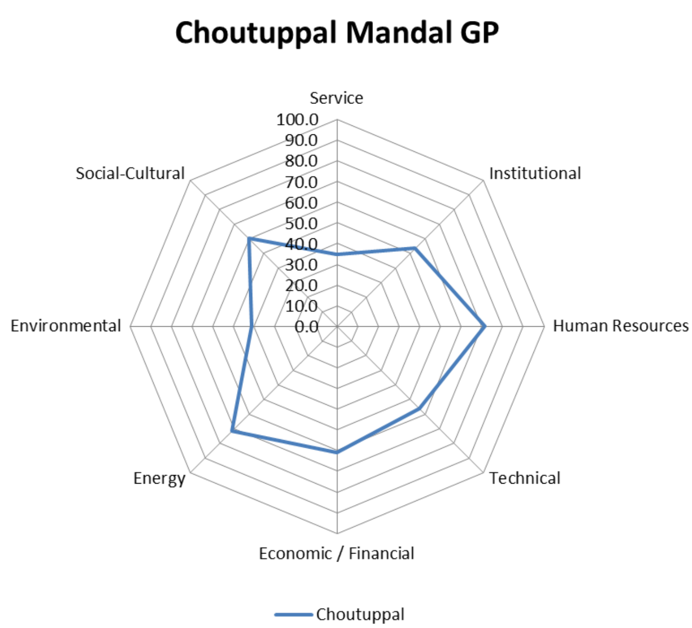

Figure 38: Community capacity assessment of Choutuppal GP.

Note that this area has better access to electricity because of its convenient location near Hyderabad and along main roads; yet struggles with ecological resources.

Table 25: Aggregate capacity assessment of Choutuppal Mandal.

Factor	Choutuppal
Institutional	B
Human Resources	A
Technical	B
Economic / Financial	B
Energy	A
Environmental	C
Social-Cultural	B
~ACCG	**B**

7.1.7 *Devarkonda Mandal*

Devarkonda was one of the most fluoride-ridden Mandals in Nalgonda originally, until a pointed campaign sought to eradicate it by bringing in CPWSS water and defluoridation plants. However, Deputy Engineer K. Hamsaram Rao and Hand pump mechanic Lakshmachari comment that problems arise when the water does not come from their associated treating station of CPWSS at Narsarpally Pumping Station. It is not the stations fault, but rather a breakdown along the piping lines, a failure that occurs frequently and causes stoppage for up to half a week. Because of this uncertainty, almost all houses have their own small storage containers now for backup. The water for the Mandal households is pumped out of a water sump located in Devarkonda RWS subdivision. The electricity is fairly unreliable so the Devarkonda Mandal provides the diesel for operating the pump. Additionally, the DE notes that Devarkonda supports its neighboring Chandempet Mandal during the summers because their groundwater tables bottom out. Both the DE and the mechanic note, separately, that the public participation is very low and often competitive in nature. They say that the few areas where the public participation is high is where the supply system does best.

The DE notes that the RWS office is engaging women to increase public participation and general ownership. Mahila Sangam is a women-focused NGO that provides education about water and sanitation services and is funded by the government; it operates in this area because of the proximity to Scheduled Caste and Schedule Tribe villages. Even still, prostitution and alcoholism seemed common place in this Mandal more so than anywhere else. Some of the water sump operators were visibly drunk on the job at the early hour of 8AM; talking freely about how most people in the area make and drink "Sara," an South Indian moonshine of sorts.

Finally the DE and mechanic spoke about the plans for the future. Since Devarkonda is attracting investment due to possible coal and uranium deposits in the area, they have formally put in a plea to become municipality, making the area eligible for state funding. The community capacity assessment is summarized below.

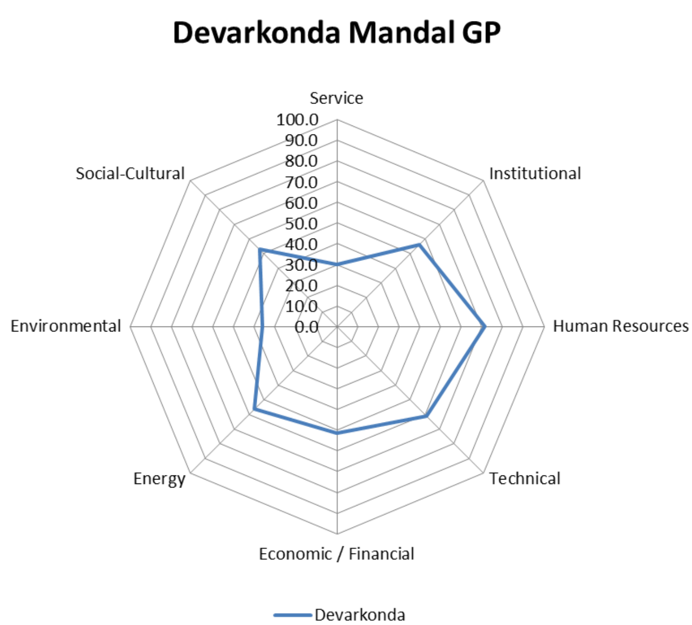

Figure 39: Community capacity assessment for Devarkonda. Note the low environmental/ecological and social-cultural scores.

Because of the rampant prostitution and alcoholism in the area, along with the marginalization of the scheduled castes and tribes in the area, the Mandal as a whole score the poorest along with Chandempet for social-cultural.

Table 26: Aggregate capacity assessment of Devarkonda Mandal. Note that the C indicates a high level of failure with CPWSS, which is currently occurring.

Factor	Devarkonda
Institutional	B
Human Resources	B
Technical	B
Economic / Financial	B
Energy	B
Environmental	C
Social-Cultural	D
~ACCG	**C**

7.1.8 Huzurnagar Mandal

Huzurnagar is on the southeast side of the Nalgonda District. Huzurnagar enjoys a better location in terms of the water shed as well as an economic boost from nearby Miyalaguda. However, less than half of its villages are fully covered. The primary stated reasons for this inconsistency are the diversion of water supply to Miryalaguda municipality as well as lack of human capital. Deputy Engineer Venkat Reddy and Assistant Engineer Brahmam Babu note that the remaining one-third is scheduled to be covered as soon as the CPWSS has been expanded. Meanwhile, the area depends on groundwater supply and sometimes water tankers during the summer. The area does not face a quality issue as much as that to the north and west, but it still struggles with proper sanitary conditions. The engineers note that the proximity to a successful Mandal is both a blessing and a curse – it provides for some jobs, but it also means that the young talent leaves Huzurnagar as quickly as they can, causing problems in low- to mid-level work.

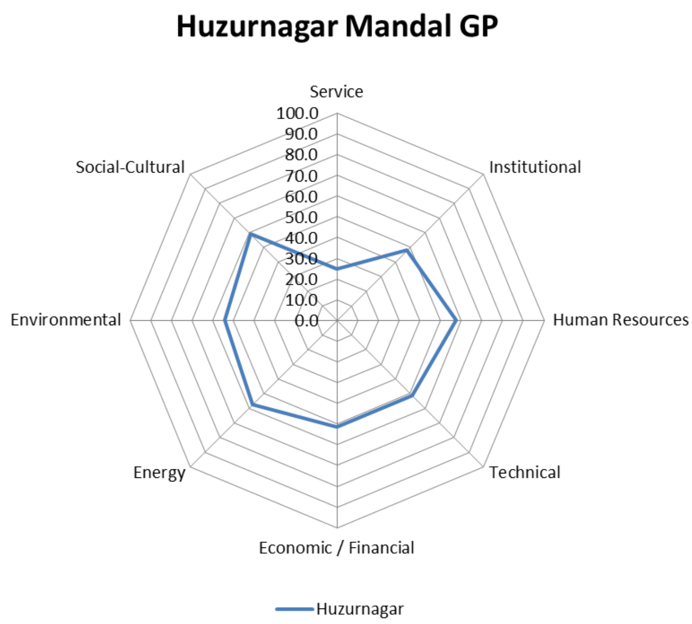

Figure 40: Community capacity assessment of Huzurnagar GP.

Due to the challenges that the area faces in maintaining a sustainable institutional pattern as well as keeping human capital, Huzurnagar ends up being a lower performing Mandal even though an RWS subdivision office is located there. It is expected by Reddy and Babu, however, that with proper focus on infrastructural self-growth rather than relying or Miryalaguda, Huzurnagar may become a better place for families to develop. However, the infrastructural growth has to start with a soft system overlay, or otherwise risk similar pipeline failures as those encountered in Deverkonda.

Table 27: Aggregate capacity assessment of Huzurnagar Mandal.

Factor	Huzurnagar
Institutional	C
Human Resources	C
Technical	C
Economic / Financial	C
Energy	B
Environmental	B
Social-Cultural	B
~ACCG	**C**

7.1.9 Marriguda Mandal

Marriguda Mandal is located south of Choutuppal and is a great case study of a high-fluoride zone that was also coping with difficulties with water supply, but is now doing better because of the CPWSS expansion to the area. The area was toured with a set of hand pump mechanics, A. Sathya and A. Yaddaya. Both assure that the current status of water is good for the village, yet their further comments indicate that the area is simply doing better than in the past. The area is approximately 75% fully covered, with the remaining villages anticipated to be covered within the next 5 years. The mechanics seemed thankful for access to CPWSS but said that it has introduced a new set of problems. The CPWSS was expanded to area less than two years before the visit. Some places, however, are showing signs of falling apart already. Poorly built storage reservoirs, broken or leaky pipes, and improper or no maintenance has led to a series of distribution-side failures. The problem now has changed from dental and skeletal fluorosis to malaria, cholera, and diarrheal incidences.

Figure 41: Leaking pipe from a CPWSS-fed central reservoir in Anthampeta GP.

The Village Development Officer offered further insight into the situation during the site visit. The domestic water is not coming to all the households, but rather a central point in the village. This is forcing households to balance their water use between hand pumps for generic domestic use and the AMR Project water for drinking and cooking. Furthermore, he said that the area had been experimenting with RHS but stopped after CPWSS was delivered. The process of treating rain water via bleach or chlorine is supposed to be applied to the AMR Project water but locals assume that the water is already fully clean. Furthermore lack of maintenance of the sanitation channels has also contributed to increase in cases of malaria and cholera. The VDO said these are the type of cases that the Sarpanch or Deputy Sarpanch should be taking care of, yet they are often not found by the villagers or when asked by the Mandal. The community capacity assessments for Marriguda are summarized in Figure 42.

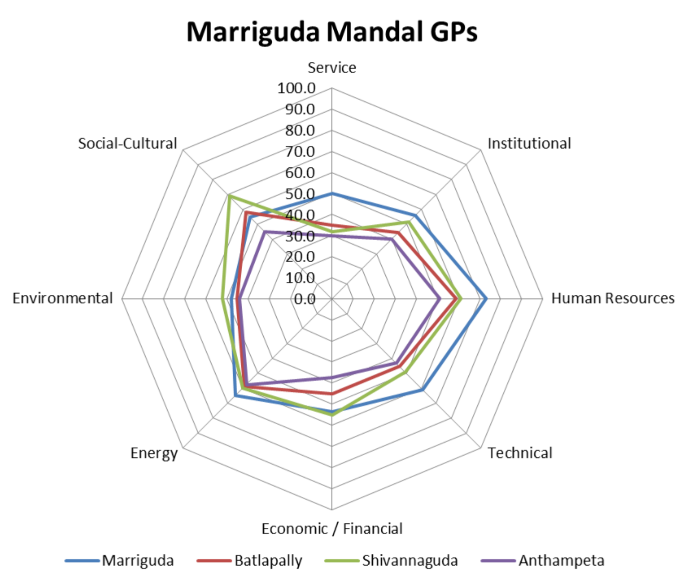

Figure 42: Community capacity assessments of the visited GPs in Marriguda Mandal.

Given the significant variance amongst the capacity factors, excepting energy, a red flag is raised on the sustainable operation of any sort of centralized infrastructure.

Marriguda GP does pretty well across the board because of the presence of development office and access to the main CPWSS line directly to the headquarters. Furthermore, its historic location along fort walls of the Nizam kingdom's horse stables also helped create a transportation infrastructure and corresponding economic boost. Shivannaguda is another religious site dedicated to Lord Shiva, and thus enjoys the respective benefits. However, the other areas suffer easily from lack of empowerment or lack of knowledge or guidance of their newly equipped system. Thus, the Marriguda Mandal places ends up being a mid-level capacity Mandal whose soft system may be built up to properly maintain its own respective water and sanitation infrastructure.

Table 28: Aggregate community capacity of Marriguda Mandal.

Factor	Marriguda
Institutional	C
Human Resources	B
Technical	C
Economic / Financial	B
Energy	B
Environmental	C
Social-Cultural	B
~ACCG	**B**

7.1.10 Miryalaguda Mandal

Miryalaguda is a large municipality and Mandal in the southeastern part of Nalgonda. The Mandal has a geographic advantage of being nestled between two smaller rivers that break from the Krishna River, which is dammed at the Nagarjuna Sagar. However, Miryalaguda uses water from before the dam through an extended canal system from the Puthangadi Balancing Reservoir, which is the first main reservoir of the AMR Project. The water travels via the North-South Left Canal to the Peda Devulapally

Balancing Reservoir, where it is treated and supplied to the Miryalaguda area. As such, it essentially has two different supply lines. Miryalaguda uses the smaller rivers for industrial purposes, such as fishing and mining.

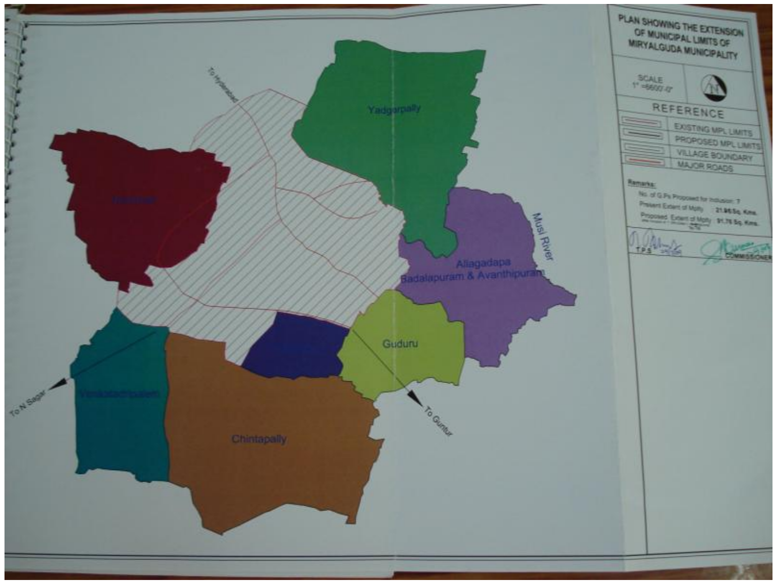

Figure 43: Town Planning Officer shows the plans for the absorption of surrounding GPs into Miryalaguda municipality. One of the evaluated GPs, Chinthapally, is south of Miryalaguda and another, Venkatadripallam, is southwest of Miryalaguda.

At the time of the visit, Miryalaguda's municipality was issued a government order to add seven GPs, essentially an order to expand the municipal infrastructure to the respective areas of the Mandal. The municipality received Rs. 140 crore [~$27M] to expand to the surrounding GPs, but Rosaiah says that at least Rs. 46 crore [~$9M] for the system to be implemented properly. The order to develop surrounding GPs is laudable, but it invokes the classic wealth-tax system rather than internal development. As can be seen by the capacity assessment, one of the rural areas has been entrepreneurial while another has faced tremendous institutional and social-cultural challenges. The Town Planning Officer Rahul R. believes that it is possible to expand services, but the biggest problem is lack of knowledge of the communities, which he believes to be a two-way street. He proposes a creative solution of taking a GIS survey of the Miryalaguda area, as well as the entire Nalgonda District and Telangana region. The micro-level GIS data helps with better understanding the watershed, village details, and existing systems such as water and sewage lines. He was enthusiastic in pitching the idea, but quickly identified that the bureaucracy of approving such level of work would be tremendous. In addition, the GIS would become public data, which may not sit well with some of the officials who are corrupt and take advantage of information parity.

Two important people, Miryalaguda Municipal Chairperson Marugu Rosaiah and the municipality's Deputy Engineer Venkataswarulu, were able to afford time for an interview. Both officers started the conversation with underlining that Miryalaguda still faces water scarcity despite the official statistics. The previous funds for expansion to municipality level was not enough for providing all of the allocated residents with sufficient water supply; their comments fall against the 96% fully covered and 86 lpcd statistics for the municipality. This indicates inconsistency between the reported statistics and the actual statistics. As they further described the system, it is clear that the reported statistics could be a greater average across the year and thus not account for periodic breakdowns. Currently, the municipality supplies water by ward, exchanging which ward will get the supply every three days. For the allocated day, that ward receives water for about 2-4 hours, which they say is enough to fill up their respective tanks, usually 1,000L in size. Assuming that this tank is meant for a typical household of six, it comes out to roughly 60lpcd. These assumptions fail for the many apartment complexes that are in the area, which may have larger tanks, but also are much denser.

Finally, it is important to note that this municipality and Mandal in general seem richer in technical expertise, in institutional awareness, and human capital. While one visited village, Venkatadripallam, had an underwhelming assessment due to lack of leadership and poor maintenance, others performed either equal to or better than the rest of the villages in the district. Zapthiveeragudem and Chinthapally especially demonstrate that entrepreneurial efforts by community members with regards to water supply may have a positive impact. Miryalaguda's capacity summary is shown here.

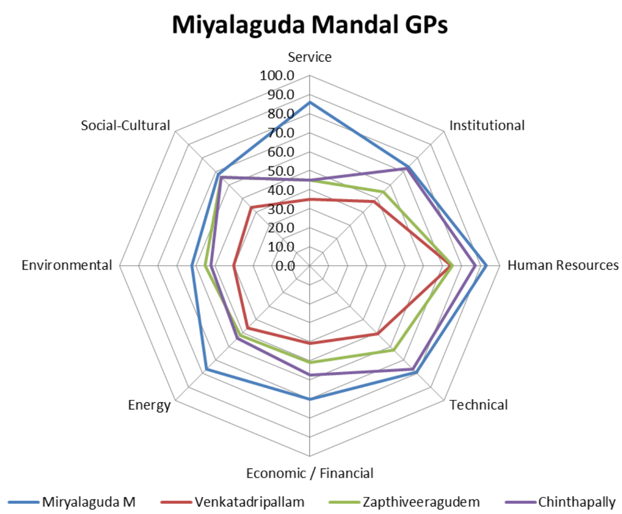

Figure 44: Community assessment of the Mandals visited in Miryalaguda Mandal. The wide blue circle is the assessment of Miryalaguda municipality itself. Note that two of the visited villages with different capacities are being absorbed by Miryalaguda's municipality expansion.

Even though Miryalaguda fares much better than most other Mandals in institutional awareness and operation, human capital, and economy, significant variances within the Mandal indicate fully advanced centralized supply systems may not yet fit the still developing area. Rather, creative solutions such as a GIS survey of the area, as suggested by Rahul R., or private entrepreneurial ventures, such as the defluoridation treatment and water distribution facility conceived by Police Constable Sudhaker, supported with quality monitoring by the area government, may be better for the area.

Table 29: Aggregate capacity of the Miryalaguda Mandal.

Factor	Miryalaguda
Institutional	A
Human Resources	A
Technical	B
Economic / Financial	A
Energy	B
Environmental	B
Social-Cultural	B
~ACCG	**B**

7.1.11 Nakrekal Mandal

Nakrekal Mandal is east of Nalgonda Mandal and northwest of Miryalaguda. It is at a crossroads between the three major municipalities of Nalgonda, Miryalaguda, and Suryapet, and grow out as a trade and mining town. A canal passes through Nakrekal intended for agricultural purposes; water flows only after the moon season after the summer and the canal dries up within six months. While drinking water is extended to the households in Nakrekal from the Panagal Reservior in Nalgonda through the AMR Project CPWSS, much of the actual domestic water supply is supplied by PWSS and hand pumps. This diversified portfolio of water supply has lent the area a better water supply than most habitations in the District. However, Nakrekal's offices are struggling to manage this diversified portfolio without the human capital or the technical capability. In a sense, it is a system that sees multiple different sources of input, but faces an uncertainty in knowledge of their capabilities of management, in a sense the respective decision and control variables available to the Mandal. As such, the expansion of CPWSS, according to the RWS Section Officer Madhushudharan, has been much slower than expected and thus slowed such provision to surrounding Mandals, such as

Thipparthy, which shall be addressed in a subsequent section. Furthermore the area struggles in managing their respective solid waste and general sanitation as well as proper supply of electricity. The summarized capacity assessment is presented in Figure 45.

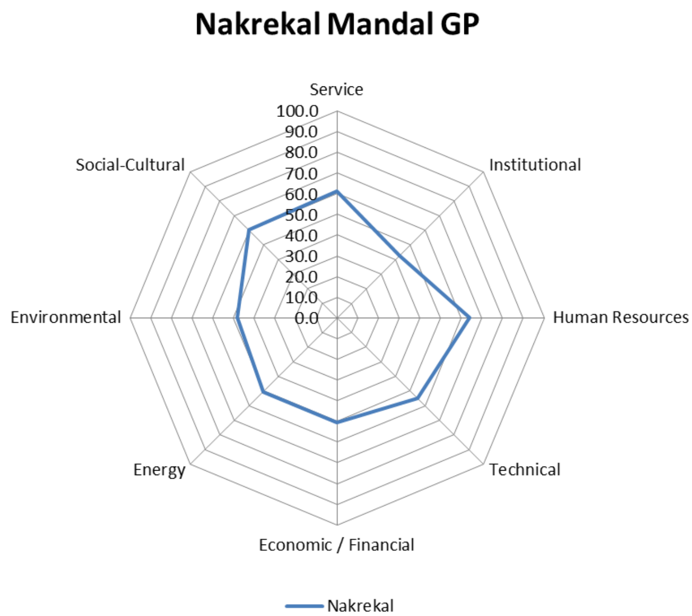

Figure 45: Community assessment of Nakrekal Mandal.

Though much of Nakrekal Mandal has greater access to drinking water supply, its aggregate capacity falls lower due to lack of leverage in human, environmental, and institutional ability to achieve sustainable operation of the greater domestic water system.

Table 30: Aggregate capacity of Nakrekal Mandal.

Factor	Nakrekal
Institutional	B
Human Resources	C
Technical	B
Economic / Financial	B
Energy	B
Environmental	C
Social-Cultural	B
~ACCG	**B**

7.1.12 Nalgonda Mandal

Nalgonda Mandal is at the heart of the Nalgonda District; the Mandal includes Nalgonda municipality that houses all the Zilla Parishad, the RWS department headquarters, and the Drinking Water Management Agency. The Mandal is well equipped with water supply and is upgrading its infrastructure to include larger sewage and power lines for a bigger tomorrow. All of the Mandal is supplied by the AMR Project water that comes from Nagarjuna Sagar and travels via canal to the Panagal Reservoir. However, the challenge going forward for the Nalgonda Mandal area is that of multi-system design and integration. As per Suresh, the area can no longer afford to "keep digging the same road month after month just to fix or lay another line."

Here it is important to make a special note about the DWMA. Though its name suggests heavy involvement with the drinking water supply, its sole purpose is to monitor the groundwater levels and quality in the Nalgonda District and sponsor work as published by Rafiuddin (2007). However, it should be better integrated with the RWS for better recommendation of installment of PWSS, hand pump, and general watershed information. Currently, it serves more of a think-tank rather than an agency of the government.

Panagal, where the reservoir, centralized treatment facility, and RWS headquarters are located, was also chosen as a place for site visit. It presented an interesting dichotomy of advanced technology with historic systems and a typical village. Panagal is home to one of the oldest temples in India; the temple is pictured in Figure 46. The temple served as not only a space for worship, but also a place for rain water collection and small-scale farming. Thought it is not actively maintained, the temple still serves as a striking example of a visionary sustainable life-style for its personnel. Unfortunately, it was battered and vandalized during raids by the Islamic Nizam Empire. The habitants of Panagal still clean the temple once or twice every month as a sign of respect to their respective heritage.

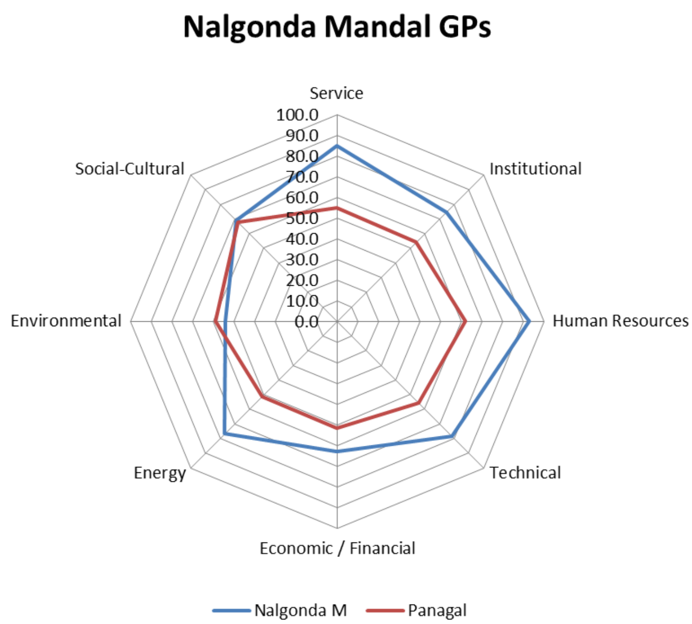

Figure 46: Community assessment of GPs visited in Nalgonda Mandal.

Nalgonda's infrastructure is already advanced and well-equipped with CPWSS; as a result of the exposure over the last decade to the development of CPWSS for not just the Mandal but also the District. The institutional capacity in the Mandal has increased tremendously and is still rising to meet the needs of the growing concerns of Nalgonda. The local colleges and universities have also been feeding well into the RWS services, where jobs have increased due to foreign direct investment, foreign service aid, and governmental institution. Lastly, the technical capabilities have diversified; in dealing with the many initial problems associated with CPWSS, the operation and maintenance has become streamlined in the Mandal.

Table 31: Aggregate capacity assessment of the Nalgonda Mandal.

Factor	Nalgonda
Institutional	A
Human Resources	A
Technical	A
Economic / Financial	B
Energy	B
Environmental	B
Social-Cultural	B
~ACCG	**B**

7.1.13 P. A. Pally Mandal

P. A. Pally is located southwest of Nalgonda Mandal and east of Devarkonda Mandal. In order to go to the Nagarjuna Sagar Dam, one typically travels through or stays in P. A. Pally Mandal. The area is rural, but its geographic proximity to Narsarpally Treatment Facility, a main treatment and distribution node of the AMR Project CPWSS network, means that P. A. Pally Mandal has the chance to be fully covered. However, this was only true to just over half of the habitations in the Mandal. The site visit to Chilkamarry brought this to light. According to Venkatasham, the hand mechanic who was the guide to the P. A. Pally area and Chilkamarry specifically, this was "the biggest problem village," for which he provided three main reasons. First and foremost, Chilkamarry had very poor leadership; its Sarpanch was often nowhere to be found and did not participate in the greater Mandal meetings of Sarpanches that occur every three months. Secondly, the village was unfamiliar with the technical operations of a PWSS even. The pump and defluoridation equipment stayed locked up in a small house, to which the Sarpanch has the key, but no one knew how to operate and maintain it even if they were given the key.

Figure 47: Picture of the Overhead Storage Reservoir (OHSR) in Chilkamarry. The OHSR was almost always empty which prompts the villagers to use hand pumps as the main source of water. Note the small house next to the OHSR, where the pump and defluoridation equipment for this PWSS was kept locked.

Lastly, the area had poor knowledge of proper sanitation and hygiene, which further aggravated the negative results of poor water supply. Venkatasham further commented on the social impact of Chilamarry being literally “bypassed” as fresh water went along the main road, which is next to Chilkamarry, and not to the village itself. An already poor village now felt unworthy and discarded; he compared the situation to that of transportation to school. While everyone received a free ride on the school bus, the village was like a kid who would be skipped even though he was directly on the bus’s route.

Aside from the specific situation of Chilkamarry, the rest of P. A. Pally mandal enjoyed better water supply, better economy from the regional tourism for the Sagar, and better transportation service because of the road direct from Hyderabad to the Sagar. However, it still suffered from frequent power outages. Furthermore, the lack of accountability of local leadership often exacerbated human services-related problems.

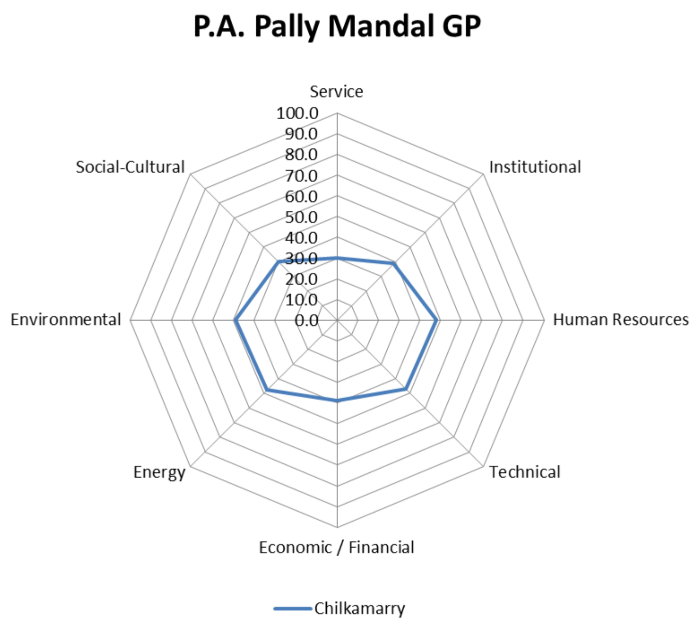

Figure 48: Community capacity assessment of the visited GP in P.A. Pally.

Even though the rest of the Mandal may be better equipped to handle higher-level technological alternatives, the fact remains that the Mandal's leadership does not have a set of operational rules to handle localized breakdowns or faults in leadership. The 5-year term is supposed to be constantly reviewed by the greater leadership, and thus indicates a higher-level failure. Furthermore, a village like Chilkamarry should not be ignored access based on their socio-cultural capital (in caste or tribe), much less economic status.

Table 32: Aggregate capacity assessment of P.A. Pally Mandal.

Factor	P.A. Pally
Institutional	C
Human Resources	B
Technical	B
Economic / Financial	B
Energy	B
Environmental	B
Social-Cultural	C
~ACCG	**B**

7.1.14 Narayanpur Mandal

Narayanpur Mandal is south of Choutuppal and east of Marriguda. It receives moderate levels of drinking water supply, with much of the area being supplied by the AMR Project CPWSS. Of the 72 villages, 42 are fully covered and the rest have varied levels of coverage below 40lpcd. Narayanpur also faces problems with water quality, as with Marriguda Mandal, and has thus received the CPWSS water to curb the heavy fluoride mineral content in the area's groundwater. Before the network had been extended to Naryanpur, the area suffered from common drought, which was only worsened by the heavy fluoride content. Some parts have adopted RHSs as a means to cope with seasonal variations in water availability and water quality. One such village that was visited was Vaillapally.

Figure 49: A rainwater harvesting scheme outside the house of the Deputy Sarpanch of Vaillapally.

Vaillapally is a 6,000-strong GP located in the heart of Narayanpur and is a testament to possible success of RHS on a large scale in the Nalgonda Region. The GP is made up of several smaller habitations and villages, but almost all of them have RHS.

The systems is setup as follows: each household uses the flat roofs as a catchment for rainwater, which is then collected by sinkhole and sent through PVC pipe to a rapid ash-and-sand filter and then into a ground-level, cement-based storage tank. The size of these tanks varies, but it was found that a common household has two 3,000L tanks. The filters are cleaned bi-weekly either by the homeowner or by a volunteering neighbor familiar with the system. Households use this water for drinking and cooking year around, and the deputy Sarpanch claims that many prefer rainwater to CPWSS water because it "tastes better." In all, latest census puts water supply to Vaillapally at just over 61lpcd.

In addition to the RHS, the community supplements its domestic needs with CPWSS water and PWSS water. However, the PWSS water is never used for drinking or cooking purposes because of incredibly high levels of fluoride, up to 7.8mg/L. These different streams of water are provided by household connections, which each household pays Rs. 10 per month, with an astounding collection success rate of over 90%.

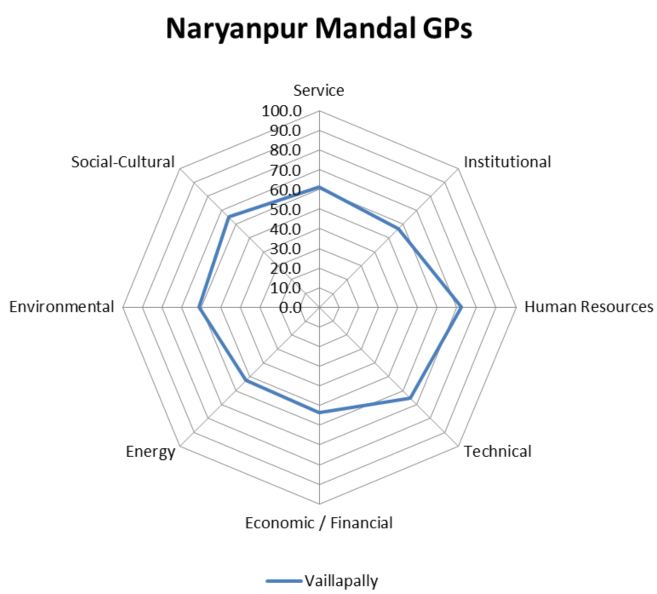

Figure 50: Community assessment of GP visited in Narayanpur.

Vaillapally may be a bit of an outlier not just in Narayanpur Mandal, but in Nalgonda as a whole. Not as many villages focus on communal success of basic water and sanitation. Nevertheless, the area still has much to improve in terms of economic will. Some new ideas for economic success in the area include mining, which would strain the water supply component, perhaps why its citizens have been careful before leaping to decisions.

Table 33: Aggregate capacity of Narayanpur Mandal.

Factor	Narayanpur
Institutional	B
Human Resources	B
Technical	A
Economic / Financial	B
Energy	B
Environmental	B
Social-Cultural	A
~ACCG	**B**

7.1.15 Suryapet Mandal

Suryapet is a major economic asset of Nalgonda District. It is a municipality and Mandal located northeast of Nalgonda and Nakrekal, and along the main road from Hyderabad to major cities along the eastern coast of Andhra Pradesh. Suryapet's primary economy comes from infrastructure-based construction contracts. These contracts often include work in Nalgonda itself. Municipal Chairman Meela Satyanaryana acted as the primary guide to the municipality and the mandal itself. He is also the Managing Director of a regional piping and construction company, Sudhaker Group of Companies. Interestingly enough, one of his bets is the proliferation of RHS as a means for drinking water sourcing and supply; he makes several levels of water drums and storage tanks, very similar to "Jo-Jo" tanks in South Africa.

Figure 51: Water drums and water storage tanks manufactured in Suryapet.

The progressive leadership of Satyanarayana helped push the municipality to full coverage; however, the rest of the Mandal lags behind. Of the 52 villages under Suryapet Mandal, only two are fully covered and a majority has access to less than 30lpcd. Despite proximity to the Musi River, the Mandal had not yet been able to tap its potential through a successful CPWSS yet, though plans are abound. Furthermore, the inconsistent power supply to the area makes it much more difficult for drawing groundwater for PWSSs. The leadership has been doing its best to control the rest of the variables, like water quality and sanitation. Mechanics and operators clean OHSRs with chlorine and alum, and then tested for quality every 15 days. The sewage system of the municipality takes care of the wastewater and solid waste within its borders; it is then taken outside of the municipality for deposit or composting. However, this doesn't exist in the rest of the Mandal.

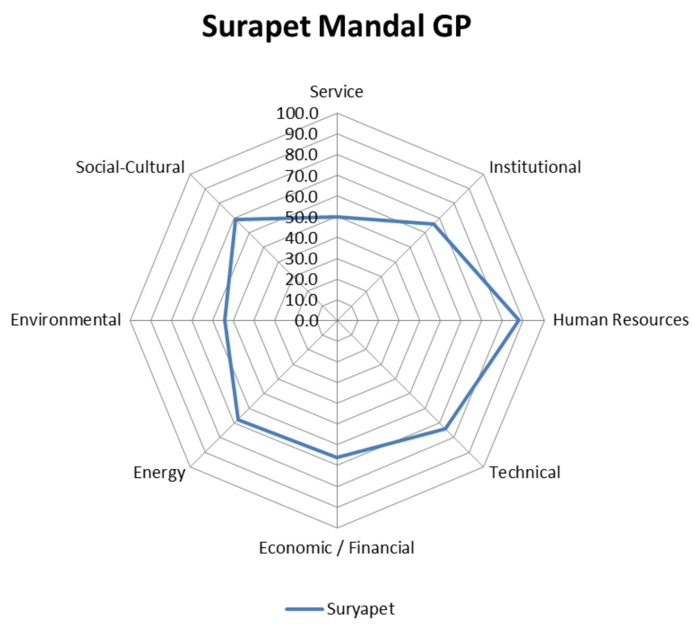

Figure 52: Community Capacity Assessment of Suryapet municipality.

Suryapet's municipality has been able to address its ecological and infrastructural shortfalls with creative uses of human capital, such as RHS and network of water operators. The Mandal at large, however, does not have that luxury. As such, it scores lower than other municipality-based Mandal areas. Specifically, the lack of power to areas outside the municipality hinders PWSSs and general drawing of water. Furthermore, this problem becomes compounded with physical water scarcity in the area.

Table 34: Aggregate capacity assessment of Suryapet Mandal.

Factor	Suryapet
Institutional	B
Human Resources	B
Technical	B
Economic / Financial	B
Energy	C
Environmental	C
Social-Cultural	B
~ACCG	**B**

7.1.16 Chandempet Mandal

Figure 53: Villagers of Timmapuram showing the only borewell for the community, for which the pump is broken. The pump inside the aluminum shed in the background.

The last area to be considered is Chandempet Mandal, which is located on the southwestern most part of Nalgonda District and borders Ranga Reddy District and Krishna River, which is the river that is dammed for Nagarjuna Sagar and feeds the AMR Project CPWSS. The portion of Chandempet that is against the River is very mountainous and does not lend itself to many villages. The sites visited are located about six kilometers short of this mountain range. Hand pump mechanic Narsimha was the guide for the site visits, and Sarpanch Pappayya led the discussion for Timmapuram specifically. The theme for this village was lack of human resources, general poverty, and social-cultural apathy, all of which contributed to Müeller's definition of water scarcity.

The area mostly consisted of scheduled castes (SC) or scheduled tribes (ST). These were previously marginalized communities that are now prioritized for provision of water, sanitation, and electricity; the hand pump's definition of this prioritization resembled affirmative action in the USA. Some NGOs, like Sri Sailam, have been assisting the area. The community members complained that leadership becomes corrupt because of this prioritization; the elected Sarpanch who must be of the respective SC or ST is typically hand-picked by the wealthier non-SC or ST families in the same village. According to the villagers, money allocated towards communal projects, such as motors for groundwater pumping or digging of sewage canals, would mysteriously disappear. Essentially, almost all villagers including the hand pump mechanic and the Sarpanch himself claimed that the money burned away in bureaucratic corruption

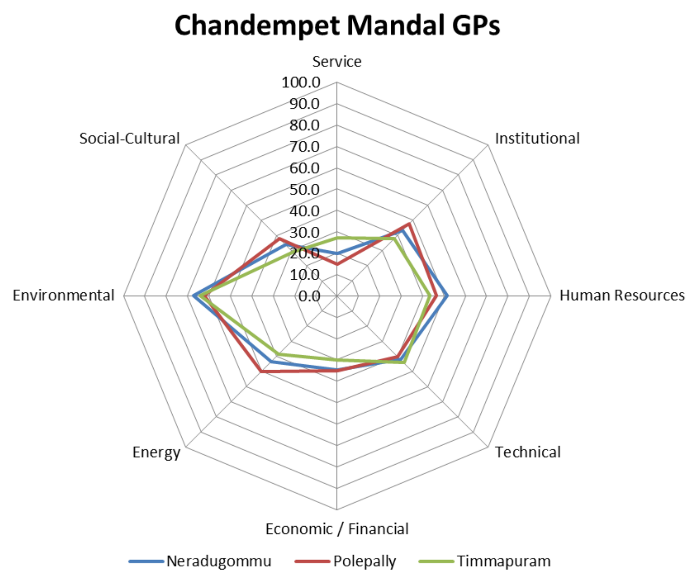

Figure 54: Community capacity assessment of visited GPs in Chandempet Mandal.

Of 101 habitations, only a third of Chandempet is fully covered, with the rest at varied levels of coverage and eight with access to non-safe sources. Most of the area is covered by PWSS and rely heavily on groundwater pumps, and thus electricity. Moreover, residents complain that broken pumps are rarely fixed; here, Narsimha notes that some folks typically steal and sell the pump parts rather than use it for intended purposes. Additionally, Narsimha states some of the borewells end up being submerged during the monsoons because of the proximity to the Krishna River. It was also noted that households do not pay Rs. 30 per month maintenance fee in addition to not paying the initial connection costs, which range from Rs. 2500-3000. Furthermore, Narsimha said that the incoming project funds were often allocated to outside the community contractors rather than in-community labor force, making it possible for leadership to take paybacks with very little evidence. Narsimha and some of the residents also commented on the sad state of school affairs. Only a third of the district-funded teachers showed up for work and most were incompetent or drunk on the job. As such, the literacy rate has been dropping from the already low rate of 40%.

Table 35: Aggregate capacity of Chandempet Mandal.

Factor	Chandempet
Institutional	C
Human Resources	C
Technical	B
Economic / Financial	C
Energy	B
Environmental	B
Social-Cultural	C
~ACCG	**C**

Though Chandempet has a better ecological system, its soft system breakdowns contribute to water scarcity to the area. Efforts by Sri Sailam should be focused in increasing awareness of proper water system operation and management along with delivering water supply, as they had planned to do. Effectively, this NGO's approach would be akin to implementing a CPWSS for multiple areas in Chandempet; and the evidence is overwhelming that such a system has a chance of multiple levels of failure.

7.2 Summary of Capacity Assessment of Nalgonda

Table 36: Summary of aggregate capacities of Mandals in Nalgonda District.

Mandal	Institutional	Human Resources	Technical	Economic / Financial	Energy	Environmental	Social-Cultural	*~ACCG*
Alair	C	C	C	B	B	C	B	**C**
Bhongir	B	C	B	B	B	C	B	**B**
Chandempet	C	C	B	C	B	B	C	**C**
Choutuppal	B	A	B	B	A	C	B	**B**
Devarkonda	B	B	B	B	B	C	D	**C**
Huzurnagar	C	C	C	C	B	B	B	**C**
Marriguda	C	B	C	B	B	C	B	**B**
Miryalaguda	A	A	B	A	B	B	B	**B**
Mothkur	C	B	B	B	B	B	B	**B**
Nakrekal	B	C	B	B	B	C	B	**B**
Nalgonda	A	A	A	B	B	B	B	**B**
Narayanpur	B	B	A	B	B	B	A	**B**
P.A. Pally	C	B	B	B	B	B	C	**C**
Suryapet	B	B	B	B	C	C	B	**B**
Voligonda	B	B	B	B	B	B	B	**B**
Yadagirigutta	B	B	C	B	A	B	B	**B**

From the table, it can be concluded that Nalgonda as a District has an ACCG of B. In considering the capacity grades assigned to the Mandals that were visited, one immediately notices that no Mandal's ACCG is either too high (no A's) or too low (no D's). Five Mandals have an ACCG of C, indicating that these Mandals are ill-equipped to handle complicated systems like CPWSS or even PWSS, both of which received a PCG of A and B, respectively. Of those that received a B, some may be considered of higher capacity, such as Miryalaguda and Nalgonda Mandals, while others may be considered lower, such as Marriguda Mandal. Nevertheless, this provides a holistic picture of what types of solutions each Mandal may be capable of handling.

Consider the success of the respect of CPWSS, PWSSs, or RHSs that are in the communities with the associated capacity grade. Places like Nalgonda and Miryalaguda municipalities have higher success rates with CPWSS because of their tight institutional awareness, keen technical control, and human capital. Yet, for the exact opposite reasons, you can find CPWSS failing or on the cusp of failing in places like Marriguda and Devarkonda Mandals. While the LOCCA methodology is not a sure measure of risk in design, it provides helpful information on possible successes or failures of policies such as CPWSS. Furthermore, it provides a platform for both quantitative and qualitative assessment between governance levels, which could assist leaders at these levels to make better informed decisions. Lastly, this process also helped engage the voice of the community and identify ways in which individual members could participate in the greater system for communal good.

Chapter 8: Conclusion

Water supply remains a significant challenge for communities around the world, irrespective of socio-economic status or ecological advantage. Improper institutional leadership, lack of technical knowledge, apathy or lack of agency, and general lack of access to resources are prime reasons for why the matter is worse developing communities around the world. Decision frameworks are used to predict what may be the best solution for any given community; however, many of these frameworks are unable to capture a comprehensive snapshot across institutional levels and typically forget to include community members and leaders as part of the decision-making process. The Louis-Ostrom Comprehensive Capacity Analysis (LOCCA) methodology is suggested as a possible framework that could address these shortfalls. The crux of the methodology is a recursive assessment of capacity at the village level which is then aggregated across other villages in the same Mandal. The aggregate community capacity grades of Mandals are then compared and aggregated once more to arrive at the ACCG for the District. This multi-level process accounts for a comprehensive, intra-institutional, and participatory assessment of a community's ability to adopt water-related technology-based policies.

The LOCCA methodology is presented through a case study of the Nalgonda region, which faces water scarcity, poor water quality, and operational challenges with water supply in general. Three technologies that are prevalent in the area are first considered: comprehensive protected water supply schemes (CPWSS), protected water supply schemes (PWSS), and rainwater harvesting schemes (RHS). CPWSS is a surface water-sourced and centralized treatment water delivery method across a wide network of villages. PWSS is a groundwater-based scheme that addresses the needs of a couple villages with quality control through defluoridation equipment. RHS is typically a household-level roof-based rainwater harvesting system that supplements water from additional sources like PWSS or RHS.

In considering Nalgonda, several challenges crop up in employing a wide network style solution like CPWSS. These include institutional knowledge, technical capabilities, communal ownership and agency, and follow-through. CPWSS has found success in areas where these issues have been properly addressed, like in the municipalities of Nalgonda and Miryalaguda. It has also faced failure in places like Devarkonda. PWSS is the ready alternative, but relies heavily on consistent access to electricity, proper communal maintenance, and defluoridation equipment due to heavy mineral content in water. RHS has acted primarily as supplementary mechanism for drinking and domestic uses of water, and has found success in almost all places implemented.

In addressing the drinking water situation in Nalgonda, the District should support RHS-type solutions to trap the monsoon pouring and increment domestic water supply by up to 20lpcd. Furthermore, leadership should consider greater level of accountabilities by implementing a shorter term for Sarpanches or providing more power to the Gram Sabha. In addition, the relationship between domestic and economic uses of water should be clearly delineated and educated to folks around the District as to prevent overdrawing for agricultural and mining purposes. Finally, alternative means of financing and budgeting of infrastructure-related projects should be considered to lower corruption and increase rate of return on investment on installed projects.

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Appendix I: Community Capacity Assessment of Nalgonda, with RWS

	Capacity Factors	1-20	21-40	41-60	61-80	81-100	Score	Weight
1	**Service Capacity**							
C_{11}	Service Level	< 20 l/p/d	20 - 40 l/p/d	40 - 60 l/p/d	60 - 80 l/p/d	> 80 l/p/d	40	1
f_1	*Score Service Capacity*					$\sum C_{ij} w_j$	*40*	*1*
2	**Institutional Capacity**							
C_{21}	Body of Legislation	None	Basic	Intermediate	Complete	Advanced	21	0.1
C_{22}	Associated Regulation	None	Basic	Intermediate	Complete	Advanced	21	0.1
C_{23}	Administrative Agencies	None	State	District	Mandal	Local	60	0.25
C_{24}	Administrative Processes	None	Basic	Intermediate	Complete	Advanced	21	0.25
C_{25}	Governance	None	National	Regional	State	Local	81	0.3
f_2	*Score Institutional Capacity*					$\sum C_{ij} w_j$	*48.8*	*1*
3	**Human Resources Capacity (service provider)**							
C_{31}	Professionals	None	None	Administrative supervisor	Administrative manager	Administrative manager	65	0.2
				Health Scientist	Health Scientist	Health Scientist		
					Engineer	Engineer		
						Lawyer		
						Public relations manager		
C_{32}	Skilled Labor	None	Mechanic	Maintenance technician	Maintenance technician	Maintenance technician	45	0.4
				Laboratory technician	Laboratory technician	Laboratory technician		
				Water systems operator	Water systems operator	Water systems operator		
					Health Inspector	Health Inspector		
					Administrative assistant	Administrative assistant		
					Water meter leader	Water meter leader		
						IT technician		
C_{33}	Unskilled Labor	Craftsman	Clerk	Clerk			100	0.3
			Mechanic assistant	Water meter reader				
				Water systems worker				
C_{34}	Illiterate	Caretaker	Caretaker				100	0.1
f_3	*Score Human Resources Capacity*					$\sum C_{ij} w_j$	*71*	
4	**Technical Capacity**							
C_{41}	Operations	Water Use	Pumping Water	Pumping Water	Monitor water systems	Monitor water systems	50	0.3
				Control Water Quality	Control Water Quality	Control Water Quality		
					Control Pipes	Monitor pipes network		
						Monitor Treatment		
C_{42}	Maintenance	None	Clean water systems	Check water systems	Check/maintain water systems	Check/maintain water systems	41	0.4
			Minor repair	Major repair	Major repair	Check/maintain network		
					Maintain pipes	Check/maintain meter		
						Maintain IT systems		
C_{43}	Adaptation	None	Rarely	Occasionally	Usually	Frequently	21	0.2
C_{44}	Supply Chain	None	National supplier	Regional supplier	National manufacturer	National manufacturer	61	0.1
					regional supplier	local supplier		
f_4	*Score Technical Capacity*					$\sum C_{ij} w_j$	*41.7*	
5	**Economical and Financial Capacity**							
C_{51}	Private Sector %	None	International	National	Regional	Local	70	0.10
C_{52}	Bonds Rating	None	Regional	State	District	Mandal and Local	70	0.10
C_{53}	User Fees	None	Uniform flat rate	Single block rate	Increasing block rate	Increasing block rate	25	0.30
C_{54}	Budget	None	Basic accounting	Annual	Tracked bi-annually	Tracked quarterly	45	0.20
C_{55}	Asset Values	None	Real Estate	Real estate	Real estate	Real estate	61	0.20
				Equipment	Equipment	Equipment		
					Cash	Cash - Stocks		
C_{56}	Debt	None	Rating (b)	Rating (bb)	Medium Large Rating	Rating (a-aa)	55	0.10
f_5	*Score Economical and Financial Capacity*					$\sum C_{ij} w_j$	*54.3*	
6	**Energy Capacity**							
C_{61}	Primary Source	None	Non-conventional	Conventional electricity	Electricity mid-voltage	Electricity high voltage	70	0.4
C_{62}	Back up	None	None	Generator < 10 HP	Generator < 50 HP	Generator > 50 HP	40	0.1
C_{63}	% of Budget	None	Very high	High	Medium	Low	50	0.1
C_{64}	Outage Rate	None	High	Medium	Low	Very low	30	0.4
f_6	*Score Energy Capacity*					$\sum C_{ij} w_j$	*47.5*	
7	**Environmental Capacity**							
C_{71}	Quality and Sensitivity	Very low	Low	Medium	High	Very high	50	0.75
C_{72}	Quantity (stock)	Very low	Low	Medium	High	Very high	41	0.25
f_7	*Score Environmental Capacity*					$\sum C_{ij} w_j$	*45.5*	
8	**Social and Cultural Capacity**							
C_{81}	Communities/Ownership	Very low	Low	Intermediate	High	Very high	41	0.4
C_{82}	Stability	Very low	Low	Intermediate	High	Very high	41	0.2
C_{83}	Equity	Very low	Low	Intermediate	High	Very high	50	0.1
C_{84}	Castes	Very low	Low	Intermediate	High	Very high	40	0.1
C_{85}	Participation of Women	Very low	Low	Intermediate	High	Very high	50	0.2
f_8	*Score Social-Cultural Capacity*					$\sum C_{ij} w_j$	*44.4*	

Appendix II.A: Technology Capacity Level Scores – CPWSS

		Partitioned Scoring							
	Capacity Factors	1-20	21-40	41-60	61-80	81-100	Score	Weight	CF score
1	Service Capacity								
C_{11}	Effective service level	< 20 l/p/d	20 - 40 l/p/d	40 - 60 l/p/d	60 - 80 l/p/d	> 80 l/p/d	70	1	70
f_1	*Score Service Capacity*					$\sum C_{ij} w_j$		*1*	**70**
2	Institutional Capacity								
C_{21}	Body of legislation	None	Basic	Intermediate	Complete	Advanced	60	0.1667	10
C_{22}	Operational rules	None	Basic	Intermediate	Complete	Advanced	60	0.1667	10
C_{23}	Administrative agencies	None	State	District	Mandal	Habitational	75	0.1667	12.5
C_{24}	Administrative processes	None	Basic	Intermediate	Complete	Advanced	50	0.1667	8.333333
C_{25}	Governance	None	State	District	Mandal	Habitational	95	0.1667	15.83333
C_{26}	Presence of NGOs	None	Low	Medium	High	Very High	75	0.1667	12.5
f_2	*Score Institutional Capacity*					$\sum C_{ij} w_j$		*1*	**69.16667**
3	Human Resources Capacity (service provider)								
C_{31}	Professionals	None	None	Administrative supervisor	Administrative manager	Administrative manager	82	0.2	16.4
				Health Scientist	Health Scientist	Health Scientist			
					Engineer	Engineer			
						Lawyer			
						Public relations manager			
C_{32}	Skilled Labor	None	Mechanic	Maintenance technician	Maintenance technician	Maintenance technician	85	0.2	17
				Laboratory technician	Laboratory technician	Laboratory technician			
				Water systems operator	Water systems operator	Water systems operator			
					Health Inspector	Health Inspector			
					Administratrive assistant	Administratrive assistant			
					Water meter leader	Water meter leader			
						IT technician			
C_{33}	Unskilled Labor	Craftsman	Clerk	Clerk			100	0.2	20
			Mechanic assistant	Water meter reader					
				Water systems worker					
C_{34}	Illiterate	Caretaker	Caretaker				100	0.2	20
C_{35}	Access to Higher Education	None	State	Regional	District	Mandal	65	0.2	13
f_3	*Score Human Resources Capacity*					$\sum C_{ij} w_j$		*1*	**86.4**
4	Technical Capacity								
C_{41}	Operations	Water Use	Pumping Water	Pumping Water	Monitor water systems	Monitor water systems	85	0.2	17
				Control Water Quality	Control Water Quality	Control Water Quality			
					Control Pipes	Monitor pipes network			
						Monitor Treatment			
C_{42}	Maintenance	None	Clean water systems	Check water systems	Check/maintain water systems	Check/maintain water systems	65	0.2	13
			Minor repair	Major repair	Major repair	Check/maintain network			
					Maintain pipes	Check/maintain meter			
						Maintain IT systems			
C_{43}	Adaptation	None	Rarely	Occasionally	Usually	Frequently	51	0.2	10.2
C_{45}	Maintenance network	None	State	District	Mandal	Habitational	65	0.2	13
C_{45}	Distribution network	None	Regional Supplier	District Supplier	Mandal Supplier	Habitational Supplier	75	0.2	15
					District Approved	District Approved			
f_4	*Score Technical Capacity*					$\sum C_{ij} w_j$		*1*	**68.2**
5	Economical and Financial Capacity								
C_{51}	Private sector investment	None	State	Regional	District	Mandal	70	0.14	10
C_{52}	Market incentives	None	Low	Medium	High	Very high	51	0.14	7.285714
C_{53}	User fees	None	Uniform flat rate	Single block rate	Increasing block rate	Increasing block rate	70	0.14	10
C_{54}	Budget	None	Basic accounting	Annual	Tracked bi-annually	Tracked quarterly	81	0.14	11.57143
C_{55}	Asset values	None	Real Estate	Real estate	Real estate	Real estate	70	0.14	10
				Equipment	Equipment	Equipment			
					Cash	Cash - Stocks			
C_{56}	Investment activities	None	Low	Medium	High	Very High	51	0.14	7.285714
C_{57}	Loss to corruption	Very High	High	Medium	Low	None	65	0.14	9.285714
f_5	*Score Economical and Financial Capacity*					$\sum C_{ij} w_j$		*1*	**65.42857**
6	Energy Capacity								
C_{61}	Primary source	None	Non-conventional	Conventional electricity	Electricity mid-voltage	Electricity high voltage	90	0.25	22.5
C_{62}	Alternative source	None	None	Generator < 10 HP	Generator < 50 HP	Generator > 50 HP	70	0.25	17.5
C_{63}	Dependence for service	Very low	Low	Medium	High	Very High	60	0.25	15
C_{64}	Outage rate	Very High	High	Medium	Low	Very low	51	0.25	12.75
f_6	*Score Energy Capacity*					$\sum C_{ij} w_j$		*1*	**67.75**
7	Environmental and Ecological Capacity								
C_{71}	Environment quality	Very low	Low	Medium	High	Very high	50	0.2	10
C_{72}	Size of resource system	Very low	Low	Medium	High	Very high	70	0.2	14
C_{73}	Predictability of resource dynamics	Very low	Low	Medium	High	Very high	75	0.2	15
C_{74}	Growth or replacement rate	Very Negati	Negative	Stable	Positive	Very Positive	50	0.2	10
C_{74}	Resource sensibility	Very low	Low	Medium	High	Very High	65	0.2	13
f_7	*Score Environmental Capacity*					$\sum C_{ij} w_j$		*1*	**62**
8	Social and Cultural Capacity								
C_{81}	Communal ownership	Very low	Low	Intermediate	High	Very high	65	0.2	13
C_{82}	Political stability	Very low	Low	Intermediate	High	Very high	85	0.2	17
C_{83}	Equity	Very low	Low	Intermediate	High	Very high	60	0.2	12
C_{84}	Leadership/entrepreneurship	Very low	Low	Intermediate	High	Very high	45	0.2	9
C_{85}	Participation of women	Very low	Low	Intermediate	High	Very high	50	0.2	10
f_8	*Score Social-Cultural Capacity*					$\sum C_{ij} w_j$		*1*	**61**

Appendix II.B: Technology Capacity Level - PWSS

		Partitioned Scoring							
	Capacity Factors	**1-20**	**21-40**	**41-60**	**61-80**	**81-100**	**Score**	**Weight**	**CF score**
1	**Service Capacity**								
C_{11}	Effective service level	< 20 l/p/d	20 - 40 l/p/d	40 - 60 l/p/d	60 - 80 l/p/d	> 80 l/p/d	50	1	50
f_1	*Score Service Capacity*					$\sum C_{ij} w_j$		1	**50**
2	**Institutional Capacity**								
C_{21}	Body of legislation	None	Basic	Intermediate	Complete	Advanced	61	0.1667	10.16667
C_{22}	Operational rules	None	Basic	Intermediate	Complete	Advanced	61	0.1667	10.16667
C_{23}	Administrative agencies	None	State	District	Mandal	Habitational	81	0.1667	13.5
C_{24}	Administrative processes	None	Basic	Intermediate	Complete	Advanced	72	0.1667	12
C_{25}	Governance	None	State	District	Mandal	Habitational	81	0.1667	13.5
C_{26}	Presence of NGOs	None	Low	Medium	High	Very High	21	0.1667	3.5
f_2	*Score Institutional Capacity*					$\sum C_{ij} w_j$		1	**62.83333**
3	**Human Resources Capacity (service provider)**								
C_{31}	Professionals	None	None	Administrative supervisor	Administrative manager	Administrative manager	60	0.2	12
				Health Scientist	Health Scientist	Health Scientist			
					Engineer	Engineer			
						Lawyer			
						Public relations manager			
C_{32}	Skilled Labor	None	Mechanic	Maintenance technician	Maintenance technician	Maintenance technician	60	0.2	12
				Laboratory technician	Laboratory technician	Laboratory technician			
				Water systems operator	Water systems operator	Water systems operator			
					Health Inspector	Health Inspector			
					Administratrive assistant	Administratrive assistant			
					Water meter leader	Water meter leader			
						IT technician			
C_{33}	Unskilled Labor	Craftsman	Clerk	Clerk			81	0.2	16.2
			Mechanic assistant	Water meter reader					
				Water systems worker					
C_{34}	Illiterate	Caretaker	Caretaker				91	0.2	18.2
C_{35}	Access to Higher Education	None	State	Regional	District	Mandal	71	0.2	14.2
f_3	*Score Human Resources Capacity*					$\sum C_{ij} w_j$		1	**72.6**
4	**Technical Capacity**								
C_{41}	Operations	Water Use	Pumping Water	Pumping Water	Monitor water systems	Monitor water systems	85	0.2	17
				Control Water Quality	Control Water Quality	Control Water Quality			
					Control Pipes	Monitor pipes network			
						Monitor Treatment			
C_{42}	Maintenance	None	Clean water systems	Check water systems	Check/maintain water systems	Check/maintain water systems	75	0.2	15
			Minor repair	Major repair	Major repair	Check/maintain network			
					Maintain pipes	Check/maintain meter			
						Maintain IT systems			
C_{43}	Adaptation	None	Rarely	Occasionally	Usually	Frequently	41	0.2	8.2
C_{45}	Maintenance network	None	State	District	Mandal	Habitational	70	0.2	14
C_{45}	Distribution network	None	Regional Supplier	District Supplier	Mandal Supplier	Habitational Supplier	81	0.2	16.2
					District Approved	District Approved			
f_4	*Score Technical Capacity*					$\sum C_{ij} w_j$		1	**70.4**
5	**Economical and Financial Capacity**								
C_{51}	Private sector investment	None	State	Regional	District	Mandal	70	0.14	10
C_{52}	Market incentives	None	Low	Medium	High	Very high	51	0.14	7.285714
C_{53}	User fees	None	Uniform flat rate	Single block rate	Increasing block rate	Increasing block rate	70	0.14	10
C_{54}	Budget	None	Basic accounting	Annual	Tracked bi-annually	Tracked quarterly	81	0.14	11.57143
C_{55}	Asset values	None	Real Estate	Real estate	Real estate	Real estate	70	0.14	10
				Equipment	Equipment	Equipment			
					Cash	Cash - Stocks			
C_{56}	Investment activities	None	Low	Medium	High	Very High	51	0.14	7.285714
C_{57}	Loss to corruption	Very High	High	Medium	Low	None	65	0.14	9.285714
f_5	*Score Economical and Financial Capacity*					$\sum C_{ij} w_j$		1	**65.42857**
6	**Energy Capacity**								
C_{61}	Primary source	None	Non-conventional	Conventional electricity	Electricity mid-voltage	Electricity high voltage	90	0.25	22.5
C_{62}	Alternative source	None	None	Generator < 10 HP	Generator < 50 HP	Generator > 50 HP	71	0.25	17.75
C_{63}	Dependence for service	Very low	Low	Medium	High	Very High	50	0.25	12.5
C_{64}	Outage rate	Very High	High	Medium	Low	Very low	70	0.25	17.5
f_6	*Score Energy Capacity*					$\sum C_{ij} w_j$		1	**70.25**
7	**Environmental and Ecological Capacity**								
C_{71}	Environment quality	Very low	Low	Medium	High	Very high	80	0.2	16
C_{72}	Size of resource system	Very low	Low	Medium	High	Very high	70	0.2	14
C_{73}	Predictability of resource dynamics	Very low	Low	Medium	High	Very high	50	0.2	10
C_{74}	Growth or replacement rate	Very Negati	Negative	Stable	Positive	Very Positive	75	0.2	15
C_{74}	Resource sensibility	Very low	Low	Medium	High	Very High	65	0.2	13
f_7	*Score Environmental Capacity*					$\sum C_{ij} w_j$		1	**68**
8	**Social and Cultural Capacity**								
C_{81}	Communal ownership	Very low	Low	Intermediate	High	Very high	85	0.2	17
C_{82}	Political stability	Very low	Low	Intermediate	High	Very high	60	0.2	12
C_{83}	Equity	Very low	Low	Intermediate	High	Very high	60	0.2	12
C_{84}	Leadership/entrepreneurship	Very low	Low	Intermediate	High	Very high	60	0.2	12
C_{85}	Participation of women	Very low	Low	Intermediate	High	Very high	65	0.2	13
f_8	*Score Social-Cultural Capacity*					$\sum C_{ij} w_j$		1	**66**

Appendix II.C: Technlogy Capacity Level – RHS

	Partitioned Scoring							
Capacity Factors	**1-20**	**21-40**	**41-60**	**61-80**	**81-100**	**Score**	**Weight**	**CF score**
Service Capacity								
Effective service level	< 20 l/p/d	20 - 40 l/p/d	40 - 60 l/p/d	60 - 80 l/p/d	> 80 l/p/d	30	1	30
Score Service Capacity					$\sum C_{ij} w_j$		*1*	**30**
Institutional Capacity								
Body of legislation	None	Basic	Intermediate	Complete	Advanced	50	0.1667	8.333333
Operational rules	None	Basic	Intermediate	Complete	Advanced	41	0.1667	6.833333
Administrative agencies	None	State	District	Mandal	Habitational	41	0.1667	6.833333
Administrative processes	None	Basic	Intermediate	Complete	Advanced	41	0.1667	6.833333
Governance	None	State	District	Mandal	Habitational	85	0.1667	14.16667
Presence of NGOs	None	Low	Medium	High	Very High	70	0.1667	11.66667
Score Institutional Capacity					$\sum C_{ij} w_j$		*1*	**54.66667**
Human Resources Capacity (service provider)								
Professionals	None	None	Administrative supervisor	Administrative manager	Administrative manager	60	0.2	12
			Health Scientist	Health Scientist	Health Scientist			
				Engineer	Engineer			
					Lawyer			
					Public relations manager			
Skilled Labor	None	Mechanic	Maintenance technician	Maintenance technician	Maintenance technician	60	0.2	12
			Laboratory technician	Laboratory technician	Laboratory technician			
			Water systems operator	Water systems operator	Water systems operator			
				Health Inspector	Health Inspector			
				Administratrive assistant	Administratrive assistant			
				Water meter leader	Water meter leader			
					IT technician			
Unskilled Labor	Craftsman	Clerk	Clerk			81	0.2	16.2
		Mechanic assistant	Water meter reader					
			Water systems worker					
Illiterate	Caretaker	Caretaker				91	0.2	18.2
Access to Higher Education	None	State	Regional	District	Mandal	71	0.2	14.2
Score Human Resources Capacity					$\sum C_{ij} w_j$		*1*	**72.6**
Technical Capacity								
Operations	Water Use	Pumping Water	Pumping Water	Monitor water systems	Monitor water systems	60	0.2	12
			Control Water Quality	Control Water Quality	Control Water Quality			
				Control Pipes	Monitor pipes network			
					Monitor Treatment			
Maintenance	None	Clean water systems	Check water systems	Check/maintain water systems	Check/maintain water systems	80	0.2	16
		Minor repair	Major repair	Major repair	Check/maintain network			
				Maintain pipes	Check/maintain meter			
					Maintain IT systems			
Adaptation	None	Rarely	Occasionally	Usually	Frequently	50	0.2	10
Maintenance network	None	State	District	Mandal	Habitational	90	0.2	18
Distribution network	None	Regional Supplier	District Supplier	Mandal Supplier	Habitational Supplier	45	0.2	9
				District Approved	District Approved			
Score Technical Capacity					$\sum C_{ij} w_j$		*1*	**65**
Economical and Financial Capacity								
Private sector investment	None	State	Regional	District	Mandal	80	0.14	11.42857
Market incentives	None	Low	Medium	High	Very high	71	0.14	10.14286
User fees	None	Uniform flat rate	Single block rate	Increasing block rate	Increasing block rate	40	0.14	5.714286
Budget	None	Basic accounting	Annual	Tracked bi-annually	Tracked quarterly	31	0.14	4.428571
Asset values	None	Real Estate	Real estate	Real estate	Real estate	55	0.14	7.857143
			Equipment	Equipment	Equipment			
				Cash	Cash - Stocks			
Investment activities	None	Low	Medium	High	Very High	55	0.14	7.857143
Loss to corruption	Very High	High	Medium	Low	None	55	0.14	7.857143
Score Economical and Financial Capacity					$\sum C_{ij} w_j$		*1*	**55.28571**
Energy Capacity								
Primary source	None	Non-conventional	Conventional electricity	Electricity mid-voltage	Electricity high voltage	50	0.25	12.5
Alternative source	None	None	Generator < 10 HP	Generator < 50 HP	Generator > 50 HP	40	0.25	10
Dependence for service	Very low	Low	Medium	High	Very High	50	0.25	12.5
Outage rate	Very High	High	Medium	Low	Very low	41	0.25	10.25
Score Energy Capacity					$\sum C_{ij} w_j$		*1*	**45.25**
Environmental and Ecological Capacity								
Environment quality	Very low	Low	Medium	High	Very high	81	0.2	16.2
Size of resource system	Very low	Low	Medium	High	Very high	50	0.2	10
Predictability of resource dynamics	Very low	Low	Medium	High	Very high	70	0.2	14
Growth or replacement rate	Very Negati	Negative	Stable	Positive	Very Positive	60	0.2	12
Resource sensibility	Very low	Low	Medium	High	Very High	80	0.2	16
Score Environmental Capacity					$\sum C_{ij} w_j$		*1*	**68.2**
Social and Cultural Capacity								
Communal ownership	Very low	Low	Intermediate	High	Very high	80	0.2	16
Political stability	Very low	Low	Intermediate	High	Very high	60	0.2	12
Equity	Very low	Low	Intermediate	High	Very high	60	0.2	12
Leadership/entrepreneurship	Very low	Low	Intermediate	High	Very high	61	0.2	12.2
Participation of women	Very low	Low	Intermediate	High	Very high	65	0.2	13
Score Social-Cultural Capacity					$\sum C_{ij} w_j$		*1*	**65.2**

Appendix III.A: Policy Capacity Grade – CPWSS

Grade	Institutional	Human Resources	Technical	Economic and Financial	Energy	Environmental and Ecological	Social and Cultural
A	• Strong local, Mandal, and District level regulation • Local governance, minimal supervision • Integrated government agencies • High legislative standards for water quality	• Heavy social capital • Several higher educational institutions • Training or mentoring facilities and programs • Illiterates trained as operators or caretakers	• Capable of complex water unit operations • Experts with tech maintenance • Reliance network is close to point of use • Source is nearby point of use	• Strong market • Maintains accurate budget • Very little corruption • Users pay towards system use	• Primary source powers groundwater pumps and filters • Alternative source capable of drawing groundwater • Low dependence • Very low outage	• No natural or manmade pollutants in water • High groundwater level, rainfall • High resource conscience • Waste and wastewater curbing plans	• Sense of communal ownership exists • Low political rift • No segregation or affirmative action necessary • Women are leaders, not just participators
B	• Strong Mandal & District level regulation • Local governance, Mandal supervision • Legislative standards • Communication between institutional agencies • NGO presence	• Medium Social capital • Few higher educational institutions • Illiterates trained as operators or caretakers	• Capable of operating medium-level water technology • Familiar with tech maintenance • Reliance network is in neighboring Mandal • Source is far from point of use	• Strong market • Maintains annual budget • Some corruption • Users pay towards system use, but collection rate is not high	• Primary source varies over course of day • Alternative source capable of drawing groundwater • Medium dependence • Outage no more than 8 hours per day	• Some natural pollutants • No manmade pollutants in water • Resource supply > demand • Resource conscience • Some waste curbing plans	• Sense of communal ownership exists • Some political rift • Some segregation or affirmative action • Women participate in central activities • Motivated leaders
C	• District-level regulation • Little governance structure, relies on District officers • No standards or legislation • No communication between agencies	• Low social capital • Basic schools exist • Apprenticeship in water management comes from agriculture experience	• Capable of operating low-level water technology • Maintains system without familiarity • Reliance network is farther than immediate neighbor	• Market exists • Maintains annual budget • Frequent corruption • Users pay towards system use, but collection rate is very low	• Primary source varies over course of day • Alternative source can only power lights • High dependence • Outage no more than 16 hours/day, predictable	• Some natural pollutants & manmade pollutants in water • Resource supply = demand • No resource conscience • No waste cleanup	• Little sense of communal ownership • High political rift • Heavy segregation or affirmative action • Women participate in menial activities • Leaders participate sometimes
D	• Little or no regulation • Little or no governance, relies on District intervention • No standards or legislation • NGO intervention seen as necessary	• Low social capital • Basic schools exist, but no teachers • Apprenticeship in water management comes from agriculture experience	• Operates low-level water technology without background • No system maintenance • Reliance network is farther than immediate neighbor	• No market • Uncertain budget • Frequent corruption • No collection of user fees • Low asset values • Investors wary, little entrepreneurship	• Primary source no more than 6 hours a day • No alternative • Very high outage, inconsistent and unpredictable	• High natural pollutants & manmade pollutants in water • Resource supply < demand • No resource conscience • No waste cleanup	• No sense of communal ownership • High political rift • Heavy segregation or affirmative action • Women do not participate • Poor leadership

Appendix III.B: Policy Capacity Grade – Proliferation of PWSS

Grade	Institutional	Human Resources	Technical	Economic and Financial	Energy	Environmental and Ecological	Social and Cultural
A	• Strong local, Mandal, and District level regulation • Local governance, minimal supervision • Integrated government agencies • High legislative standards for water quality	• Heavy social capital • Several higher educational institutions • Training or mentoring facilities and programs • Illiterates trained as operators or caretakers	• Capable of complex water unit operations • Experts with tech maintenance • Reliance network is close to point of use • Source is nearby point of use	• Strong market • Maintains accurate budget • Very little corruption • Users pay towards system use	• Primary source powers groundwater pumps and filters • Alternative source capable of drawing groundwater • Low dependence • Very low outage	• No natural or manmade pollutants in water • High groundwater level, rainfall • High resource conscience • Waste and wastewater curbing plans	• Sense of communal ownership exists • Low political rift • No segregation or affirmative action necessary • Women are leaders, not just participators
B	• Strong Mandal & District level regulation • Local governance, Mandal supervision • Legislative standards • Communication between institutional agencies • NGO presence	• Medium Social capital • Few higher educational institutions • Illiterates trained as operators or caretakers	• Capable of operating medium-level water technology • Familiar with tech maintenance • Reliance network is in neighboring Mandal • Source is far from point of use	• Strong market • Maintains annual budget • Some corruption • Users pay towards system use, but collection rate is not high	• Primary source varies over course of day • Alternative source capable of drawing groundwater • Medium dependence • Outage no more than 8 hours per day	• Some natural pollutants • No manmade pollutants in water • Resource supply > demand • Resource conscience • Some waste curbing plans	• Sense of communal ownership exists • Some political rift • Some segregation or affirmative action • Women participate in central activities • Motivated leaders
C	• District-level regulation • Little governance structure, relies on District officers • No standards or legislation • No communication between agencies	• Low social capital • Basic schools exist • Apprenticeship in water management comes from agriculture experience	• Capable of operating low-level water technology • Maintains system without familiarity • Reliance network is farther than immediate neighbor	• Market exists • Maintains annual budget • Frequent corruption • Users pay towards system use, but collection rate is very low	• Primary source varies over course of day • Alternative source can only power lights • High dependence • Outage no more than 16 hours/day, predictable	• Some natural pollutants & manmade pollutants in water • Resource supply = demand • No resource conscience • No waste cleanup	• Little sense of communal ownership • High political rift • Heavy segregation or affirmative action • Women participate in menial activities • Leaders participate sometimes
D	• Little or no regulation • Little or no governance, relies on District intervention • No standards or legislation • NGO intervention seen as necessary	• Low social capital • Basic schools exist, but no teachers • Apprenticeship in water management comes from agriculture experience	• Operates low-level water technology without background • No system maintenance • Reliance network is farther than immediate neighbor	• No market • Uncertain budget • Frequent corruption • No collection of user fees • Low asset values • Investors wary, little entrepreneurship	• Primary source no more than 6 hours a day • No alternative • Very high outage, inconsistent and unpredictable	• High natural pollutants & manmade pollutants in water • Resource supply < demand • No resource conscience • No waste cleanup	• No sense of communal ownership • High political rift • Heavy segregation or affirmative action • Women do not participate • Poor leadership

Appendix III.C: Policy Capacity Grade – Proliferation of RWS

Grade	Institutional	Human Resources	Technical	Economic and Financial	Energy	Environmental and Ecological	Social and Cultural
A	• Strong local, Mandal, and District level regulation • Local governance, minimal supervision • Integrated government agencies • High legislative standards for water quality	• Heavy social capital • Several higher educational institutions • Training or mentoring facilities and programs • Illiterates trained as operators or caretakers	• Capable of complex water unit operations • Experts with tech maintenance • Reliance network is close to point of use • Source is nearby point of use	• Strong market • Maintains accurate budget • Very little corruption • Users pay towards system use	• Primary source powers groundwater pumps and filters • Alternative source capable of drawing groundwater • Low dependence • Very low outage	• No natural or manmade pollutants in water • High groundwater level, rainfall • High resource conscience • Waste and wastewater curbing plans	• Sense of communal ownership exists • Low political rift • No segregation or affirmative action necessary • Women are leaders, not just participators
B	• Strong Mandal & District level regulation • Local governance, Mandal supervision • Legislative standards • Communication between institutional agencies • NGO presence	• Medium Social capital • Few higher educational institutions • Illiterates trained as operators or caretakers	• Capable of operating medium-level water technology • Familiar with tech maintenance • Reliance network is in neighboring Mandal • Source is far from point of use	• Strong market • Maintains annual budget • Some corruption • Users pay towards system use, but collection rate is not high	• Primary source varies over course of day • Alternative source capable of drawing groundwater • Medium dependence • Outage no more than 8 hours per day	• Some natural pollutants • No manmade pollutants in water • Resource supply > demand • Resource conscience • Some waste curbing plans	• Sense of communal ownership exists • Some political rift • Some segregation or affirmative action • Women participate in central activities • Motivated leaders
C	• District-level regulation • Little governance structure, relies on District officers • No standards or legislation • No communication between agencies	• Low social capital • Basic schools exist • Apprenticeship in water management comes from agriculture experience	• Capable of operating low-level water technology • Maintains system without familiarity • Reliance network is farther than immediate neighbor	• Market exists • Maintains annual budget • Frequent corruption • Users pay towards system use, but collection rate is very low	• Primary source varies over course of day • Alternative source can only power lights • High dependence • Outage no more than 16 hours/day, predictable	• Some natural pollutants & manmade pollutants in water • Resource supply = demand • No resource conscience • No waste cleanup	• Little sense of communal ownership • High political rift • Heavy segregation or affirmative action • Women participate in menial activities • Leaders participate sometimes
D	• Little or no regulation • Little or no governance, relies on District intervention • No standards or legislation • NGO intervention seen as necessary	• Low social capital • Basic schools exist, but no teachers • Apprenticeship in water management comes from agriculture experience	• Operates low-level water technology without background • No system maintenance • Reliance network is farther than immediate neighbor	• No market • Uncertain budget • Frequent corruption • No collection of user fees • Low asset values • Investors wary, little entrepreneurship	• Primary source no more than 6 hours a day • No alternative • Very high outage, inconsistent and unpredictable	• High natural pollutants & manmade pollutants in water • Resource supply < demand • No resource conscience • No waste cleanup	• No sense of communal ownership • High political rift • Heavy segregation or affirmative action • Women do not participate • Poor leadership

Appendix IV.A.1: Bhongir Mandal – Bhongir Municipality

		Partitioned Scoring							
	Capacity Factors	1-20	21-40	41-60	61-80	81-100	Score	Weight	CF score
1	Service Capacity								
C_{11}	Effective service level	< 20 l/p/d	20 - 40 l/p/d	40 - 60 l/p/d	60 - 80 l/p/d	> 80 l/p/d	65	1	65
f_1	Score Service Capacity					$\sum C_{ij} w_j$		1	**65**
2	Institutional Capacity								
C_{21}	Body of legislation	None	Basic	Intermediate	Complete	Advanced	65	0.1667	10.83333
C_{22}	Operational rules	None	Basic	Intermediate	Complete	Advanced	70	0.1667	11.66667
C_{23}	Administrative agencies	None	State	District	Mandal	Habitational	70	0.1667	11.66667
C_{24}	Administrative processes	None	Basic	Intermediate	Complete	Advanced	70	0.1667	11.66667
C_{25}	Governance	None	State	District	Mandal	Habitational	81	0.1667	13.5
C_{26}	Presence of NGOs	None	Low	Medium	High	Very High	45	0.1667	7.5
f_2	Score Institutional Capacity					$\sum C_{ij} w_j$		1	**66.83333**
3	Human Resources Capacity (service provider)								
C_{31}	Professionals	None	None	Administrative supervisor	Administrative manager	Administrative manager	85	0.2	17
				Health Scientist	Health Scientist	Health Scientist			
					Engineer	Engineer			
						Lawyer			
						Public relations manager			
C_{32}	Skilled Labor	None	Mechanic	Maintenance technician	Maintenance technician	Maintenance technician	65	0.2	13
				Laboratory technician	Laboratory technician	Laboratory technician			
				Water systems operator	Water systems operator	Water systems operator			
					Health Inspector	Health Inspector			
					Administratrive assistant	Administratrive assistant			
					Water meter leader	Water meter leader			
						IT technician			
C_{33}	Unskilled Labor	Craftsman	Clerk	Clerk			85	0.2	17
			Mechanic assistant	Water meter reader					
				Water systems worker					
C_{34}	Illiterate	Caretaker	Caretaker				95	0.2	19
C_{35}	Access to Higher Education	None	State	Regional	District	Mandal	85	0.2	17
f_3	Score Human Resources Capacity					$\sum C_{ij} w_j$		1	**83**
4	Technical Capacity								
C_{41}	Operations	Water Use	Pumping Water	Pumping Water	Monitor water systems	Monitor water systems	70	0.2	14
				Control Water Quality	Control Water Quality	Control Water Quality			
					Control Pipes	Monitor pipes network			
						Monitor Treatment			
C_{42}	Maintenance	None	Clean water systems	Check water systems	Check/maintain water systems	Check/maintain water systems	70	0.2	14
			Minor repair	Major repair	Major repair	Check/maintain network			
					Maintain pipes	Check/maintain meter			
						Maintain IT systems			
C_{43}	Adaptation	None	Rarely	Occasionally	Usually	Frequently	75	0.2	15
C_{45}	Maintenance network	None	State	District	Mandal	Habitational	70	0.2	14
C_{45}	Distribution network	None	Regional Supplier	District Supplier	Mandal Supplier	Habitational Supplier	85	0.2	17
					District Approved	District Approved			
f_4	Score Technical Capacity					$\sum C_{ij} w_j$		1	**74**
5	Economical and Financial Capacity								
C_{51}	Private sector investment	None	State	Regional	District	Mandal	75	0.14	10.71429
C_{52}	Market incentives	None	Low	Medium	High	Very high	70	0.14	10
C_{53}	User fees	None	Uniform flat rate	Single block rate	Increasing block rate	Increasing block rate	50	0.14	7.142857
C_{54}	Budget	None	Basic accounting	Annual	Tracked bi-annually	Tracked quarterly	60	0.14	8.571429
C_{55}	Asset values	None	Real Estate	Real estate	Real estate	Real estate	70	0.14	10
				Equipment	Equipment	Equipment			
					Cash	Cash - Stocks			
C_{56}	Investment activities	None	Low	Medium	High	Very High	60	0.14	8.571429
C_{57}	Loss to corruption	Very High	High	Medium	Low	None	70	0.14	10
f_5	Score Economical and Financial Capacity					$\sum C_{ij} w_j$		1	**65**
6	Energy Capacity								
C_{61}	Primary source	None	Non-conventional	Conventional electricity	Electricity mid-voltage	Electricity high voltage	75	0.25	18.75
C_{62}	Alternative source	None	None	Generator < 10 HP	Generator < 50 HP	Generator > 50 HP	75	0.25	18.75
C_{63}	Dependence for service	Very low	Low	Medium	High	Very High	80	0.25	20
C_{64}	Outage rate	Very High	High	Medium	Low	Very low	50	0.25	12.5
f_6	Score Energy Capacity					$\sum C_{ij} w_j$		1	**70**
7	Environmental and Ecological Capacity								
C_{71}	Environment quality	Very low	Low	Medium	High	Very high	40	0.2	8
C_{72}	Size of resource system	Very low	Low	Medium	High	Very high	50	0.2	10
C_{73}	Predictability of resource dynamics	Very low	Low	Medium	High	Very high	60	0.2	12
C_{74}	Growth or replacement rate	Very Negati	Negative	Stable	Positive	Very Positive	41	0.2	8.2
C_{74}	Resource sensibility	Very low	Low	Medium	High	Very High	45	0.2	9
f_7	Score Environmental Capacity					$\sum C_{ij} w_j$		1	**47.2**
8	Social and Cultural Capacity								
C_{81}	Communal ownership	Very low	Low	Intermediate	High	Very high	55	0.2	11
C_{82}	Political stability	Very low	Low	Intermediate	High	Very high	61	0.2	12.2
C_{83}	Equity	Very low	Low	Intermediate	High	Very high	60	0.2	12
C_{84}	Leadership/entrepreneurship	Very low	Low	Intermediate	High	Very high	65	0.2	13
C_{85}	Participation of women	Very low	Low	Intermediate	High	Very high	50	0.2	10
f_8	Score Social-Cultural Capacity					$\sum C_{ij} w_j$		1	**58.2**

Appendix IV.A.2: Bhongir Mandal – Banda Samaram

		Partitioned Scoring							
	Capacity Factors	1-20	21-40	41-60	61-80	81-100	Score	Weight	CF score
1	Service Capacity								
C_{11}	Effective service level	< 20 l/p/d	20 - 40 l/p/d	40 - 60 l/p/d	60 - 80 l/p/d	> 80 l/p/d	40	1	40
f_1	Score Service Capacity					$\sum C_{ij} w_j$		1	**40**
2	Institutional Capacity								
C_{21}	Body of legislation	None	Basic	Intermediate	Complete	Advanced	50	0.1667	8.333333
C_{22}	Operational rules	None	Basic	Intermediate	Complete	Advanced	50	0.1667	8.333333
C_{23}	Administrative agencies	None	State	District	Mandal	Habitational	60	0.1667	10
C_{24}	Administrative processes	None	Basic	Intermediate	Complete	Advanced	50	0.1667	8.333333
C_{25}	Governance	None	State	District	Mandal	Habitational	61	0.1667	10.16667
C_{26}	Presence of NGOs	None	Low	Medium	High	Very High	25	0.1667	4.166667
f_2	Score Institutional Capacity					$\sum C_{ij} w_j$		1	**49.33333**
3	Human Resources Capacity (service provider)								
C_{31}	Professionals	None	None	Administrative supervisor	Administrative manager	Administrative manager	45	0.2	9
				Health Scientist	Health Scientist	Health Scientist			
					Engineer	Engineer			
						Lawyer			
						Public relations manager			
C_{32}	Skilled Labor	None	Mechanic	Maintenance technician	Maintenance technician	Maintenance technician	40	0.2	8
				Laboratory technician	Laboratory technician	Laboratory technician			
				Water systems operator	Water systems operator	Water systems operator			
					Health Inspector	Health Inspector			
					Administratrive assistant	Administratrive assistant			
					Water meter leader	Water meter leader			
						IT technician			
C_{33}	Unskilled Labor	Craftsman	Clerk	Clerk			75	0.2	15
			Mechanic assistant	Water meter reader					
				Water systems worker					
C_{34}	Illiterate	Caretaker	Caretaker				75	0.2	15
C_{35}	Access to Higher Education	None	State	Regional	District	Mandal	81	0.2	16.2
f_3	Score Human Resources Capacity					$\sum C_{ij} w_j$		1	**63.2**
4	Technical Capacity								
C_{41}	Operations	Water Use	Pumping Water	Pumping Water	Monitor water systems	Monitor water systems	40	0.2	8
				Control Water Quality	Control Water Quality	Control Water Quality			
					Control Pipes	Monitor pipes network			
						Monitor Treatment			
C_{42}	Maintenance	None	Clean water systems	Check water systems	Check/maintain water systems	Check/maintain water systems	40	0.2	8
			Minor repair	Major repair	Major repair	Check/maintain network			
					Maintain pipes	Check/maintain meter			
						Maintain IT systems			
C_{43}	Adaptation	None	Rarely	Occasionally	Usually	Frequently	40	0.2	8
C_{45}	Maintenance network	None	State	District	Mandal	Habitational	75	0.2	15
C_{45}	Distribution network	None	Regional Supplier	District Supplier	Mandal Supplier	Habitational Supplier	81	0.2	16.2
					District Approved	District Approved			
f_4	Score Technical Capacity					$\sum C_{ij} w_j$		1	**55.2**
5	Economical and Financial Capacity								
C_{51}	Private sector investment	None	State	Regional	District	Mandal	81	0.14	11.57143
C_{52}	Market incentives	None	Low	Medium	High	Very high	30	0.14	4.285714
C_{53}	User fees	None	Uniform flat rate	Single block rate	Increasing block rate	Increasing block rate	40	0.14	5.714286
C_{54}	Budget	None	Basic accounting	Annual	Tracked bi-annually	Tracked quarterly	40	0.14	5.714286
C_{55}	Asset values	None	Real Estate	Real estate	Real estate	Real estate	50	0.14	7.142857
				Equipment	Equipment	Equipment			
					Cash	Cash - Stocks			
C_{56}	Investment activities	None	Low	Medium	High	Very High	40	0.14	5.714286
C_{57}	Loss to corruption	Very High	High	Medium	Low	None	50	0.14	7.142857
f_5	Score Economical and Financial Capacity					$\sum C_{ij} w_j$		1	**47.28571**
6	Energy Capacity								
C_{61}	Primary source	None	Non-conventional	Conventional electricity	Electricity mid-voltage	Electricity high voltage	75	0.25	18.75
C_{62}	Alternative source	None	None	Generator < 10 HP	Generator < 50 HP	Generator > 50 HP	50	0.25	12.5
C_{63}	Dependence for service	Very low	Low	Medium	High	Very High	40	0.25	10
C_{64}	Outage rate	Very High	High	Medium	Low	Very low	50	0.25	12.5
f_6	Score Energy Capacity					$\sum C_{ij} w_j$		1	**53.75**
7	Environmental and Ecological Capacity								
C_{71}	Environment quality	Very low	Low	Medium	High	Very high	50	0.2	10
C_{72}	Size of resource system	Very low	Low	Medium	High	Very high	45	0.2	9
C_{73}	Predictability of resource dynamics	Very low	Low	Medium	High	Very high	25	0.2	5
C_{74}	Growth or replacement rate	Very Negati	Negative	Stable	Positive	Very Positive	45	0.2	9
C_{74}	Resource sensibility	Very low	Low	Medium	High	Very High	50	0.2	10
f_7	Score Environmental Capacity					$\sum C_{ij} w_j$		1	**43**
8	Social and Cultural Capacity								
C_{81}	Communal ownership	Very low	Low	Intermediate	High	Very high	50	0.2	10
C_{82}	Political stability	Very low	Low	Intermediate	High	Very high	85	0.2	17
C_{83}	Equity	Very low	Low	Intermediate	High	Very high	60	0.2	12
C_{84}	Leadership/entrepreneurship	Very low	Low	Intermediate	High	Very high	55	0.2	11
C_{85}	Participation of women	Very low	Low	Intermediate	High	Very high	55	0.2	11
f_8	Score Social-Cultural Capacity					$\sum C_{ij} w_j$		1	**61**

Appendix IV.A.3: Bhongir Mandal – Raigiri

		Partitioned Scoring							
	Capacity Factors	1-20	21-40	41-60	61-80	81-100	Score	Weight	CF score
1	Service Capacity								
C_{11}	Effective service level	< 20 l/p/d	20 - 40 l/p/d	40 - 60 l/p/d	60 - 80 l/p/d	> 80 l/p/d	40	1	40
f_1	*Score Service Capacity*					$\sum C_{ij} w_j$		1	**40**
2	Institutional Capacity								
C_{21}	Body of legislation	None	Basic	Intermediate	Complete	Advanced	50	0.1667	8.333333
C_{22}	Operational rules	None	Basic	Intermediate	Complete	Advanced	50	0.1667	8.333333
C_{23}	Administrative agencies	None	State	District	Mandal	Habitational	60	0.1667	10
C_{24}	Administrative processes	None	Basic	Intermediate	Complete	Advanced	60	0.1667	10
C_{25}	Governance	None	State	District	Mandal	Habitational	81	0.1667	13.5
C_{26}	Presence of NGOs	None	Low	Medium	High	Very High	61	0.1667	10.16667
f_2	*Score Institutional Capacity*					$\sum C_{ij} w_j$		1	**60.33333**
3	Human Resources Capacity (service provider)								
C_{31}	Professionals	None	None	Administrative supervisor	Administrative manager	Administrative manager	61	0.2	12.2
				Health Scientist	Health Scientist	Health Scientist			
					Engineer	Engineer			
						Lawyer			
						Public relations manager			
C_{32}	Skilled Labor	None	Mechanic	Maintenance technician	Maintenance technician	Maintenance technician	55	0.2	11
				Laboratory technician	Laboratory technician	Laboratory technician			
				Water systems operator	Water systems operator	Water systems operator			
					Health Inspector	Health Inspector			
					Administratrive assistant	Administratrive assistant			
					Water meter leader	Water meter leader			
						IT technician			
C_{33}	Unskilled Labor	Craftsman	Clerk	Clerk			75	0.2	15
			Mechanic assistant	Water meter reader					
				Water systems worker					
C_{34}	Illiterate	Caretaker	Caretaker				75	0.2	15
C_{35}	Access to Higher Education	None	State	Regional	District	Mandal	81	0.2	16.2
f_3	*Score Human Resources Capacity*					$\sum C_{ij} w_j$		1	**69.4**
4	Technical Capacity								
C_{41}	Operations	Water Use	Pumping Water	Pumping Water	Monitor water systems	Monitor water systems	45	0.2	9
				Control Water Quality	Control Water Quality	Control Water Quality			
					Control Pipes	Monitor pipes network			
						Monitor Treatment			
C_{42}	Maintenance	None	Clean water systems	Check water systems	Check/maintain water systems	Check/maintain water systems	40	0.2	8
			Minor repair	Major repair	Major repair	Check/maintain network			
					Maintain pipes	Check/maintain meter			
						Maintain IT systems			
C_{43}	Adaptation	None	Rarely	Occasionally	Usually	Frequently	40	0.2	8
C_{45}	Maintenance network	None	State	District	Mandal	Habitational	65	0.2	13
C_{45}	Distribution network	None	Regional Supplier	District Supplier	Mandal Supplier	Habitational Supplier	65	0.2	13
					District Approved	District Approved			
f_4	*Score Technical Capacity*					$\sum C_{ij} w_j$		1	**51**
5	Economical and Financial Capacity								
C_{51}	Private sector investment	None	State	Regional	District	Mandal	65	0.14	9.285714
C_{52}	Market incentives	None	Low	Medium	High	Very high	45	0.14	6.428571
C_{53}	User fees	None	Uniform flat rate	Single block rate	Increasing block rate	Increasing block rate	30	0.14	4.285714
C_{54}	Budget	None	Basic accounting	Annual	Tracked bi-annually	Tracked quarterly	40	0.14	5.714286
C_{55}	Asset values	None	Real Estate	Real estate	Real estate	Real estate	55	0.14	7.857143
				Equipment	Equipment	Equipment			
					Cash	Cash - Stocks			
C_{56}	Investment activities	None	Low	Medium	High	Very High	55	0.14	7.857143
C_{57}	Loss to corruption	Very High	High	Medium	Low	None	60	0.14	8.571429
f_5	*Score Economical and Financial Capacity*					$\sum C_{ij} w_j$		1	**50**
6	Energy Capacity								
C_{61}	Primary source	None	Non-conventional	Conventional electricity	Electricity mid-voltage	Electricity high voltage	65	0.25	16.25
C_{62}	Alternative source	None	None	Generator < 10 HP	Generator < 50 HP	Generator > 50 HP	55	0.25	13.75
C_{63}	Dependence for service	Very low	Low	Medium	High	Very High	65	0.25	16.25
C_{64}	Outage rate	Very High	High	Medium	Low	Very low	45	0.25	11.25
f_6	*Score Energy Capacity*					$\sum C_{ij} w_j$		1	**57.5**
7	Environmental and Ecological Capacity								
C_{71}	Environment quality	Very low	Low	Medium	High	Very high	55	0.2	11
C_{72}	Size of resource system	Very low	Low	Medium	High	Very high	45	0.2	9
C_{73}	Predictability of resource dynamics	Very low	Low	Medium	High	Very high	50	0.2	10
C_{74}	Growth or replacement rate	Very Negati	Negative	Stable	Positive	Very Positive	45	0.2	9
C_{74}	Resource sensibility	Very low	Low	Medium	High	Very High	50	0.2	10
f_7	*Score Environmental Capacity*					$\sum C_{ij} w_j$		1	**49**
8	Social and Cultural Capacity								
C_{81}	Communal ownership	Very low	Low	Intermediate	High	Very high	45	0.2	9
C_{82}	Political stability	Very low	Low	Intermediate	High	Very high	65	0.2	13
C_{83}	Equity	Very low	Low	Intermediate	High	Very high	60	0.2	12
C_{84}	Leadership/entrepreneurship	Very low	Low	Intermediate	High	Very high	45	0.2	9
C_{85}	Participation of women	Very low	Low	Intermediate	High	Very high	60	0.2	12
f_8	*Score Social-Cultural Capacity*					$\sum C_{ij} w_j$		1	**55**

Appendix IV.A.4: Bhongir Mandal – Kesaram

		Partitioned Scoring							
	Capacity Factors	1-20	21-40	41-60	61-80	81-100	Score	Weight	CF score
1	Service Capacity								
C_{11}	Effective service level	< 20 l/p/d	20 - 40 l/p/d	40 - 60 l/p/d	60 - 80 l/p/d	> 80 l/p/d	35	1	35
f_1	Score Service Capacity					$\sum C_{ij} w_j$		1	35
2	Institutional Capacity								
C_{21}	Body of legislation	None	Basic	Intermediate	Complete	Advanced	50	0.1667	8.333333
C_{22}	Operational rules	None	Basic	Intermediate	Complete	Advanced	40	0.1667	6.666667
C_{23}	Administrative agencies	None	State	District	Mandal	Habitational	50	0.1667	8.333333
C_{24}	Administrative processes	None	Basic	Intermediate	Complete	Advanced	40	0.1667	6.666667
C_{25}	Governance	None	State	District	Mandal	Habitational	65	0.1667	10.83333
C_{26}	Presence of NGOs	None	Low	Medium	High	Very High	15	0.1667	2.5
f_2	Score Institutional Capacity					$\sum C_{ij} w_j$		1	43.33333
3	Human Resources Capacity (service provider)								
C_{31}	Professionals	None	None	Administrative supervisor	Administrative manager	Administrative manager	45	0.2	9
				Health Scientist	Health Scientist	Health Scientist			
					Engineer	Engineer			
						Lawyer			
						Public relations manager			
C_{32}	Skilled Labor	None	Mechanic	Maintenance technician	Maintenance technician	Maintenance technician	40	0.2	8
				Laboratory technician	Laboratory technician	Laboratory technician			
				Water systems operator	Water systems operator	Water systems operator			
					Health Inspector	Health Inspector			
					Administratrive assistant	Administratrive assistant			
					Water meter leader	Water meter leader			
						IT technician			
C_{33}	Unskilled Labor	Craftsman	Clerk	Clerk			60	0.2	12
			Mechanic assistant	Water meter reader					
				Water systems worker					
C_{34}	Illiterate	Caretaker	Caretaker				60	0.2	12
C_{35}	Access to Higher Education	None	State	Regional	District	Mandal	81	0.2	16.2
f_3	Score Human Resources Capacity					$\sum C_{ij} w_j$		1	57.2
4	Technical Capacity								
C_{41}	Operations	Water Use	Pumping Water	Pumping Water	Monitor water systems	Monitor water systems	40	0.2	8
				Control Water Quality	Control Water Quality	Control Water Quality			
					Control Pipes	Monitor pipes network			
						Monitor Treatment			
C_{42}	Maintenance	None	Clean water systems	Check water systems	Check/maintain water systems	Check/maintain water systems	40	0.2	8
			Minor repair	Major repair	Major repair	Check/maintain network			
					Maintain pipes	Check/maintain meter			
						Maintain IT systems			
C_{43}	Adaptation	None	Rarely	Occasionally	Usually	Frequently	25	0.2	5
C_{45}	Maintenance network	None	State	District	Mandal	Habitational	61	0.2	12.2
C_{45}	Distribution network	None	Regional Supplier	District Supplier	Mandal Supplier	Habitational Supplier	61	0.2	12.2
					District Approved	District Approved			
f_4	Score Technical Capacity					$\sum C_{ij} w_j$		1	45.4
5	Economical and Financial Capacity								
C_{51}	Private sector investment	None	State	Regional	District	Mandal	50	0.14	7.142857
C_{52}	Market incentives	None	Low	Medium	High	Very high	35	0.14	5
C_{53}	User fees	None	Uniform flat rate	Single block rate	Increasing block rate	Increasing block rate	30	0.14	4.285714
C_{54}	Budget	None	Basic accounting	Annual	Tracked bi-annually	Tracked quarterly	30	0.14	4.285714
C_{55}	Asset values	None	Real Estate	Real estate	Real estate	Real estate	41	0.14	5.857143
				Equipment	Equipment	Equipment			
					Cash	Cash - Stocks			
C_{56}	Investment activities	None	Low	Medium	High	Very High	50	0.14	7.142857
C_{57}	Loss to corruption	Very High	High	Medium	Low	None	75	0.14	10.71429
f_5	Score Economical and Financial Capacity					$\sum C_{ij} w_j$		1	44.42857
6	Energy Capacity								
C_{61}	Primary source	None	Non-conventional	Conventional electricity	Electricity mid-voltage	Electricity high voltage	70	0.25	17.5
C_{62}	Alternative source	None	None	Generator < 10 HP	Generator < 50 HP	Generator > 50 HP	60	0.25	15
C_{63}	Dependence for service	Very low	Low	Medium	High	Very High	60	0.25	15
C_{64}	Outage rate	Very High	High	Medium	Low	Very low	55	0.25	13.75
f_6	Score Energy Capacity					$\sum C_{ij} w_j$		1	61.25
7	Environmental and Ecological Capacity								
C_{71}	Environment quality	Very low	Low	Medium	High	Very high	65	0.2	13
C_{72}	Size of resource system	Very low	Low	Medium	High	Very high	55	0.2	11
C_{73}	Predictability of resource dynamics	Very low	Low	Medium	High	Very high	50	0.2	10
C_{74}	Growth or replacement rate	Very Negati	Negative	Stable	Positive	Very Positive	55	0.2	11
C_{74}	Resource sensibility	Very low	Low	Medium	High	Very High	41	0.2	8.2
f_7	Score Environmental Capacity					$\sum C_{ij} w_j$		1	53.2
8	Social and Cultural Capacity								
C_{81}	Communal ownership	Very low	Low	Intermediate	High	Very high	55	0.2	11
C_{82}	Political stability	Very low	Low	Intermediate	High	Very high	65	0.2	13
C_{83}	Equity	Very low	Low	Intermediate	High	Very high	60	0.2	12
C_{84}	Leadership/entrepreneurship	Very low	Low	Intermediate	High	Very high	60	0.2	12
C_{85}	Participation of women	Very low	Low	Intermediate	High	Very high	61	0.2	12.2
f_8	Score Social-Cultural Capacity					$\sum C_{ij} w_j$		1	60.2

Appendix IV.A.5: Bhongir Mandal – Ramachandrapur

		Partitioned Scoring							
	Capacity Factors	1-20	21-40	41-60	61-80	81-100	Score	Weight	CF score
1	Service Capacity								
C_{11}	Effective service level	< 20 l/p/d	20 - 40 l/p/d	40 - 60 l/p/d	60 - 80 l/p/d	> 80 l/p/d	40	1	40
f_1	*Score Service Capacity*					$\sum C_{ij} w_j$		1	**40**
2	Institutional Capacity								
C_{21}	Body of legislation	None	Basic	Intermediate	Complete	Advanced	50	0.1667	8.333333
C_{22}	Operational rules	None	Basic	Intermediate	Complete	Advanced	60	0.1667	10
C_{23}	Administrative agencies	None	State	District	Mandal	Habitational	60	0.1667	10
C_{24}	Administrative processes	None	Basic	Intermediate	Complete	Advanced	60	0.1667	10
C_{25}	Governance	None	State	District	Mandal	Habitational	75	0.1667	12.5
C_{26}	Presence of NGOs	None	Low	Medium	High	Very High	25	0.1667	4.166667
f_2	*Score Institutional Capacity*					$\sum C_{ij} w_j$		1	**55**
3	Human Resources Capacity (service provider)								
C_{31}	Professionals	None	None	Administrative supervisor	Administrative manager	Administrative manager	50	0.2	10
				Health Scientist	Health Scientist	Health Scientist			
					Engineer	Engineer			
						Lawyer			
						Public relations manager			
C_{32}	Skilled Labor	None	Mechanic	Maintenance technician	Maintenance technician	Maintenance technician	50	0.2	10
				Laboratory technician	Laboratory technician	Laboratory technician			
				Water systems operator	Water systems operator	Water systems operator			
					Health Inspector	Health Inspector			
					Administratrive assistant	Administratrive assistant			
					Water meter leader	Water meter leader			
						IT technician			
C_{33}	Unskilled Labor	Craftsman	Clerk	Clerk			75	0.2	15
			Mechanic assistant	Water meter reader					
				Water systems worker					
C_{34}	Illiterate	Caretaker	Caretaker				70	0.2	14
C_{35}	Access to Higher Education	None	State	Regional	District	Mandal	81	0.2	16.2
f_3	*Score Human Resources Capacity*					$\sum C_{ij} w_j$		1	**65.2**
4	Technical Capacity								
C_{41}	Operations	Water Use	Pumping Water	Pumping Water	Monitor water systems	Monitor water systems	40	0.2	8
				Control Water Quality	Control Water Quality	Control Water Quality			
					Control Pipes	Monitor pipes network			
						Monitor Treatment			
C_{42}	Maintenance	None	Clean water systems	Check water systems	Check/maintain water systems	Check/maintain water systems	40	0.2	8
			Minor repair	Major repair	Major repair	Check/maintain network			
					Maintain pipes	Check/maintain meter			
						Maintain IT systems			
C_{43}	Adaptation	None	Rarely	Occasionally	Usually	Frequently	40	0.2	8
C_{45}	Maintenance network	None	State	District	Mandal	Habitational	65	0.2	13
C_{45}	Distribution network	None	Regional Supplier	District Supplier	Mandal Supplier	Habitational Supplier	70	0.2	14
					District Approved	District Approved			
f_4	*Score Technical Capacity*					$\sum C_{ij} w_j$		1	**51**
5	Economical and Financial Capacity								
C_{51}	Private sector investment	None	State	Regional	District	Mandal	70	0.14	10
C_{52}	Market incentives	None	Low	Medium	High	Very high	50	0.14	7.142857
C_{53}	User fees	None	Uniform flat rate	Single block rate	Increasing block rate	Increasing block rate	40	0.14	5.714286
C_{54}	Budget	None	Basic accounting	Annual	Tracked bi-annually	Tracked quarterly	40	0.14	5.714286
C_{55}	Asset values	None	Real Estate	Real estate	Real estate	Real estate	55	0.14	7.857143
				Equipment	Equipment	Equipment			
					Cash	Cash - Stocks			
C_{56}	Investment activities	None	Low	Medium	High	Very High	50	0.14	7.142857
C_{57}	Loss to corruption	Very High	High	Medium	Low	None	60	0.14	8.571429
f_5	*Score Economical and Financial Capacity*					$\sum C_{ij} w_j$		1	**52.14286**
6	Energy Capacity								
C_{61}	Primary source	None	Non-conventional	Conventional electricity	Electricity mid-voltage	Electricity high voltage	70	0.25	17.5
C_{62}	Alternative source	None	None	Generator < 10 HP	Generator < 50 HP	Generator > 50 HP	45	0.25	11.25
C_{63}	Dependence for service	Very low	Low	Medium	High	Very High	50	0.25	12.5
C_{64}	Outage rate	Very High	High	Medium	Low	Very low	45	0.25	11.25
f_6	*Score Energy Capacity*					$\sum C_{ij} w_j$		1	**52.5**
7	Environmental and Ecological Capacity								
C_{71}	Environment quality	Very low	Low	Medium	High	Very high	60	0.2	12
C_{72}	Size of resource system	Very low	Low	Medium	High	Very high	55	0.2	11
C_{73}	Predictability of resource dynamics	Very low	Low	Medium	High	Very high	55	0.2	11
C_{74}	Growth or replacement rate	Very Negati	Negative	Stable	Positive	Very Positive	50	0.2	10
C_{74}	Resource sensibility	Very low	Low	Medium	High	Very High	55	0.2	11
f_7	*Score Environmental Capacity*					$\sum C_{ij} w_j$		1	**55**
8	Social and Cultural Capacity								
C_{81}	Communal ownership	Very low	Low	Intermediate	High	Very high	65	0.2	13
C_{82}	Political stability	Very low	Low	Intermediate	High	Very high	65	0.2	13
C_{83}	Equity	Very low	Low	Intermediate	High	Very high	60	0.2	12
C_{84}	Leadership/entrepreneurship	Very low	Low	Intermediate	High	Very high	60	0.2	12
C_{85}	Participation of women	Very low	Low	Intermediate	High	Very high	65	0.2	13
f_8	*Score Social-Cultural Capacity*					$\sum C_{ij} w_j$		1	**63**

Appendix IV.B.1: Alair Mandal – Alair

		Partitioned Scoring							
	Capacity Factors	1-20	21-40	41-60	61-80	81-100	Score	Weight	CF score
1	**Service Capacity**								
C_{11}	Effective service level	< 20 l/p/d	20 - 40 l/p/d	40 - 60 l/p/d	60 - 80 l/p/d	> 80 l/p/d	30	1	30
f_1	*Score Service Capacity*					$\sum C_{ij} w_j$		1	**30**
2	**Institutional Capacity**								
C_{21}	Body of legislation	None	Basic	Intermediate	Complete	Advanced	50	0.1667	8.333333
C_{22}	Operational rules	None	Basic	Intermediate	Complete	Advanced	50	0.1667	8.333333
C_{23}	Administrative agencies	None	State	District	Mandal	Habitational	55	0.1667	9.166667
C_{24}	Administrative processes	None	Basic	Intermediate	Complete	Advanced	55	0.1667	9.166667
C_{25}	Governance	None	State	District	Mandal	Habitational	65	0.1667	10.83333
C_{26}	Presence of NGOs	None	Low	Medium	High	Very High	35	0.1667	5.833333
f_2	*Score Institutional Capacity*					$\sum C_{ij} w_j$		1	**51.66667**
3	**Human Resources Capacity (service provider)**								
C_{31}	Professionals	None	None	Administrative supervisor	Administrative manager	Administrative manager	65	0.2	13
				Health Scientist	Health Scientist	Health Scientist			
					Engineer	Engineer			
						Lawyer			
						Public relations manager			
C_{32}	Skilled Labor	None	Mechanic	Maintenance technician	Maintenance technician	Maintenance technician	60	0.2	12
				Laboratory technician	Laboratory technician	Laboratory technician			
				Water systems operator	Water systems operator	Water systems operator			
					Health Inspector	Health Inspector			
					Administratrive assistant	Administratrive assistant			
					Water meter leader	Water meter leader			
						IT technician			
C_{33}	Unskilled Labor	Craftsman	Clerk	Clerk			85	0.2	17
			Mechanic assistant	Water meter reader					
				Water systems worker					
C_{34}	Illiterate	Caretaker	Caretaker				85	0.2	17
C_{35}	Access to Higher Education	None	State	Regional	District	Mandal	70	0.2	14
f_3	*Score Human Resources Capacity*					$\sum C_{ij} w_j$		1	**73**
4	**Technical Capacity**								
C_{41}	Operations	Water Use	Pumping Water	Pumping Water	Monitor water systems	Monitor water systems	50	0.2	10
				Control Water Quality	Control Water Quality	Control Water Quality			
					Control Pipes	Monitor pipes network			
						Monitor Treatment			
C_{42}	Maintenance	None	Clean water systems	Check water systems	Check/maintain water systems	Check/maintain water systems	45	0.2	9
			Minor repair	Major repair	Major repair	Check/maintain network			
					Maintain pipes	Check/maintain meter			
						Maintain IT systems			
C_{43}	Adaptation	None	Rarely	Occasionally	Usually	Frequently	40	0.2	8
C_{45}	Maintenance network	None	State	District	Mandal	Habitational	65	0.2	13
C_{45}	Distribution network	None	Regional Supplier	District Supplier	Mandal Supplier	Habitational Supplier	61	0.2	12.2
					District Approved	District Approved			
f_4	*Score Technical Capacity*					$\sum C_{ij} w_j$		1	**52.2**
5	**Economical and Financial Capacity**								
C_{51}	Private sector investment	None	State	Regional	District	Mandal	70	0.14	10
C_{52}	Market incentives	None	Low	Medium	High	Very high	50	0.14	7.142857
C_{53}	User fees	None	Uniform flat rate	Single block rate	Increasing block rate	Increasing block rate	40	0.14	5.714286
C_{54}	Budget	None	Basic accounting	Annual	Tracked bi-annually	Tracked quarterly	40	0.14	5.714286
C_{55}	Asset values	None	Real Estate	Real estate	Real estate	Real estate	55	0.14	7.857143
				Equipment	Equipment	Equipment			
					Cash	Cash - Stocks			
C_{56}	Investment activities	None	Low	Medium	High	Very High	45	0.14	6.428571
C_{57}	Loss to corruption	Very High	High	Medium	Low	None	50	0.14	7.142857
f_5	*Score Economical and Financial Capacity*					$\sum C_{ij} w_j$		1	**50**
6	**Energy Capacity**								
C_{61}	Primary source	None	Non-conventional	Conventional electricity	Electricity mid-voltage	Electricity high voltage	75	0.25	18.75
C_{62}	Alternative source	None	None	Generator < 10 HP	Generator < 50 HP	Generator > 50 HP	70	0.25	17.5
C_{63}	Dependence for service	Very low	Low	Medium	High	Very High	70	0.25	17.5
C_{64}	Outage rate	Very High	High	Medium	Low	Very low	60	0.25	15
f_6	*Score Energy Capacity*					$\sum C_{ij} w_j$		1	**68.75**
7	**Environmental and Ecological Capacity**								
C_{71}	Environment quality	Very low	Low	Medium	High	Very high	45	0.2	9
C_{72}	Size of resource system	Very low	Low	Medium	High	Very high	45	0.2	9
C_{73}	Predictability of resource dynamics	Very low	Low	Medium	High	Very high	50	0.2	10
C_{74}	Growth or replacement rate	Very Negati	Negative	Stable	Positive	Very Positive	45	0.2	9
C_{74}	Resource sensibility	Very low	Low	Medium	High	Very High	45	0.2	9
f_7	*Score Environmental Capacity*					$\sum C_{ij} w_j$		1	**46**
8	**Social and Cultural Capacity**								
C_{81}	Communal ownership	Very low	Low	Intermediate	High	Very high	60	0.2	12
C_{82}	Political stability	Very low	Low	Intermediate	High	Very high	65	0.2	13
C_{83}	Equity	Very low	Low	Intermediate	High	Very high	60	0.2	12
C_{84}	Leadership/entrepreneurship	Very low	Low	Intermediate	High	Very high	60	0.2	12
C_{85}	Participation of women	Very low	Low	Intermediate	High	Very high	65	0.2	13
f_8	*Score Social-Cultural Capacity*					$\sum C_{ij} w_j$		1	**62**

Appendix IV. C.1: Yadagirigutta Mandal – Yadagirigutta

		Partitioned Scoring							
	Capacity Factors	**1-20**	**21-40**	**41-60**	**61-80**	**81-100**	**Score**	**Weight**	**CF score**
1	**Service Capacity**								
C_{11}	Effective service level	< 20 l/p/d	20 - 40 l/p/d	40 - 60 l/p/d	60 - 80 l/p/d	> 80 l/p/d	35	1	35
f_1	*Score Service Capacity*					$\sum C_{ij} w_j$		*1*	**35**
2	**Institutional Capacity**								
C_{21}	Body of legislation	None	Basic	Intermediate	Complete	Advanced	65	0.1667	10.83333
C_{22}	Operational rules	None	Basic	Intermediate	Complete	Advanced	65	0.1667	10.83333
C_{23}	Administrative agencies	None	State	District	Mandal	Habitational	55	0.1667	9.166667
C_{24}	Administrative processes	None	Basic	Intermediate	Complete	Advanced	55	0.1667	9.166667
C_{25}	Governance	None	State	District	Mandal	Habitational	70	0.1667	11.66667
C_{26}	Presence of NGOs	None	Low	Medium	High	Very High	65	0.1667	10.83333
f_2	*Score Institutional Capacity*					$\sum C_{ij} w_j$		*1*	**62.5**
3	**Human Resources Capacity (service provider)**								
C_{31}	Professionals	None	None	Administrative supervisor	Administrative manager	Administrative manager	81	0.2	16.2
				Health Scientist	Health Scientist	Health Scientist			
					Engineer	Engineer			
						Lawyer			
						Public relations manager			
C_{32}	Skilled Labor	None	Mechanic	Maintenance technician	Maintenance technician	Maintenance technician	61	0.2	12.2
				Laboratory technician	Laboratory technician	Laboratory technician			
				Water systems operator	Water systems operator	Water systems operator			
					Health Inspector	Health Inspector			
					Administratrive assistant	Administratrive assistant			
					Water meter leader	Water meter leader			
						IT technician			
C_{33}	Unskilled Labor	Craftsman	Clerk	Clerk			90	0.2	18
			Mechanic assistant	Water meter reader					
				Water systems worker					
C_{34}	Illiterate	Caretaker	Caretaker				85	0.2	17
C_{35}	Access to Higher Education	None	State	Regional	District	Mandal	65	0.2	13
f_3	*Score Human Resources Capacity*					$\sum C_{ij} w_j$		*1*	**76.4**
4	**Technical Capacity**								
C_{41}	Operations	Water Use	Pumping Water	Pumping Water	Monitor water systems	Monitor water systems	55	0.2	11
				Control Water Quality	Control Water Quality	Control Water Quality			
					Control Pipes	Monitor pipes network			
						Monitor Treatment			
C_{42}	Maintenance	None	Clean water systems	Check water systems	Check/maintain water systems	Check/maintain water systems	55	0.2	11
			Minor repair	Major repair	Major repair	Check/maintain network			
					Maintain pipes	Check/maintain meter			
						Maintain IT systems			
C_{43}	Adaptation	None	Rarely	Occasionally	Usually	Frequently	50	0.2	10
C_{45}	Maintenance network	None	State	District	Mandal	Habitational	61	0.2	12.2
C_{45}	Distribution network	None	Regional Supplier	District Supplier	Mandal Supplier	Habitational Supplier	61	0.2	12.2
					District Approved	District Approved			
f_4	*Score Technical Capacity*					$\sum C_{ij} w_j$		*1*	**56.4**
5	**Economical and Financial Capacity**								
C_{51}	Private sector investment	None	State	Regional	District	Mandal	81	0.14	11.57143
C_{52}	Market incentives	None	Low	Medium	High	Very high	81	0.14	11.57143
C_{53}	User fees	None	Uniform flat rate	Single block rate	Increasing block rate	Increasing block rate	55	0.14	7.857143
C_{54}	Budget	None	Basic accounting	Annual	Tracked bi-annually	Tracked quarterly	55	0.14	7.857143
C_{55}	Asset values	None	Real Estate	Real estate	Real estate	Real estate	65	0.14	9.285714
				Equipment	Equipment	Equipment			
					Cash	Cash - Stocks			
C_{56}	Investment activities	None	Low	Medium	High	Very High	65	0.14	9.285714
C_{57}	Loss to corruption	Very High	High	Medium	Low	None	41	0.14	5.857143
f_5	*Score Economical and Financial Capacity*					$\sum C_{ij} w_j$		*1*	**63.28571**
6	**Energy Capacity**								
C_{61}	Primary source	None	Non-conventional	Conventional electricity	Electricity mid-voltage	Electricity high voltage	81	0.25	20.25
C_{62}	Alternative source	None	None	Generator < 10 HP	Generator < 50 HP	Generator > 50 HP	81	0.25	20.25
C_{63}	Dependence for service	Very low	Low	Medium	High	Very High	70	0.25	17.5
C_{64}	Outage rate	Very High	High	Medium	Low	Very low	81	0.25	20.25
f_6	*Score Energy Capacity*					$\sum C_{ij} w_j$		*1*	**78.25**
7	**Environmental and Ecological Capacity**								
C_{71}	Environment quality	Very low	Low	Medium	High	Very high	41	0.2	8.2
C_{72}	Size of resource system	Very low	Low	Medium	High	Very high	45	0.2	9
C_{73}	Predictability of resource dynamics	Very low	Low	Medium	High	Very high	45	0.2	9
C_{74}	Growth or replacement rate	Very Negati	Negative	Stable	Positive	Very Positive	41	0.2	8.2
C_{74}	Resource sensibility	Very low	Low	Medium	High	Very High	60	0.2	12
f_7	*Score Environmental Capacity*					$\sum C_{ij} w_j$		*1*	**46.4**
8	**Social and Cultural Capacity**								
C_{81}	Communal ownership	Very low	Low	Intermediate	High	Very high	61	0.2	12.2
C_{82}	Political stability	Very low	Low	Intermediate	High	Very high	70	0.2	14
C_{83}	Equity	Very low	Low	Intermediate	High	Very high	60	0.2	12
C_{84}	Leadership/entrepreneurship	Very low	Low	Intermediate	High	Very high	81	0.2	16.2
C_{85}	Participation of women	Very low	Low	Intermediate	High	Very high	70	0.2	14
f_8	*Score Social-Cultural Capacity*					$\sum C_{ij} w_j$		*1*	**68.4**

Appendix IV.D.1: Voligonda Mandal – Voligonda

		Partitioned Scoring							
	Capacity Factors	**1-20**	**21-40**	**41-60**	**61-80**	**81-100**	**Score**	**Weight**	**CF score**
1	**Service Capacity**								
C_{11}	Effective service level	< 20 l/p/d	20 - 40 l/p/d	40 - 60 l/p/d	60 - 80 l/p/d	> 80 l/p/d	37	1	37
f_1	*Score Service Capacity*					$\sum C_{ij} w_j$		*1*	**37**
2	**Institutional Capacity**								
C_{21}	Body of legislation	None	Basic	Intermediate	Complete	Advanced	60	0.1667	10
C_{22}	Operational rules	None	Basic	Intermediate	Complete	Advanced	60	0.1667	10
C_{23}	Administrative agencies	None	State	District	Mandal	Habitational	60	0.1667	10
C_{24}	Administrative processes	None	Basic	Intermediate	Complete	Advanced	50	0.1667	8.333333
C_{25}	Governance	None	State	District	Mandal	Habitational	65	0.1667	10.83333
C_{26}	Presence of NGOs	None	Low	Medium	High	Very High	65	0.1667	10.83333
f_2	*Score Institutional Capacity*					$\sum C_{ij} w_j$		*1*	**60**
3	**Human Resources Capacity (service provider)**								
C_{31}	Professionals	None	None	Administrative supervisor	Administrative manager	Administrative manager	65	0.2	13
				Health Scientist	Health Scientist	Health Scientist			
					Engineer	Engineer			
						Lawyer			
						Public relations manager			
C_{32}	Skilled Labor	None	Mechanic	Maintenance technician	Maintenance technician	Maintenance technician	65	0.2	13
				Laboratory technician	Laboratory technician	Laboratory technician			
				Water systems operator	Water systems operator	Water systems operator			
					Health Inspector	Health Inspector			
					Administratrive assistant	Administratrive assistant			
					Water meter leader	Water meter leader			
						IT technician			
C_{33}	Unskilled Labor	Craftsman	Clerk	Clerk			81	0.2	16.2
			Mechanic assistant	Water meter reader					
				Water systems worker					
C_{34}	Illiterate	Caretaker	Caretaker				81	0.2	16.2
C_{35}	Access to Higher Education	None	State	Regional	District	Mandal	81	0.2	16.2
f_3	*Score Human Resources Capacity*					$\sum C_{ij} w_j$		*1*	**74.6**
4	**Technical Capacity**								
C_{41}	Operations	Water Use	Pumping Water	Pumping Water	Monitor water systems	Monitor water systems	61	0.2	12.2
				Control Water Quality	Control Water Quality	Control Water Quality			
					Control Pipes	Monitor pipes network			
						Monitor Treatment			
C_{42}	Maintenance	None	Clean water systems	Check water systems	Check/maintain water systems	Check/maintain water systems	50	0.2	10
			Minor repair	Major repair	Major repair	Check/maintain network			
					Maintain pipes	Check/maintain meter			
						Maintain IT systems			
C_{43}	Adaptation	None	Rarely	Occasionally	Usually	Frequently	60	0.2	12
C_{45}	Maintenance network	None	State	District	Mandal	Habitational	65	0.2	13
C_{45}	Distribution network	None	Regional Supplier	District Supplier	Mandal Supplier	Habitational Supplier	65	0.2	13
					District Approved	District Approved			
f_4	*Score Technical Capacity*					$\sum C_{ij} w_j$		*1*	**60.2**
5	**Economical and Financial Capacity**								
C_{51}	Private sector investment	None	State	Regional	District	Mandal	81	0.14	11.57143
C_{52}	Market incentives	None	Low	Medium	High	Very high	70	0.14	10
C_{53}	User fees	None	Uniform flat rate	Single block rate	Increasing block rate	Increasing block rate	50	0.14	7.142857
C_{54}	Budget	None	Basic accounting	Annual	Tracked bi-annually	Tracked quarterly	55	0.14	7.857143
C_{55}	Asset values	None	Real Estate	Real estate	Real estate	Real estate	65	0.14	9.285714
				Equipment	Equipment	Equipment			
					Cash	Cash - Stocks			
C_{56}	Investment activities	None	Low	Medium	High	Very High	61	0.14	8.714286
C_{57}	Loss to corruption	Very High	High	Medium	Low	None	70	0.14	10
f_5	*Score Economical and Financial Capacity*					$\sum C_{ij} w_j$		*1*	**64.57143**
6	**Energy Capacity**								
C_{61}	Primary source	None	Non-conventional	Conventional electricity	Electricity mid-voltage	Electricity high voltage	65	0.25	16.25
C_{62}	Alternative source	None	None	Generator < 10 HP	Generator < 50 HP	Generator > 50 HP	61	0.25	15.25
C_{63}	Dependence for service	Very low	Low	Medium	High	Very High	61	0.25	15.25
C_{64}	Outage rate	Very High	High	Medium	Low	Very low	45	0.25	11.25
f_6	*Score Energy Capacity*					$\sum C_{ij} w_j$		*1*	**58**
7	**Environmental and Ecological Capacity**								
C_{71}	Environment quality	Very low	Low	Medium	High	Very high	41	0.2	8.2
C_{72}	Size of resource system	Very low	Low	Medium	High	Very high	55	0.2	11
C_{73}	Predictability of resource dynamics	Very low	Low	Medium	High	Very high	50	0.2	10
C_{74}	Growth or replacement rate	Very Negati	Negative	Stable	Positive	Very Positive	45	0.2	9
C_{74}	Resource sensibility	Very low	Low	Medium	High	Very High	55	0.2	11
f_7	*Score Environmental Capacity*					$\sum C_{ij} w_j$		*1*	**49.2**
8	**Social and Cultural Capacity**								
C_{81}	Communal ownership	Very low	Low	Intermediate	High	Very high	65	0.2	13
C_{82}	Political stability	Very low	Low	Intermediate	High	Very high	65	0.2	13
C_{83}	Equity	Very low	Low	Intermediate	High	Very high	65	0.2	13
C_{84}	Leadership/entrepreneurship	Very low	Low	Intermediate	High	Very high	65	0.2	13
C_{85}	Participation of women	Very low	Low	Intermediate	High	Very high	60	0.2	12
f_8	*Score Social-Cultural Capacity*					$\sum C_{ij} w_j$		*1*	**64**

Appendix IV.D.2: Voligonda Mandal – Sunkishala

		Partitioned Scoring							
	Capacity Factors	**1-20**	**21-40**	**41-60**	**61-80**	**81-100**	**Score**	**Weight**	**CF score**
1	**Service Capacity**								
C_{11}	Effective service level	< 20 l/p/d	20 - 40 l/p/d	40 - 60 l/p/d	60 - 80 l/p/d	> 80 l/p/d	30	1	30
f_1	*Score Service Capacity*					$\sum C_{ij} w_j$		*1*	**30**
2	**Institutional Capacity**								
C_{21}	Body of legislation	None	Basic	Intermediate	Complete	Advanced	50	0.1667	8.333333
C_{22}	Operational rules	None	Basic	Intermediate	Complete	Advanced	60	0.1667	10
C_{23}	Administrative agencies	None	State	District	Mandal	Habitational	55	0.1667	9.166667
C_{24}	Administrative processes	None	Basic	Intermediate	Complete	Advanced	50	0.1667	8.333333
C_{25}	Governance	None	State	District	Mandal	Habitational	81	0.1667	13.5
C_{26}	Presence of NGOs	None	Low	Medium	High	Very High	45	0.1667	7.5
f_2	*Score Institutional Capacity*					$\sum C_{ij} w_j$		*1*	**56.83333**
3	**Human Resources Capacity (service provider)**								
C_{31}	Professionals	None	None	Administrative supervisor	Administrative manager	Administrative manager	60	0.2	12
				Health Scientist	Health Scientist	Health Scientist			
					Engineer	Engineer			
						Lawyer			
						Public relations manager			
C_{32}	Skilled Labor	None	Mechanic	Maintenance technician	Maintenance technician	Maintenance technician	60	0.2	12
				Laboratory technician	Laboratory technician	Laboratory technician			
				Water systems operator	Water systems operator	Water systems operator			
					Health Inspector	Health Inspector			
					Administratrive assistant	Administratrive assistant			
					Water meter leader	Water meter leader			
						IT technician			
C_{33}	Unskilled Labor	Craftsman	Clerk	Clerk			80	0.2	16
			Mechanic assistant	Water meter reader					
				Water systems worker					
C_{34}	Illiterate	Caretaker	Caretaker				80	0.2	16
C_{35}	Access to Higher Education	None	State	Regional	District	Mandal	81	0.2	16.2
f_3	*Score Human Resources Capacity*					$\sum C_{ij} w_j$		*1*	**72.2**
4	**Technical Capacity**								
C_{41}	Operations	Water Use	Pumping Water	Pumping Water	Monitor water systems	Monitor water systems	65	0.2	13
				Control Water Quality	Control Water Quality	Control Water Quality			
					Control Pipes	Monitor pipes network			
						Monitor Treatment			
C_{42}	Maintenance	None	Clean water systems	Check water systems	Check/maintain water systems	Check/maintain water systems	55	0.2	11
			Minor repair	Major repair	Major repair	Check/maintain network			
					Maintain pipes	Check/maintain meter			
						Maintain IT systems			
C_{43}	Adaptation	None	Rarely	Occasionally	Usually	Frequently	55	0.2	11
C_{45}	Maintenance network	None	State	District	Mandal	Habitational	70	0.2	14
C_{45}	Distribution network	None	Regional Supplier	District Supplier	Mandal Supplier	Habitational Supplier	81	0.2	16.2
					District Approved	District Approved			
f_4	*Score Technical Capacity*					$\sum C_{ij} w_j$		*1*	**65.2**
5	**Economical and Financial Capacity**								
C_{51}	Private sector investment	None	State	Regional	District	Mandal	75	0.14	10.71429
C_{52}	Market incentives	None	Low	Medium	High	Very high	40	0.14	5.714286
C_{53}	User fees	None	Uniform flat rate	Single block rate	Increasing block rate	Increasing block rate	30	0.14	4.285714
C_{54}	Budget	None	Basic accounting	Annual	Tracked bi-annually	Tracked quarterly	50	0.14	7.142857
C_{55}	Asset values	None	Real Estate	Real estate	Real estate	Real estate	50	0.14	7.142857
				Equipment	Equipment	Equipment			
					Cash	Cash - Stocks			
C_{56}	Investment activities	None	Low	Medium	High	Very High	50	0.14	7.142857
C_{57}	Loss to corruption	Very High	High	Medium	Low	None	60	0.14	8.571429
f_5	*Score Economical and Financial Capacity*					$\sum C_{ij} w_j$		*1*	**50.71429**
6	**Energy Capacity**								
C_{61}	Primary source	None	Non-conventional	Conventional electricity	Electricity mid-voltage	Electricity high voltage	70	0.25	17.5
C_{62}	Alternative source	None	None	Generator < 10 HP	Generator < 50 HP	Generator > 50 HP	45	0.25	11.25
C_{63}	Dependence for service	Very low	Low	Medium	High	Very High	55	0.25	13.75
C_{64}	Outage rate	Very High	High	Medium	Low	Very low	41	0.25	10.25
f_6	*Score Energy Capacity*					$\sum C_{ij} w_j$		*1*	**52.75**
7	**Environmental and Ecological Capacity**								
C_{71}	Environment quality	Very low	Low	Medium	High	Very high	65	0.2	13
C_{72}	Size of resource system	Very low	Low	Medium	High	Very high	65	0.2	13
C_{73}	Predictability of resource dynamics	Very low	Low	Medium	High	Very high	60	0.2	12
C_{74}	Growth or replacement rate	Very Negati	Negative	Stable	Positive	Very Positive	55	0.2	11
C_{74}	Resource sensibility	Very low	Low	Medium	High	Very High	60	0.2	12
f_7	*Score Environmental Capacity*					$\sum C_{ij} w_j$		*1*	**61**
8	**Social and Cultural Capacity**								
C_{81}	Communal ownership	Very low	Low	Intermediate	High	Very high	65	0.2	13
C_{82}	Political stability	Very low	Low	Intermediate	High	Very high	65	0.2	13
C_{83}	Equity	Very low	Low	Intermediate	High	Very high	65	0.2	13
C_{84}	Leadership/entrepreneurship	Very low	Low	Intermediate	High	Very high	60	0.2	12
C_{85}	Participation of women	Very low	Low	Intermediate	High	Very high	70	0.2	14
f_8	*Score Social-Cultural Capacity*					$\sum C_{ij} w_j$		*1*	**65**

Appendix IV.E.1: Mothkur Mandal – Mothkur

		Partitioned Scoring							
	Capacity Factors	**1-20**	**21-40**	**41-60**	**61-80**	**81-100**	**Score**	**Weight**	**CF score**
1	**Service Capacity**								
C_{11}	Effective service level	< 20 l/p/d	20 - 40 l/p/d	40 - 60 l/p/d	60 - 80 l/p/d	> 80 l/p/d	45	1	45
f_1	*Score Service Capacity*					$\sum C_{ij} w_j$		*1*	**45**
2	**Institutional Capacity**								
C_{21}	Body of legislation	None	Basic	Intermediate	Complete	Advanced	55	0.1667	9.166667
C_{22}	Operational rules	None	Basic	Intermediate	Complete	Advanced	60	0.1667	10
C_{23}	Administrative agencies	None	State	District	Mandal	Habitational	65	0.1667	10.83333
C_{24}	Administrative processes	None	Basic	Intermediate	Complete	Advanced	65	0.1667	10.83333
C_{25}	Governance	None	State	District	Mandal	Habitational	81	0.1667	13.5
C_{26}	Presence of NGOs	None	Low	Medium	High	Very High	65	0.1667	10.83333
f_2	*Score Institutional Capacity*					$\sum C_{ij} w_j$		*1*	**65.16667**
3	**Human Resources Capacity (service provider)**								
C_{31}	Professionals	None	None	Administrative supervisor	Administrative manager	Administrative manager	65	0.2	13
				Health Scientist	Health Scientist	Health Scientist			
					Engineer	Engineer			
						Lawyer			
						Public relations manager			
C_{32}	Skilled Labor	None	Mechanic	Maintenance technician	Maintenance technician	Maintenance technician	55	0.2	11
				Laboratory technician	Laboratory technician	Laboratory technician			
				Water systems operator	Water systems operator	Water systems operator			
					Health Inspector	Health Inspector			
					Administratrive assistant	Administratrive assistant			
					Water meter leader	Water meter leader			
						IT technician			
C_{33}	Unskilled Labor	Craftsman	Clerk	Clerk			95	0.2	19
			Mechanic assistant	Water meter reader					
				Water systems worker					
C_{34}	Illiterate	Caretaker	Caretaker				85	0.2	17
C_{35}	Access to Higher Education	None	State	Regional	District	Mandal	65	0.2	13
f_3	*Score Human Resources Capacity*					$\sum C_{ij} w_j$		*1*	**73**
4	**Technical Capacity**								
C_{41}	Operations	Water Use	Pumping Water	Pumping Water	Monitor water systems	Monitor water systems	65	0.2	13
				Control Water Quality	Control Water Quality	Control Water Quality			
					Control Pipes	Monitor pipes network			
						Monitor Treatment			
C_{42}	Maintenance	None	Clean water systems	Check water systems	Check/maintain water systems	Check/maintain water systems	55	0.2	11
			Minor repair	Major repair	Major repair	Check/maintain network			
					Maintain pipes	Check/maintain meter			
						Maintain IT systems			
C_{43}	Adaptation	None	Rarely	Occasionally	Usually	Frequently	60	0.2	12
C_{45}	Maintenance network	None	State	District	Mandal	Habitational	81	0.2	16.2
C_{45}	Distribution network	None	Regional Supplier	District Supplier	Mandal Supplier	Habitational Supplier	60	0.2	12
					District Approved	District Approved			
f_4	*Score Technical Capacity*					$\sum C_{ij} w_j$		*1*	**64.2**
5	**Economical and Financial Capacity**								
C_{51}	Private sector investment	None	State	Regional	District	Mandal	65	0.14	9.285714
C_{52}	Market incentives	None	Low	Medium	High	Very high	45	0.14	6.428571
C_{53}	User fees	None	Uniform flat rate	Single block rate	Increasing block rate	Increasing block rate	40	0.14	5.714286
C_{54}	Budget	None	Basic accounting	Annual	Tracked bi-annually	Tracked quarterly	50	0.14	7.142857
C_{55}	Asset values	None	Real Estate	Real estate	Real estate	Real estate	65	0.14	9.285714
				Equipment	Equipment	Equipment			
					Cash	Cash - Stocks			
C_{56}	Investment activities	None	Low	Medium	High	Very High	60	0.14	8.571429
C_{57}	Loss to corruption	Very High	High	Medium	Low	None	65	0.14	9.285714
f_5	*Score Economical and Financial Capacity*					$\sum C_{ij} w_j$		*1*	**55.71429**
6	**Energy Capacity**								
C_{61}	Primary source	None	Non-conventional	Conventional electricity	Electricity mid-voltage	Electricity high voltage	70	0.25	17.5
C_{62}	Alternative source	None	None	Generator < 10 HP	Generator < 50 HP	Generator > 50 HP	61	0.25	15.25
C_{63}	Dependence for service	Very low	Low	Medium	High	Very High	61	0.25	15.25
C_{64}	Outage rate	Very High	High	Medium	Low	Very low	50	0.25	12.5
f_6	*Score Energy Capacity*					$\sum C_{ij} w_j$		*1*	**60.5**
7	**Environmental and Ecological Capacity**								
C_{71}	Environment quality	Very low	Low	Medium	High	Very high	55	0.2	11
C_{72}	Size of resource system	Very low	Low	Medium	High	Very high	41	0.2	8.2
C_{73}	Predictability of resource dynamics	Very low	Low	Medium	High	Very high	41	0.2	8.2
C_{74}	Growth or replacement rate	Very Negati	Negative	Stable	Positive	Very Positive	45	0.2	9
C_{74}	Resource sensibility	Very low	Low	Medium	High	Very High	40	0.2	8
f_7	*Score Environmental Capacity*					$\sum C_{ij} w_j$		*1*	**44.4**
8	**Social and Cultural Capacity**								
C_{81}	Communal ownership	Very low	Low	Intermediate	High	Very high	55	0.2	11
C_{82}	Political stability	Very low	Low	Intermediate	High	Very high	65	0.2	13
C_{83}	Equity	Very low	Low	Intermediate	High	Very high	60	0.2	12
C_{84}	Leadership/entrepreneurship	Very low	Low	Intermediate	High	Very high	70	0.2	14
C_{85}	Participation of women	Very low	Low	Intermediate	High	Very high	60	0.2	12
f_8	*Score Social-Cultural Capacity*					$\sum C_{ij} w_j$		*1*	**62**

Appendix IV.E.2: Mothkur Mandal – Anajipuram

		Partitioned Scoring							
	Capacity Factors	1-20	21-40	41-60	61-80	81-100	Score	Weight	CF score
1	Service Capacity								
C_{11}	Effective service level	< 20 l/p/d	20 - 40 l/p/d	40 - 60 l/p/d	60 - 80 l/p/d	> 80 l/p/d	40	1	40
f_1	Score Service Capacity					$\sum C_{ij} w_j$		1	**40**
2	Institutional Capacity								
C_{21}	Body of legislation	None	Basic	Intermediate	Complete	Advanced	50	0.1667	8.333333
C_{22}	Operational rules	None	Basic	Intermediate	Complete	Advanced	50	0.1667	8.333333
C_{23}	Administrative agencies	None	State	District	Mandal	Habitational	61	0.1667	10.16667
C_{24}	Administrative processes	None	Basic	Intermediate	Complete	Advanced	45	0.1667	7.5
C_{25}	Governance	None	State	District	Mandal	Habitational	61	0.1667	10.16667
C_{26}	Presence of NGOs	None	Low	Medium	High	Very High	30	0.1667	5
f_2	Score Institutional Capacity					$\sum C_{ij} w_j$		1	**49.5**
3	Human Resources Capacity (service provider)								
C_{31}	Professionals	None	None	Administrative supervisor	Administrative manager	Administrative manager	41	0.2	8.2
				Health Scientist	Health Scientist	Health Scientist			
					Engineer	Engineer			
						Lawyer			
						Public relations manager			
C_{32}	Skilled Labor	None	Mechanic	Maintenance technician	Maintenance technician	Maintenance technician	41	0.2	8.2
				Laboratory technician	Laboratory technician	Laboratory technician			
				Water systems operator	Water systems operator	Water systems operator			
					Health Inspector	Health Inspector			
					Administratrive assistant	Administratrive assistant			
					Water meter leader	Water meter leader			
						IT technician			
C_{33}	Unskilled Labor	Craftsman	Clerk	Clerk			60	0.2	12
			Mechanic assistant	Water meter reader					
				Water systems worker					
C_{34}	Illiterate	Caretaker	Caretaker				60	0.2	12
C_{35}	Access to Higher Education	None	State	Regional	District	Mandal	61	0.2	12.2
f_3	Score Human Resources Capacity					$\sum C_{ij} w_j$		1	**52.6**
4	Technical Capacity								
C_{41}	Operations	Water Use	Pumping Water	Pumping Water	Monitor water systems	Monitor water systems	40	0.2	8
				Control Water Quality	Control Water Quality	Control Water Quality			
					Control Pipes	Monitor pipes network			
						Monitor Treatment			
C_{42}	Maintenance	None	Clean water systems	Check water systems	Check/maintain water systems	Check/maintain water systems	40	0.2	8
			Minor repair	Major repair	Major repair	Check/maintain network			
					Maintain pipes	Check/maintain meter			
						Maintain IT systems			
C_{43}	Adaptation	None	Rarely	Occasionally	Usually	Frequently	40	0.2	8
C_{45}	Maintenance network	None	State	District	Mandal	Habitational	65	0.2	13
C_{45}	Distribution network	None	Regional Supplier	District Supplier	Mandal Supplier	Habitational Supplier	61	0.2	12.2
					District Approved	District Approved			
f_4	Score Technical Capacity					$\sum C_{ij} w_j$		1	**49.2**
5	Economical and Financial Capacity								
C_{51}	Private sector investment	None	State	Regional	District	Mandal	61	0.14	8.714286
C_{52}	Market incentives	None	Low	Medium	High	Very high	50	0.14	7.142857
C_{53}	User fees	None	Uniform flat rate	Single block rate	Increasing block rate	Increasing block rate	40	0.14	5.714286
C_{54}	Budget	None	Basic accounting	Annual	Tracked bi-annually	Tracked quarterly	55	0.14	7.857143
C_{55}	Asset values	None	Real Estate	Real estate	Real estate	Real estate	55	0.14	7.857143
				Equipment	Equipment	Equipment			
					Cash	Cash - Stocks			
C_{56}	Investment activities	None	Low	Medium	High	Very High	61	0.14	8.714286
C_{57}	Loss to corruption	Very High	High	Medium	Low	None	45	0.14	6.428571
f_5	Score Economical and Financial Capacity					$\sum C_{ij} w_j$		1	**52.42857**
6	Energy Capacity								
C_{61}	Primary source	None	Non-conventional	Conventional electricity	Electricity mid-voltage	Electricity high voltage	55	0.25	13.75
C_{62}	Alternative source	None	None	Generator < 10 HP	Generator < 50 HP	Generator > 50 HP	45	0.25	11.25
C_{63}	Dependence for service	Very low	Low	Medium	High	Very High	40	0.25	10
C_{64}	Outage rate	Very High	High	Medium	Low	Very low	45	0.25	11.25
f_6	Score Energy Capacity					$\sum C_{ij} w_j$		1	**46.25**
7	Environmental and Ecological Capacity								
C_{71}	Environment quality	Very low	Low	Medium	High	Very high	60	0.2	12
C_{72}	Size of resource system	Very low	Low	Medium	High	Very high	55	0.2	11
C_{73}	Predictability of resource dynamics	Very low	Low	Medium	High	Very high	50	0.2	10
C_{74}	Growth or replacement rate	Very Negati	Negative	Stable	Positive	Very Positive	55	0.2	11
C_{74}	Resource sensibility	Very low	Low	Medium	High	Very High	55	0.2	11
f_7	Score Environmental Capacity					$\sum C_{ij} w_j$		1	**55**
8	Social and Cultural Capacity								
C_{81}	Communal ownership	Very low	Low	Intermediate	High	Very high	55	0.2	11
C_{82}	Political stability	Very low	Low	Intermediate	High	Very high	60	0.2	12
C_{83}	Equity	Very low	Low	Intermediate	High	Very high	65	0.2	13
C_{84}	Leadership/entrepreneurship	Very low	Low	Intermediate	High	Very high	65	0.2	13
C_{85}	Participation of women	Very low	Low	Intermediate	High	Very high	55	0.2	11
f_8	Score Social-Cultural Capacity					$\sum C_{ij} w_j$		1	**60**

Appendix IV.E.3: Mothkur Mandal – Bujilapuram

		Partitioned Scoring							
	Capacity Factors	1-20	21-40	41-60	61-80	81-100	Score	Weight	CF score
1	Service Capacity								
C_{11}	Effective service level	< 20 l/p/d	20 - 40 l/p/d	40 - 60 l/p/d	60 - 80 l/p/d	> 80 l/p/d	38	1	38
f_1	Score Service Capacity					$\sum C_{ij} w_j$		1	38
2	Institutional Capacity								
C_{21}	Body of legislation	None	Basic	Intermediate	Complete	Advanced	50	0.1667	8.333333
C_{22}	Operational rules	None	Basic	Intermediate	Complete	Advanced	50	0.1667	8.333333
C_{23}	Administrative agencies	None	State	District	Mandal	Habitational	50	0.1667	8.333333
C_{24}	Administrative processes	None	Basic	Intermediate	Complete	Advanced	45	0.1667	7.5
C_{25}	Governance	None	State	District	Mandal	Habitational	61	0.1667	10.16667
C_{26}	Presence of NGOs	None	Low	Medium	High	Very High	25	0.1667	4.166667
f_2	Score Institutional Capacity					$\sum C_{ij} w_j$		1	46.83333
3	Human Resources Capacity (service provider)								
C_{31}	Professionals	None	None	Administrative supervisor	Administrative manager	Administrative manager	40	0.2	8
				Health Scientist	Health Scientist	Health Scientist			
					Engineer	Engineer			
						Lawyer			
						Public relations manager			
C_{32}	Skilled Labor	None	Mechanic	Maintenance technician	Maintenance technician	Maintenance technician	45	0.2	9
				Laboratory technician	Laboratory technician	Laboratory technician			
				Water systems operator	Water systems operator	Water systems operator			
					Health Inspector	Health Inspector			
					Administratrive assistant	Administratrive assistant			
					Water meter leader	Water meter leader			
						IT technician			
C_{33}	Unskilled Labor	Craftsman	Clerk	Clerk			60	0.2	12
			Mechanic assistant	Water meter reader					
				Water systems worker					
C_{34}	Illiterate	Caretaker	Caretaker				60	0.2	12
C_{35}	Access to Higher Education	None	State	Regional	District	Mandal	61	0.2	12.2
f_3	Score Human Resources Capacity					$\sum C_{ij} w_j$		1	53.2
4	Technical Capacity								
C_{41}	Operations	Water Use	Pumping Water	Pumping Water	Monitor water systems	Monitor water systems	40	0.2	8
				Control Water Quality	Control Water Quality	Control Water Quality			
					Control Pipes	Monitor pipes network			
						Monitor Treatment			
C_{42}	Maintenance	None	Clean water systems	Check water systems	Check/maintain water systems	Check/maintain water systems	40	0.2	8
			Minor repair	Major repair	Major repair	Check/maintain network			
					Maintain pipes	Check/maintain meter			
						Maintain IT systems			
C_{43}	Adaptation	None	Rarely	Occasionally	Usually	Frequently	40	0.2	8
C_{45}	Maintenance network	None	State	District	Mandal	Habitational	65	0.2	13
C_{45}	Distribution network	None	Regional Supplier	District Supplier	Mandal Supplier	Habitational Supplier	61	0.2	12.2
					District Approved	District Approved			
f_4	Score Technical Capacity					$\sum C_{ij} w_j$		1	49.2
5	Economical and Financial Capacity								
C_{51}	Private sector investment	None	State	Regional	District	Mandal	61	0.14	8.714286
C_{52}	Market incentives	None	Low	Medium	High	Very high	45	0.14	6.428571
C_{53}	User fees	None	Uniform flat rate	Single block rate	Increasing block rate	Increasing block rate	40	0.14	5.714286
C_{54}	Budget	None	Basic accounting	Annual	Tracked bi-annually	Tracked quarterly	40	0.14	5.714286
C_{55}	Asset values	None	Real Estate	Real estate	Real estate	Real estate	45	0.14	6.428571
				Equipment	Equipment	Equipment			
					Cash	Cash - Stocks			
C_{56}	Investment activities	None	Low	Medium	High	Very High	45	0.14	6.428571
C_{57}	Loss to corruption	Very High	High	Medium	Low	None	50	0.14	7.142857
f_5	Score Economical and Financial Capacity					$\sum C_{ij} w_j$		1	46.57143
6	Energy Capacity								
C_{61}	Primary source	None	Non-conventional	Conventional electricity	Electricity mid-voltage	Electricity high voltage	60	0.25	15
C_{62}	Alternative source	None	None	Generator < 10 HP	Generator < 50 HP	Generator > 50 HP	45	0.25	11.25
C_{63}	Dependence for service	Very low	Low	Medium	High	Very High	45	0.25	11.25
C_{64}	Outage rate	Very High	High	Medium	Low	Very low	45	0.25	11.25
f_6	Score Energy Capacity					$\sum C_{ij} w_j$		1	48.75
7	Environmental and Ecological Capacity								
C_{71}	Environment quality	Very low	Low	Medium	High	Very high	60	0.2	12
C_{72}	Size of resource system	Very low	Low	Medium	High	Very high	60	0.2	12
C_{73}	Predictability of resource dynamics	Very low	Low	Medium	High	Very high	60	0.2	12
C_{74}	Growth or replacement rate	Very Negati	Negative	Stable	Positive	Very Positive	50	0.2	10
C_{74}	Resource sensibility	Very low	Low	Medium	High	Very High	55	0.2	11
f_7	Score Environmental Capacity					$\sum C_{ij} w_j$		1	57
8	Social and Cultural Capacity								
C_{81}	Communal ownership	Very low	Low	Intermediate	High	Very high	60	0.2	12
C_{82}	Political stability	Very low	Low	Intermediate	High	Very high	65	0.2	13
C_{83}	Equity	Very low	Low	Intermediate	High	Very high	65	0.2	13
C_{84}	Leadership/entrepreneurship	Very low	Low	Intermediate	High	Very high	65	0.2	13
C_{85}	Participation of women	Very low	Low	Intermediate	High	Very high	65	0.2	13
f_8	Score Social-Cultural Capacity					$\sum C_{ij} w_j$		1	64

Appendix IV.E.4: Mothkur Mandal – Dharmapur

		Partitioned Scoring							
	Capacity Factors	1-20	21-40	41-60	61-80	81-100	Score	Weight	CF score
1	Service Capacity								
C_{11}	Effective service level	< 20 l/p/d	20 - 40 l/p/d	40 - 60 l/p/d	60 - 80 l/p/d	> 80 l/p/d	35	1	35
f_1	Score Service Capacity					$\sum C_{ij} w_j$		1	35
2	Institutional Capacity								
C_{21}	Body of legislation	None	Basic	Intermediate	Complete	Advanced	50	0.1667	8.333333
C_{22}	Operational rules	None	Basic	Intermediate	Complete	Advanced	45	0.1667	7.5
C_{23}	Administrative agencies	None	State	District	Mandal	Habitational	41	0.1667	6.833333
C_{24}	Administrative processes	None	Basic	Intermediate	Complete	Advanced	40	0.1667	6.666667
C_{25}	Governance	None	State	District	Mandal	Habitational	61	0.1667	10.16667
C_{26}	Presence of NGOs	None	Low	Medium	High	Very High	35	0.1667	5.833333
f_2	Score Institutional Capacity					$\sum C_{ij} w_j$		1	45.33333
3	Human Resources Capacity (service provider)								
C_{31}	Professionals	None	None	Administrative supervisor	Administrative manager	Administrative manager	61	0.2	12.2
				Health Scientist	Health Scientist	Health Scientist			
					Engineer	Engineer			
						Lawyer			
						Public relations manager			
C_{32}	Skilled Labor	None	Mechanic	Maintenance technician	Maintenance technician	Maintenance technician	45	0.2	9
				Laboratory technician	Laboratory technician	Laboratory technician			
				Water systems operator	Water systems operator	Water systems operator			
					Health Inspector	Health Inspector			
					Administratrive assistant	Administratrive assistant			
					Water meter leader	Water meter leader			
						IT technician			
C_{33}	Unskilled Labor	Craftsman	Clerk	Clerk			75	0.2	15
			Mechanic assistant	Water meter reader					
				Water systems worker					
C_{34}	Illiterate	Caretaker	Caretaker				70	0.2	14
C_{35}	Access to Higher Education	None	State	Regional	District	Mandal	61	0.2	12.2
f_3	Score Human Resources Capacity					$\sum C_{ij} w_j$		1	62.4
4	Technical Capacity								
C_{41}	Operations	Water Use	Pumping Water	Pumping Water	Monitor water systems	Monitor water systems	50	0.2	10
				Control Water Quality	Control Water Quality	Control Water Quality			
					Control Pipes	Monitor pipes network			
						Monitor Treatment			
C_{42}	Maintenance	None	Clean water systems	Check water systems	Check/maintain water systems	Check/maintain water systems	40	0.2	8
			Minor repair	Major repair	Major repair	Check/maintain network			
					Maintain pipes	Check/maintain meter			
						Maintain IT systems			
C_{43}	Adaptation	None	Rarely	Occasionally	Usually	Frequently	40	0.2	8
C_{45}	Maintenance network	None	State	District	Mandal	Habitational	61	0.2	12.2
C_{45}	Distribution network	None	Regional Supplier	District Supplier	Mandal Supplier	Habitational Supplier	55	0.2	11
					District Approved	District Approved			
f_4	Score Technical Capacity					$\sum C_{ij} w_j$		1	49.2
5	Economical and Financial Capacity								
C_{51}	Private sector investment	None	State	Regional	District	Mandal	61	0.14	8.714286
C_{52}	Market incentives	None	Low	Medium	High	Very high	45	0.14	6.428571
C_{53}	User fees	None	Uniform flat rate	Single block rate	Increasing block rate	Increasing block rate	40	0.14	5.714286
C_{54}	Budget	None	Basic accounting	Annual	Tracked bi-annually	Tracked quarterly	40	0.14	5.714286
C_{55}	Asset values	None	Real Estate	Real estate	Real estate	Real estate	50	0.14	7.142857
				Equipment	Equipment	Equipment			
					Cash	Cash - Stocks			
C_{56}	Investment activities	None	Low	Medium	High	Very High	50	0.14	7.142857
C_{57}	Loss to corruption	Very High	High	Medium	Low	None	50	0.14	7.142857
f_5	Score Economical and Financial Capacity					$\sum C_{ij} w_j$		1	48
6	Energy Capacity								
C_{61}	Primary source	None	Non-conventional	Conventional electricity	Electricity mid-voltage	Electricity high voltage	61	0.25	15.25
C_{62}	Alternative source	None	None	Generator < 10 HP	Generator < 50 HP	Generator > 50 HP	45	0.25	11.25
C_{63}	Dependence for service	Very low	Low	Medium	High	Very High	50	0.25	12.5
C_{64}	Outage rate	Very High	High	Medium	Low	Very low	45	0.25	11.25
f_6	Score Energy Capacity					$\sum C_{ij} w_j$		1	50.25
7	Environmental and Ecological Capacity								
C_{71}	Environment quality	Very low	Low	Medium	High	Very high	61	0.2	12.2
C_{72}	Size of resource system	Very low	Low	Medium	High	Very high	50	0.2	10
C_{73}	Predictability of resource dynamics	Very low	Low	Medium	High	Very high	50	0.2	10
C_{74}	Growth or replacement rate	Very Negati	Negative	Stable	Positive	Very Positive	55	0.2	11
C_{74}	Resource sensibility	Very low	Low	Medium	High	Very High	55	0.2	11
f_7	Score Environmental Capacity					$\sum C_{ij} w_j$		1	54.2
8	Social and Cultural Capacity								
C_{81}	Communal ownership	Very low	Low	Intermediate	High	Very high	55	0.2	11
C_{82}	Political stability	Very low	Low	Intermediate	High	Very high	70	0.2	14
C_{83}	Equity	Very low	Low	Intermediate	High	Very high	70	0.2	14
C_{84}	Leadership/entrepreneurship	Very low	Low	Intermediate	High	Very high	55	0.2	11
C_{85}	Participation of women	Very low	Low	Intermediate	High	Very high	70	0.2	14
f_8	Score Social-Cultural Capacity					$\sum C_{ij} w_j$		1	64

Appendix.IV.F.1: Chouttupal Mandal – Chouttupal

		Partitioned Scoring							
	Capacity Factors	**1-20**	**21-40**	**41-60**	**61-80**	**81-100**	**Score**	**Weight**	**CF score**
1	**Service Capacity**								
C_{11}	Effective service level	< 20 l/p/d	20 - 40 l/p/d	40 - 60 l/p/d	60 - 80 l/p/d	> 80 l/p/d	35	1	35
f_1	*Score Service Capacity*					$\sum C_{ij} w_j$		1	**35**
2	**Institutional Capacity**								
C_{21}	Body of legislation	None	Basic	Intermediate	Complete	Advanced	60	0.1667	10
C_{22}	Operational rules	None	Basic	Intermediate	Complete	Advanced	60	0.1667	10
C_{23}	Administrative agencies	None	State	District	Mandal	Habitational	50	0.1667	8.333333
C_{24}	Administrative processes	None	Basic	Intermediate	Complete	Advanced	50	0.1667	8.333333
C_{25}	Governance	None	State	District	Mandal	Habitational	65	0.1667	10.83333
C_{26}	Presence of NGOs	None	Low	Medium	High	Very High	35	0.1667	5.833333
f_2	*Score Institutional Capacity*					$\sum C_{ij} w_j$		1	**53.33333**
3	**Human Resources Capacity (service provider)**								
C_{31}	Professionals	None	None	Administrative supervisor	Administrative manager	Administrative manager	81	0.2	16.2
				Health Scientist	Health Scientist	Health Scientist			
					Engineer	Engineer			
						Lawyer			
						Public relations manager			
C_{32}	Skilled Labor	None	Mechanic	Maintenance technician	Maintenance technician	Maintenance technician	45	0.2	9
				Laboratory technician	Laboratory technician	Laboratory technician			
				Water systems operator	Water systems operator	Water systems operator			
					Health Inspector	Health Inspector			
					Administratrive assistant	Administratrive assistant			
					Water meter leader	Water meter leader			
						IT technician			
C_{33}	Unskilled Labor	Craftsman	Clerk	Clerk			80	0.2	16
			Mechanic assistant	Water meter reader					
				Water systems worker					
C_{34}	Illiterate	Caretaker	Caretaker				80	0.2	16
C_{35}	Access to Higher Education	None	State	Regional	District	Mandal	70	0.2	14
f_3	*Score Human Resources Capacity*					$\sum C_{ij} w_j$		1	**71.2**
4	**Technical Capacity**								
C_{41}	Operations	Water Use	Pumping Water	Pumping Water	Monitor water systems	Monitor water systems	60	0.2	12
				Control Water Quality	Control Water Quality	Control Water Quality			
					Control Pipes	Monitor pipes network			
						Monitor Treatment			
C_{42}	Maintenance	None	Clean water systems	Check water systems	Check/maintain water systems	Check/maintain water systems	55	0.2	11
			Minor repair	Major repair	Major repair	Check/maintain network			
					Maintain pipes	Check/maintain meter			
						Maintain IT systems			
C_{43}	Adaptation	None	Rarely	Occasionally	Usually	Frequently	40	0.2	8
C_{45}	Maintenance network	None	State	District	Mandal	Habitational	65	0.2	13
C_{45}	Distribution network	None	Regional Supplier	District Supplier	Mandal Supplier	Habitational Supplier	61	0.2	12.2
					District Approved	District Approved			
f_4	*Score Technical Capacity*					$\sum C_{ij} w_j$		1	**56.2**
5	**Economical and Financial Capacity**								
C_{51}	Private sector investment	None	State	Regional	District	Mandal	81	0.14	11.57143
C_{52}	Market incentives	None	Low	Medium	High	Very high	60	0.14	8.571429
C_{53}	User fees	None	Uniform flat rate	Single block rate	Increasing block rate	Increasing block rate	55	0.14	7.857143
C_{54}	Budget	None	Basic accounting	Annual	Tracked bi-annually	Tracked quarterly	60	0.14	8.571429
C_{55}	Asset values	None	Real Estate	Real estate	Real estate	Real estate	65	0.14	9.285714
				Equipment	Equipment	Equipment			
					Cash	Cash - Stocks			
C_{56}	Investment activities	None	Low	Medium	High	Very High	60	0.14	8.571429
C_{57}	Loss to corruption	Very High	High	Medium	Low	None	45	0.14	6.428571
f_5	*Score Economical and Financial Capacity*					$\sum C_{ij} w_j$		1	**60.85714**
6	**Energy Capacity**								
C_{61}	Primary source	None	Non-conventional	Conventional electricity	Electricity mid-voltage	Electricity high voltage	81	0.25	20.25
C_{62}	Alternative source	None	None	Generator < 10 HP	Generator < 50 HP	Generator > 50 HP	75	0.25	18.75
C_{63}	Dependence for service	Very low	Low	Medium	High	Very High	60	0.25	15
C_{64}	Outage rate	Very High	High	Medium	Low	Very low	70	0.25	17.5
f_6	*Score Energy Capacity*					$\sum C_{ij} w_j$		1	**71.5**
7	**Environmental and Ecological Capacity**								
C_{71}	Environment quality	Very low	Low	Medium	High	Very high	45	0.2	9
C_{72}	Size of resource system	Very low	Low	Medium	High	Very high	40	0.2	8
C_{73}	Predictability of resource dynamics	Very low	Low	Medium	High	Very high	30	0.2	6
C_{74}	Growth or replacement rate	Very Negati	Negative	Stable	Positive	Very Positive	40	0.2	8
C_{74}	Resource sensibility	Very low	Low	Medium	High	Very High	50	0.2	10
f_7	*Score Environmental Capacity*					$\sum C_{ij} w_j$		1	**41**
8	**Social and Cultural Capacity**								
C_{81}	Communal ownership	Very low	Low	Intermediate	High	Very high	65	0.2	13
C_{82}	Political stability	Very low	Low	Intermediate	High	Very high	50	0.2	10
C_{83}	Equity	Very low	Low	Intermediate	High	Very high	65	0.2	13
C_{84}	Leadership/entrepreneurship	Very low	Low	Intermediate	High	Very high	70	0.2	14
C_{85}	Participation of women	Very low	Low	Intermediate	High	Very high	50	0.2	10
f_8	*Score Social-Cultural Capacity*					$\sum C_{ij} w_j$		1	**60**

Appendix IV.G.1: Devarkonda Mandal – Devarkonda

		Partitioned Scoring							
	Capacity Factors	**1-20**	**21-40**	**41-60**	**61-80**	**81-100**	**Score**	**Weight**	**CF score**
1	**Service Capacity**								
C_{11}	Effective service level	< 20 l/p/d	20 - 40 l/p/d	40 - 60 l/p/d	60 - 80 l/p/d	> 80 l/p/d	30	1	30
f_1	*Score Service Capacity*					$\sum C_{ij} w_j$		*1*	**30**
2	**Institutional Capacity**								
C_{21}	Body of legislation	None	Basic	Intermediate	Complete	Advanced	55	0.1667	9.166667
C_{22}	Operational rules	None	Basic	Intermediate	Complete	Advanced	65	0.1667	10.83333
C_{23}	Administrative agencies	None	State	District	Mandal	Habitational	65	0.1667	10.83333
C_{24}	Administrative processes	None	Basic	Intermediate	Complete	Advanced	40	0.1667	6.666667
C_{25}	Governance	None	State	District	Mandal	Habitational	70	0.1667	11.66667
C_{26}	Presence of NGOs	None	Low	Medium	High	Very High	41	0.1667	6.833333
f_2	*Score Institutional Capacity*					$\sum C_{ij} w_j$		*1*	**56**
3	**Human Resources Capacity (service provider)**								
C_{31}	Professionals	None	None	Administrative supervisor	Administrative manager	Administrative manager	75	0.2	15
				Health Scientist	Health Scientist	Health Scientist			
					Engineer	Engineer			
						Lawyer			
						Public relations manager			
C_{32}	Skilled Labor	None	Mechanic	Maintenance technician	Maintenance technician	Maintenance technician	61	0.2	12.2
				Laboratory technician	Laboratory technician	Laboratory technician			
				Water systems operator	Water systems operator	Water systems operator			
					Health Inspector	Health Inspector			
					Administratrive assistant	Administratrive assistant			
					Water meter leader	Water meter leader			
						IT technician			
C_{33}	Unskilled Labor	Craftsman	Clerk	Clerk			80	0.2	16
			Mechanic assistant	Water meter reader					
				Water systems worker					
C_{34}	Illiterate	Caretaker	Caretaker				80	0.2	16
C_{35}	Access to Higher Education	None	State	Regional	District	Mandal	61	0.2	12.2
f_3	*Score Human Resources Capacity*					$\sum C_{ij} w_j$		1	**71.4**
4	**Technical Capacity**								
C_{41}	Operations	Water Use	Pumping Water	Pumping Water	Monitor water systems	Monitor water systems	70	0.2	14
				Control Water Quality	Control Water Quality	Control Water Quality			
					Control Pipes	Monitor pipes network			
						Monitor Treatment			
C_{42}	Maintenance	None	Clean water systems	Check water systems	Check/maintain water systems	Check/maintain water systems	60	0.2	12
			Minor repair	Major repair	Major repair	Check/maintain network			
					Maintain pipes	Check/maintain meter			
						Maintain IT systems			
C_{43}	Adaptation	None	Rarely	Occasionally	Usually	Frequently	50	0.2	10
C_{45}	Maintenance network	None	State	District	Mandal	Habitational	70	0.2	14
C_{45}	Distribution network	None	Regional Supplier	District Supplier	Mandal Supplier	Habitational Supplier	55	0.2	11
					District Approved	District Approved			
f_4	*Score Technical Capacity*					$\sum C_{ij} w_j$		*1*	**61**
5	**Economical and Financial Capacity**								
C_{51}	Private sector investment	None	State	Regional	District	Mandal	50	0.14	7.142857
C_{52}	Market incentives	None	Low	Medium	High	Very high	70	0.14	10
C_{53}	User fees	None	Uniform flat rate	Single block rate	Increasing block rate	Increasing block rate	45	0.14	6.428571
C_{54}	Budget	None	Basic accounting	Annual	Tracked bi-annually	Tracked quarterly	50	0.14	7.142857
C_{55}	Asset values	None	Real Estate	Real estate	Real estate	Real estate	70	0.14	10
				Equipment	Equipment	Equipment			
					Cash	Cash - Stocks			
C_{56}	Investment activities	None	Low	Medium	High	Very High	65	0.14	9.285714
C_{57}	Loss to corruption	Very High	High	Medium	Low	None	10	0.14	1.428571
f_5	*Score Economical and Financial Capacity*					$\sum C_{ij} w_j$		*1*	**51.42857**
6	**Energy Capacity**								
C_{61}	Primary source	None	Non-conventional	Conventional electricity	Electricity mid-voltage	Electricity high voltage	70	0.25	17.5
C_{62}	Alternative source	None	None	Generator < 10 HP	Generator < 50 HP	Generator > 50 HP	65	0.25	16.25
C_{63}	Dependence for service	Very low	Low	Medium	High	Very High	50	0.25	12.5
C_{64}	Outage rate	Very High	High	Medium	Low	Very low	40	0.25	10
f_6	*Score Energy Capacity*					$\sum C_{ij} w_j$		*1*	**56.25**
7	**Environmental and Ecological Capacity**								
C_{71}	Environment quality	Very low	Low	Medium	High	Very high	60	0.2	12
C_{72}	Size of resource system	Very low	Low	Medium	High	Very high	30	0.2	6
C_{73}	Predictability of resource dynamics	Very low	Low	Medium	High	Very high	20	0.2	4
C_{74}	Growth or replacement rate	Very Negati	Negative	Stable	Positive	Very Positive	30	0.2	6
C_{74}	Resource sensibility	Very low	Low	Medium	High	Very High	40	0.2	8
f_7	*Score Environmental Capacity*					$\sum C_{ij} w_j$		*1*	**36**
8	**Social and Cultural Capacity**								
C_{81}	Communal ownership	Very low	Low	Intermediate	High	Very high	45	0.2	9
C_{82}	Political stability	Very low	Low	Intermediate	High	Very high	45	0.2	9
C_{83}	Equity	Very low	Low	Intermediate	High	Very high	40	0.2	8
C_{84}	Leadership/entrepreneurship	Very low	Low	Intermediate	High	Very high	70	0.2	14
C_{85}	Participation of women	Very low	Low	Intermediate	High	Very high	65	0.2	13
f_8	*Score Social-Cultural Capacity*					$\sum C_{ij} w_j$		1	**53**

Appendix IV.H.1: Huzurnagar Mandal – Huzurnagar

		Partitioned Scoring							
	Capacity Factors	**1-20**	**21-40**	**41-60**	**61-80**	**81-100**	**Score**	**Weight**	**CF score**
1	**Service Capacity**								
C_{11}	Effective service level	< 20 l/p/d	20 - 40 l/p/d	40 - 60 l/p/d	60 - 80 l/p/d	> 80 l/p/d	25	1	25
f_1	*Score Service Capacity*					$\sum C_{ij} w_j$		*1*	**25**
2	**Institutional Capacity**								
C_{21}	Body of legislation	None	Basic	Intermediate	Complete	Advanced	50	0.1667	8.333333
C_{22}	Operational rules	None	Basic	Intermediate	Complete	Advanced	45	0.1667	7.5
C_{23}	Administrative agencies	None	State	District	Mandal	Habitational	61	0.1667	10.16667
C_{24}	Administrative processes	None	Basic	Intermediate	Complete	Advanced	61	0.1667	10.16667
C_{25}	Governance	None	State	District	Mandal	Habitational	55	0.1667	9.166667
C_{26}	Presence of NGOs	None	Low	Medium	High	Very High	15	0.1667	2.5
f_2	*Score Institutional Capacity*					$\sum C_{ij} w_j$		*1*	**47.83333**
3	**Human Resources Capacity (service provider)**								
C_{31}	Professionals	None	None	Administrative supervisor	Administrative manager	Administrative manager	61	0.2	12.2
				Health Scientist	Health Scientist	Health Scientist			
					Engineer	Engineer			
						Lawyer			
						Public relations manager			
C_{32}	Skilled Labor	None	Mechanic	Maintenance technician	Maintenance technician	Maintenance technician	41	0.2	8.2
				Laboratory technician	Laboratory technician	Laboratory technician			
				Water systems operator	Water systems operator	Water systems operator			
					Health Inspector	Health Inspector			
					Administratrive assistant	Administratrive assistant			
					Water meter leader	Water meter leader			
						IT technician			
C_{33}	Unskilled Labor	Craftsman	Clerk	Clerk			60	0.2	12
			Mechanic assistant	Water meter reader					
				Water systems worker					
C_{34}	Illiterate	Caretaker	Caretaker				60	0.2	12
C_{35}	Access to Higher Education	None	State	Regional	District	Mandal	65	0.2	13
f_3	*Score Human Resources Capacity*					$\sum C_{ij} w_j$		1	**57.4**
4	**Technical Capacity**								
C_{41}	Operations	Water Use	Pumping Water	Pumping Water	Monitor water systems	Monitor water systems	61	0.2	12.2
				Control Water Quality	Control Water Quality	Control Water Quality			
					Control Pipes	Monitor pipes network			
						Monitor Treatment			
C_{42}	Maintenance	None	Clean water systems	Check water systems	Check/maintain water systems	Check/maintain water systems	45	0.2	9
			Minor repair	Major repair	Major repair	Check/maintain network			
					Maintain pipes	Check/maintain meter			
						Maintain IT systems			
C_{43}	Adaptation	None	Rarely	Occasionally	Usually	Frequently	40	0.2	8
C_{45}	Maintenance network	None	State	District	Mandal	Habitational	55	0.2	11
C_{45}	Distribution network	None	Regional Supplier	District Supplier	Mandal Supplier	Habitational Supplier	55	0.2	11
					District Approved	District Approved			
f_4	*Score Technical Capacity*					$\sum C_{ij} w_j$		*1*	**51.2**
5	**Economical and Financial Capacity**								
C_{51}	Private sector investment	None	State	Regional	District	Mandal	61	0.14	8.714286
C_{52}	Market incentives	None	Low	Medium	High	Very high	45	0.14	6.428571
C_{53}	User fees	None	Uniform flat rate	Single block rate	Increasing block rate	Increasing block rate	30	0.14	4.285714
C_{54}	Budget	None	Basic accounting	Annual	Tracked bi-annually	Tracked quarterly	50	0.14	7.142857
C_{55}	Asset values	None	Real Estate	Real estate	Real estate	Real estate	65	0.14	9.285714
				Equipment	Equipment	Equipment			
					Cash	Cash - Stocks			
C_{56}	Investment activities	None	Low	Medium	High	Very High	45	0.14	6.428571
C_{57}	Loss to corruption	Very High	High	Medium	Low	None	65	0.14	9.285714
f_5	*Score Economical and Financial Capacity*					$\sum C_{ij} w_j$		*1*	**51.57143**
6	**Energy Capacity**								
C_{61}	Primary source	None	Non-conventional	Conventional electricity	Electricity mid-voltage	Electricity high voltage	70	0.25	17.5
C_{62}	Alternative source	None	None	Generator < 10 HP	Generator < 50 HP	Generator > 50 HP	65	0.25	16.25
C_{63}	Dependence for service	Very low	Low	Medium	High	Very High	50	0.25	12.5
C_{64}	Outage rate	Very High	High	Medium	Low	Very low	45	0.25	11.25
f_6	*Score Energy Capacity*					$\sum C_{ij} w_j$		*1*	**57.5**
7	**Environmental and Ecological Capacity**								
C_{71}	Environment quality	Very low	Low	Medium	High	Very high	45	0.2	9
C_{72}	Size of resource system	Very low	Low	Medium	High	Very high	60	0.2	12
C_{73}	Predictability of resource dynamics	Very low	Low	Medium	High	Very high	50	0.2	10
C_{74}	Growth or replacement rate	Very Negati	Negative	Stable	Positive	Very Positive	55	0.2	11
C_{74}	Resource sensibility	Very low	Low	Medium	High	Very High	60	0.2	12
f_7	*Score Environmental Capacity*					$\sum C_{ij} w_j$		*1*	**54**
8	**Social and Cultural Capacity**								
C_{81}	Communal ownership	Very low	Low	Intermediate	High	Very high	60	0.2	12
C_{82}	Political stability	Very low	Low	Intermediate	High	Very high	65	0.2	13
C_{83}	Equity	Very low	Low	Intermediate	High	Very high	65	0.2	13
C_{84}	Leadership/entrepreneurship	Very low	Low	Intermediate	High	Very high	45	0.2	9
C_{85}	Participation of women	Very low	Low	Intermediate	High	Very high	60	0.2	12
f_8	*Score Social-Cultural Capacity*					$\sum C_{ij} w_j$		1	**59**

Appendix IV.I.1: Marriguda Mandal – Marriguda

		Partitioned Scoring							
	Capacity Factors	1-20	21-40	41-60	61-80	81-100	Score	Weight	CF score
1	Service Capacity								
C_{11}	Effective service level	< 20 l/p/d	20 - 40 l/p/d	40 - 60 l/p/d	60 - 80 l/p/d	> 80 l/p/d	50	1	50
f_1	Score Service Capacity					$\sum C_{ij} w_j$		1	50
2	Institutional Capacity								
C_{21}	Body of legislation	None	Basic	Intermediate	Complete	Advanced	65	0.1667	10.83333
C_{22}	Operational rules	None	Basic	Intermediate	Complete	Advanced	65	0.1667	10.83333
C_{23}	Administrative agencies	None	State	District	Mandal	Habitational	60	0.1667	10
C_{24}	Administrative processes	None	Basic	Intermediate	Complete	Advanced	50	0.1667	8.333333
C_{25}	Governance	None	State	District	Mandal	Habitational	70	0.1667	11.66667
C_{26}	Presence of NGOs	None	Low	Medium	High	Very High	25	0.1667	4.166667
f_2	Score Institutional Capacity					$\sum C_{ij} w_j$		1	55.83333
3	Human Resources Capacity (service provider)								
C_{31}	Professionals	None	None	Administrative supervisor	Administrative manager	Administrative manager	65	0.2	13
				Health Scientist	Health Scientist	Health Scientist			
					Engineer	Engineer			
						Lawyer			
						Public relations manager			
C_{32}	Skilled Labor	None	Mechanic	Maintenance technician	Maintenance technician	Maintenance technician	60	0.2	12
				Laboratory technician	Laboratory technician	Laboratory technician			
				Water systems operator	Water systems operator	Water systems operator			
					Health Inspector	Health Inspector			
					Administratrive assistant	Administratrive assistant			
					Water meter leader	Water meter leader			
						IT technician			
C_{33}	Unskilled Labor	Craftsman	Clerk	Clerk			85	0.2	17
			Mechanic assistant	Water meter reader					
				Water systems worker					
C_{34}	Illiterate	Caretaker	Caretaker				90	0.2	18
C_{35}	Access to Higher Education	None	State	Regional	District	Mandal	65	0.2	13
f_3	Score Human Resources Capacity					$\sum C_{ij} w_j$		1	73
4	Technical Capacity								
C_{41}	Operations	Water Use	Pumping Water	Pumping Water	Monitor water systems	Monitor water systems	70	0.2	14
				Control Water Quality	Control Water Quality	Control Water Quality			
					Control Pipes	Monitor pipes network			
						Monitor Treatment			
C_{42}	Maintenance	None	Clean water systems	Check water systems	Check/maintain water systems	Check/maintain water systems	65	0.2	13
			Minor repair	Major repair	Major repair	Check/maintain network			
					Maintain pipes	Check/maintain meter			
						Maintain IT systems			
C_{43}	Adaptation	None	Rarely	Occasionally	Usually	Frequently	45	0.2	9
C_{45}	Maintenance network	None	State	District	Mandal	Habitational	65	0.2	13
C_{45}	Distribution network	None	Regional Supplier	District Supplier	Mandal Supplier	Habitational Supplier	60	0.2	12
					District Approved	District Approved			
f_4	Score Technical Capacity					$\sum C_{ij} w_j$		1	61
5	Economical and Financial Capacity								
C_{51}	Private sector investment	None	State	Regional	District	Mandal	65	0.14	9.285714
C_{52}	Market incentives	None	Low	Medium	High	Very high	50	0.14	7.142857
C_{53}	User fees	None	Uniform flat rate	Single block rate	Increasing block rate	Increasing block rate	30	0.14	4.285714
C_{54}	Budget	None	Basic accounting	Annual	Tracked bi-annually	Tracked quarterly	55	0.14	7.857143
C_{55}	Asset values	None	Real Estate	Real estate	Real estate	Real estate	75	0.14	10.71429
				Equipment	Equipment	Equipment			
					Cash	Cash - Stocks			
C_{56}	Investment activities	None	Low	Medium	High	Very High	55	0.14	7.857143
C_{57}	Loss to corruption	Very High	High	Medium	Low	None	45	0.14	6.428571
f_5	Score Economical and Financial Capacity					$\sum C_{ij} w_j$		1	53.57143
6	Energy Capacity								
C_{61}	Primary source	None	Non-conventional	Conventional electricity	Electricity mid-voltage	Electricity high voltage	70	0.25	17.5
C_{62}	Alternative source	None	None	Generator < 10 HP	Generator < 50 HP	Generator > 50 HP	70	0.25	17.5
C_{63}	Dependence for service	Very low	Low	Medium	High	Very High	65	0.25	16.25
C_{64}	Outage rate	Very High	High	Medium	Low	Very low	55	0.25	13.75
f_6	Score Energy Capacity					$\sum C_{ij} w_j$		1	65
7	Environmental and Ecological Capacity								
C_{71}	Environment quality	Very low	Low	Medium	High	Very high	40	0.2	8
C_{72}	Size of resource system	Very low	Low	Medium	High	Very high	45	0.2	9
C_{73}	Predictability of resource dynamics	Very low	Low	Medium	High	Very high	50	0.2	10
C_{74}	Growth or replacement rate	Very Negati	Negative	Stable	Positive	Very Positive	45	0.2	9
C_{74}	Resource sensibility	Very low	Low	Medium	High	Very High	60	0.2	12
f_7	Score Environmental Capacity					$\sum C_{ij} w_j$		1	48
8	Social and Cultural Capacity								
C_{81}	Communal ownership	Very low	Low	Intermediate	High	Very high	45	0.2	9
C_{82}	Political stability	Very low	Low	Intermediate	High	Very high	65	0.2	13
C_{83}	Equity	Very low	Low	Intermediate	High	Very high	65	0.2	13
C_{84}	Leadership/entrepreneurship	Very low	Low	Intermediate	High	Very high	50	0.2	10
C_{85}	Participation of women	Very low	Low	Intermediate	High	Very high	50	0.2	10
f_8	Score Social-Cultural Capacity					$\sum C_{ij} w_j$		1	55

Appendix IV.I.2: Marriguda Mandal – Batlapally

		Partitioned Scoring							
	Capacity Factors	1-20	21-40	41-60	61-80	81-100	Score	Weight	CF score
1	**Service Capacity**								
C_{11}	Effective service level	< 20 l/p/d	20 - 40 l/p/d	40 - 60 l/p/d	60 - 80 l/p/d	> 80 l/p/d	35	1	35
f_1	Score Service Capacity					$\sum C_{ij} w_j$		1	**35**
2	**Institutional Capacity**								
C_{21}	Body of legislation	None	Basic	Intermediate	Complete	Advanced	45	0.1667	7.5
C_{22}	Operational rules	None	Basic	Intermediate	Complete	Advanced	45	0.1667	7.5
C_{23}	Administrative agencies	None	State	District	Mandal	Habitational	45	0.1667	7.5
C_{24}	Administrative processes	None	Basic	Intermediate	Complete	Advanced	45	0.1667	7.5
C_{25}	Governance	None	State	District	Mandal	Habitational	61	0.1667	10.16667
C_{26}	Presence of NGOs	None	Low	Medium	High	Very High	25	0.1667	4.166667
f_2	Score Institutional Capacity					$\sum C_{ij} w_j$		1	**44.33333**
3	**Human Resources Capacity (service provider)**								
C_{31}	Professionals	None	None	Administrative supervisor	Administrative manager	Administrative manager	41	0.2	8.2
				Health Scientist	Health Scientist	Health Scientist			
					Engineer	Engineer			
						Lawyer			
						Public relations manager			
C_{32}	Skilled Labor	None	Mechanic	Maintenance technician	Maintenance technician	Maintenance technician	41	0.2	8.2
				Laboratory technician	Laboratory technician	Laboratory technician			
				Water systems operator	Water systems operator	Water systems operator			
					Health Inspector	Health Inspector			
					Administratrive assistant	Administratrive assistant			
					Water meter leader	Water meter leader			
						IT technician			
C_{33}	Unskilled Labor	Craftsman	Clerk	Clerk			75	0.2	15
			Mechanic assistant	Water meter reader					
				Water systems worker					
C_{34}	Illiterate	Caretaker	Caretaker				75	0.2	15
C_{35}	Access to Higher Education	None	State	Regional	District	Mandal	61	0.2	12.2
f_3	Score Human Resources Capacity					$\sum C_{ij} w_j$		1	**58.6**
4	**Technical Capacity**								
C_{41}	Operations	Water Use	Pumping Water	Pumping Water	Monitor water systems	Monitor water systems	40	0.2	8
				Control Water Quality	Control Water Quality	Control Water Quality			
					Control Pipes	Monitor pipes network			
						Monitor Treatment			
C_{42}	Maintenance	None	Clean water systems	Check water systems	Check/maintain water systems	Check/maintain water systems	40	0.2	8
			Minor repair	Major repair	Major repair	Check/maintain network			
					Maintain pipes	Check/maintain meter			
						Maintain IT systems			
C_{43}	Adaptation	None	Rarely	Occasionally	Usually	Frequently	30	0.2	6
C_{45}	Maintenance network	None	State	District	Mandal	Habitational	61	0.2	12.2
C_{45}	Distribution network	None	Regional Supplier	District Supplier	Mandal Supplier	Habitational Supplier	55	0.2	11
					District Approved	District Approved			
f_4	Score Technical Capacity					$\sum C_{ij} w_j$		1	**45.2**
5	**Economical and Financial Capacity**								
C_{51}	Private sector investment	None	State	Regional	District	Mandal	61	0.14	8.714286
C_{52}	Market incentives	None	Low	Medium	High	Very high	40	0.14	5.714286
C_{53}	User fees	None	Uniform flat rate	Single block rate	Increasing block rate	Increasing block rate	25	0.14	3.571429
C_{54}	Budget	None	Basic accounting	Annual	Tracked bi-annually	Tracked quarterly	30	0.14	4.285714
C_{55}	Asset values	None	Real Estate	Real estate	Real estate	Real estate	60	0.14	8.571429
				Equipment	Equipment	Equipment			
					Cash	Cash - Stocks			
C_{56}	Investment activities	None	Low	Medium	High	Very High	40	0.14	5.714286
C_{57}	Loss to corruption	Very High	High	Medium	Low	None	60	0.14	8.571429
f_5	Score Economical and Financial Capacity					$\sum C_{ij} w_j$		1	**45.14286**
6	**Energy Capacity**								
C_{61}	Primary source	None	Non-conventional	Conventional electricity	Electricity mid-voltage	Electricity high voltage	65	0.25	16.25
C_{62}	Alternative source	None	None	Generator < 10 HP	Generator < 50 HP	Generator > 50 HP	50	0.25	12.5
C_{63}	Dependence for service	Very low	Low	Medium	High	Very High	50	0.25	12.5
C_{64}	Outage rate	Very High	High	Medium	Low	Very low	70	0.25	17.5
f_6	Score Energy Capacity					$\sum C_{ij} w_j$		1	**58.75**
7	**Environmental and Ecological Capacity**								
C_{71}	Environment quality	Very low	Low	Medium	High	Very high	45	0.2	9
C_{72}	Size of resource system	Very low	Low	Medium	High	Very high	50	0.2	10
C_{73}	Predictability of resource dynamics	Very low	Low	Medium	High	Very high	45	0.2	9
C_{74}	Growth or replacement rate	Very Negati	Negative	Stable	Positive	Very Positive	45	0.2	9
C_{74}	Resource sensibility	Very low	Low	Medium	High	Very High	40	0.2	8
f_7	Score Environmental Capacity					$\sum C_{ij} w_j$		1	**45**
8	**Social and Cultural Capacity**								
C_{81}	Communal ownership	Very low	Low	Intermediate	High	Very high	50	0.2	10
C_{82}	Political stability	Very low	Low	Intermediate	High	Very high	50	0.2	10
C_{83}	Equity	Very low	Low	Intermediate	High	Very high	70	0.2	14
C_{84}	Leadership/entrepreneurship	Very low	Low	Intermediate	High	Very high	50	0.2	10
C_{85}	Participation of women	Very low	Low	Intermediate	High	Very high	70	0.2	14
f_8	Score Social-Cultural Capacity					$\sum C_{ij} w_j$		1	**58**

Appendix IV.I.3: Marriguda Mandal – Shivannaguda

		Partitioned Scoring							
	Capacity Factors	1-20	21-40	41-60	61-80	81-100	Score	Weight	CF score
1	Service Capacity								
C_{11}	Effective service level	< 20 l/p/d	20 - 40 l/p/d	40 - 60 l/p/d	60 - 80 l/p/d	> 80 l/p/d	32	1	32
f_1	Score Service Capacity					$\sum C_{ij} w_j$		1	32
2	Institutional Capacity								
C_{21}	Body of legislation	None	Basic	Intermediate	Complete	Advanced	50	0.1667	8.333333
C_{22}	Operational rules	None	Basic	Intermediate	Complete	Advanced	50	0.1667	8.333333
C_{23}	Administrative agencies	None	State	District	Mandal	Habitational	50	0.1667	8.333333
C_{24}	Administrative processes	None	Basic	Intermediate	Complete	Advanced	45	0.1667	7.5
C_{25}	Governance	None	State	District	Mandal	Habitational	70	0.1667	11.66667
C_{26}	Presence of NGOs	None	Low	Medium	High	Very High	45	0.1667	7.5
f_2	Score Institutional Capacity					$\sum C_{ij} w_j$		1	51.66667
3	Human Resources Capacity (service provider)								
C_{31}	Professionals	None	None	Administrative supervisor	Administrative manager	Administrative manager	45	0.2	9
				Health Scientist	Health Scientist	Health Scientist			
					Engineer	Engineer			
						Lawyer			
						Public relations manager			
C_{32}	Skilled Labor	None	Mechanic	Maintenance technician	Maintenance technician	Maintenance technician	50	0.2	10
				Laboratory technician	Laboratory technician	Laboratory technician			
				Water systems operator	Water systems operator	Water systems operator			
					Health Inspector	Health Inspector			
					Administratrive assistant	Administratrive assistant			
					Water meter leader	Water meter leader			
						IT technician			
C_{33}	Unskilled Labor	Craftsman	Clerk	Clerk			75	0.2	15
			Mechanic assistant	Water meter reader					
				Water systems worker					
C_{34}	Illiterate	Caretaker	Caretaker				75	0.2	15
C_{35}	Access to Higher Education	None	State	Regional	District	Mandal	61	0.2	12.2
f_3	Score Human Resources Capacity					$\sum C_{ij} w_j$		1	61.2
4	Technical Capacity								
C_{41}	Operations	Water Use	Pumping Water	Pumping Water	Monitor water systems	Monitor water systems	50	0.2	10
				Control Water Quality	Control Water Quality	Control Water Quality			
					Control Pipes	Monitor pipes network			
						Monitor Treatment			
C_{42}	Maintenance	None	Clean water systems	Check water systems	Check/maintain water systems	Check/maintain water systems	40	0.2	8
			Minor repair	Major repair	Major repair	Check/maintain network			
					Maintain pipes	Check/maintain meter			
						Maintain IT systems			
C_{43}	Adaptation	None	Rarely	Occasionally	Usually	Frequently	30	0.2	6
C_{45}	Maintenance network	None	State	District	Mandal	Habitational	65	0.2	13
C_{45}	Distribution network	None	Regional Supplier	District Supplier	Mandal Supplier	Habitational Supplier	60	0.2	12
					District Approved	District Approved			
f_4	Score Technical Capacity					$\sum C_{ij} w_j$		1	49
5	Economical and Financial Capacity								
C_{51}	Private sector investment	None	State	Regional	District	Mandal	81	0.14	11.57143
C_{52}	Market incentives	None	Low	Medium	High	Very high	65	0.14	9.285714
C_{53}	User fees	None	Uniform flat rate	Single block rate	Increasing block rate	Increasing block rate	40	0.14	5.714286
C_{54}	Budget	None	Basic accounting	Annual	Tracked bi-annually	Tracked quarterly	45	0.14	6.428571
C_{55}	Asset values	None	Real Estate	Real estate	Real estate	Real estate	61	0.14	8.714286
				Equipment	Equipment	Equipment			
					Cash	Cash - Stocks			
C_{56}	Investment activities	None	Low	Medium	High	Very High	45	0.14	6.428571
C_{57}	Loss to corruption	Very High	High	Medium	Low	None	50	0.14	7.142857
f_5	Score Economical and Financial Capacity					$\sum C_{ij} w_j$		1	55.28571
6	Energy Capacity								
C_{61}	Primary source	None	Non-conventional	Conventional electricity	Electricity mid-voltage	Electricity high voltage	65	0.25	16.25
C_{62}	Alternative source	None	None	Generator < 10 HP	Generator < 50 HP	Generator > 50 HP	50	0.25	12.5
C_{63}	Dependence for service	Very low	Low	Medium	High	Very High	50	0.25	12.5
C_{64}	Outage rate	Very High	High	Medium	Low	Very low	75	0.25	18.75
f_6	Score Energy Capacity					$\sum C_{ij} w_j$		1	60
7	Environmental and Ecological Capacity								
C_{71}	Environment quality	Very low	Low	Medium	High	Very high	45	0.2	9
C_{72}	Size of resource system	Very low	Low	Medium	High	Very high	55	0.2	11
C_{73}	Predictability of resource dynamics	Very low	Low	Medium	High	Very high	50	0.2	10
C_{74}	Growth or replacement rate	Very Negati	Negative	Stable	Positive	Very Positive	50	0.2	10
C_{74}	Resource sensibility	Very low	Low	Medium	High	Very High	60	0.2	12
f_7	Score Environmental Capacity					$\sum C_{ij} w_j$		1	52
8	Social and Cultural Capacity								
C_{81}	Communal ownership	Very low	Low	Intermediate	High	Very high	65	0.2	13
C_{82}	Political stability	Very low	Low	Intermediate	High	Very high	65	0.2	13
C_{83}	Equity	Very low	Low	Intermediate	High	Very high	75	0.2	15
C_{84}	Leadership/entrepreneurship	Very low	Low	Intermediate	High	Very high	70	0.2	14
C_{85}	Participation of women	Very low	Low	Intermediate	High	Very high	70	0.2	14
f_8	Score Social-Cultural Capacity					$\sum C_{ij} w_j$		1	69

Appendix IV.I.4: Marriguda Mandal – Anthampeta

		Partitioned Scoring							
	Capacity Factors	1-20	21-40	41-60	61-80	81-100	Score	Weight	CF score
1	Service Capacity								
C_{11}	Effective service level	< 20 l/p/d	20 - 40 l/p/d	40 - 60 l/p/d	60 - 80 l/p/d	> 80 l/p/d	30	1	30
f_1	Score Service Capacity					$\sum C_{ij} w_j$		1	30
2	Institutional Capacity								
C_{21}	Body of legislation	None	Basic	Intermediate	Complete	Advanced	45	0.1667	7.5
C_{22}	Operational rules	None	Basic	Intermediate	Complete	Advanced	40	0.1667	6.666667
C_{23}	Administrative agencies	None	State	District	Mandal	Habitational	40	0.1667	6.666667
C_{24}	Administrative processes	None	Basic	Intermediate	Complete	Advanced	30	0.1667	5
C_{25}	Governance	None	State	District	Mandal	Habitational	61	0.1667	10.16667
C_{26}	Presence of NGOs	None	Low	Medium	High	Very High	25	0.1667	4.166667
f_2	Score Institutional Capacity					$\sum C_{ij} w_j$		1	40.16667
3	Human Resources Capacity (service provider)								
C_{31}	Professionals	None	None	Administrative supervisor	Administrative manager	Administrative manager	35	0.2	7
				Health Scientist	Health Scientist	Health Scientist			
					Engineer	Engineer			
						Lawyer			
						Public relations manager			
C_{32}	Skilled Labor	None	Mechanic	Maintenance technician	Maintenance technician	Maintenance technician	40	0.2	8
				Laboratory technician	Laboratory technician	Laboratory technician			
				Water systems operator	Water systems operator	Water systems operator			
					Health Inspector	Health Inspector			
					Administratrive assistant	Administratrive assistant			
					Water meter leader	Water meter leader			
						IT technician			
C_{33}	Unskilled Labor	Craftsman	Clerk	Clerk			60	0.2	12
			Mechanic assistant	Water meter reader					
				Water systems worker					
C_{34}	Illiterate	Caretaker	Caretaker				60	0.2	12
C_{35}	Access to Higher Education	None	State	Regional	District	Mandal	61	0.2	12.2
f_3	Score Human Resources Capacity					$\sum C_{ij} w_j$		1	51.2
4	Technical Capacity								
C_{41}	Operations	Water Use	Pumping Water	Pumping Water	Monitor water systems	Monitor water systems	40	0.2	8
				Control Water Quality	Control Water Quality	Control Water Quality			
					Control Pipes	Monitor pipes network			
						Monitor Treatment			
C_{42}	Maintenance	None	Clean water systems	Check water systems	Check/maintain water systems	Check/maintain water systems	35	0.2	7
			Minor repair	Major repair	Major repair	Check/maintain network			
					Maintain pipes	Check/maintain meter			
						Maintain IT systems			
C_{43}	Adaptation	None	Rarely	Occasionally	Usually	Frequently	25	0.2	5
C_{45}	Maintenance network	None	State	District	Mandal	Habitational	61	0.2	12.2
C_{45}	Distribution network	None	Regional Supplier	District Supplier	Mandal Supplier	Habitational Supplier	55	0.2	11
					District Approved	District Approved			
f_4	Score Technical Capacity					$\sum C_{ij} w_j$		1	43.2
5	Economical and Financial Capacity								
C_{51}	Private sector investment	None	State	Regional	District	Mandal	61	0.14	8.714286
C_{52}	Market incentives	None	Low	Medium	High	Very high	30	0.14	4.285714
C_{53}	User fees	None	Uniform flat rate	Single block rate	Increasing block rate	Increasing block rate	25	0.14	3.571429
C_{54}	Budget	None	Basic accounting	Annual	Tracked bi-annually	Tracked quarterly	21	0.14	3
C_{55}	Asset values	None	Real Estate	Real estate	Real estate	Real estate	40	0.14	5.714286
				Equipment	Equipment	Equipment			
					Cash	Cash - Stocks			
C_{56}	Investment activities	None	Low	Medium	High	Very High	40	0.14	5.714286
C_{57}	Loss to corruption	Very High	High	Medium	Low	None	45	0.14	6.428571
f_5	Score Economical and Financial Capacity					$\sum C_{ij} w_j$		1	37.42857
6	Energy Capacity								
C_{61}	Primary source	None	Non-conventional	Conventional electricity	Electricity mid-voltage	Electricity high voltage	65	0.25	16.25
C_{62}	Alternative source	None	None	Generator < 10 HP	Generator < 50 HP	Generator > 50 HP	50	0.25	12.5
C_{63}	Dependence for service	Very low	Low	Medium	High	Very High	50	0.25	12.5
C_{64}	Outage rate	Very High	High	Medium	Low	Very low	65	0.25	16.25
f_6	Score Energy Capacity					$\sum C_{ij} w_j$		1	57.5
7	Environmental and Ecological Capacity								
C_{71}	Environment quality	Very low	Low	Medium	High	Very high	45	0.2	9
C_{72}	Size of resource system	Very low	Low	Medium	High	Very high	45	0.2	9
C_{73}	Predictability of resource dynamics	Very low	Low	Medium	High	Very high	45	0.2	9
C_{74}	Growth or replacement rate	Very Negati	Negative	Stable	Positive	Very Positive	45	0.2	9
C_{74}	Resource sensibility	Very low	Low	Medium	High	Very High	40	0.2	8
f_7	Score Environmental Capacity					$\sum C_{ij} w_j$		1	44
8	Social and Cultural Capacity								
C_{81}	Communal ownership	Very low	Low	Intermediate	High	Very high	45	0.2	9
C_{82}	Political stability	Very low	Low	Intermediate	High	Very high	41	0.2	8.2
C_{83}	Equity	Very low	Low	Intermediate	High	Very high	50	0.2	10
C_{84}	Leadership/entrepreneurship	Very low	Low	Intermediate	High	Very high	45	0.2	9
C_{85}	Participation of women	Very low	Low	Intermediate	High	Very high	45	0.2	9
f_8	Score Social-Cultural Capacity					$\sum C_{ij} w_j$		1	45.2

Appendix IV.J.1: Miryalaguda Mandal – Miryalaguda Municipality

		Partitioned Scoring							
	Capacity Factors	**1-20**	**21-40**	**41-60**	**61-80**	**81-100**	**Score**	**Weight**	**CF score**
1	**Service Capacity**								
C_{11}	Effective service level	< 20 l/p/d	20 - 40 l/p/d	40 - 60 l/p/d	60 - 80 l/p/d	> 80 l/p/d	86	1	86
f_1	*Score Service Capacity*					$\sum C_{ij} w_j$		*1*	**86**
2	**Institutional Capacity**								
C_{21}	Body of legislation	None	Basic	Intermediate	Complete	Advanced	80	0.1667	13.33333
C_{22}	Operational rules	None	Basic	Intermediate	Complete	Advanced	85	0.1667	14.16667
C_{23}	Administrative agencies	None	State	District	Mandal	Habitational	75	0.1667	12.5
C_{24}	Administrative processes	None	Basic	Intermediate	Complete	Advanced	75	0.1667	12.5
C_{25}	Governance	None	State	District	Mandal	Habitational	85	0.1667	14.16667
C_{26}	Presence of NGOs	None	Low	Medium	High	Very High	41	0.1667	6.833333
f_2	*Score Institutional Capacity*					$\sum C_{ij} w_j$		*1*	**73.5**
3	**Human Resources Capacity (service provider)**								
C_{31}	Professionals	None	None	Administrative supervisor	Administrative manager	Administrative manager	85	0.2	17
				Health Scientist	Health Scientist	Health Scientist			
					Engineer	Engineer			
						Lawyer			
						Public relations manager			
C_{32}	Skilled Labor	None	Mechanic	Maintenance technician	Maintenance technician	Maintenance technician	85	0.2	17
				Laboratory technician	Laboratory technician	Laboratory technician			
				Water systems operator	Water systems operator	Water systems operator			
					Health Inspector	Health Inspector			
					Administratrive assistant	Administratrive assistant			
					Water meter leader	Water meter leader			
						IT technician			
C_{33}	Unskilled Labor	Craftsman	Clerk	Clerk			100	0.2	20
			Mechanic assistant	Water meter reader					
				Water systems worker					
C_{34}	Illiterate	Caretaker	Caretaker				100	0.2	20
C_{35}	Access to Higher Education	None	State	Regional	District	Mandal	95	0.2	19
f_3	*Score Human Resources Capacity*					$\sum C_{ij} w_j$		*1*	**93**
4	**Technical Capacity**								
C_{41}	Operations	Water Use	Pumping Water	Pumping Water	Monitor water systems	Monitor water systems	85	0.2	17
				Control Water Quality	Control Water Quality	Control Water Quality			
					Control Pipes	Monitor pipes network			
						Monitor Treatment			
C_{42}	Maintenance	None	Clean water systems	Check water systems	Check/maintain water systems	Check/maintain water systems	75	0.2	15
			Minor repair	Major repair	Major repair	Check/maintain network			
					Maintain pipes	Check/maintain meter			
						Maintain IT systems			
C_{43}	Adaptation	None	Rarely	Occasionally	Usually	Frequently	70	0.2	14
C_{45}	Maintenance network	None	State	District	Mandal	Habitational	81	0.2	16.2
C_{45}	Distribution network	None	Regional Supplier	District Supplier	Mandal Supplier	Habitational Supplier	85	0.2	17
					District Approved	District Approved			
f_4	*Score Technical Capacity*					$\sum C_{ij} w_j$		*1*	**79.2**
5	**Economical and Financial Capacity**								
C_{51}	Private sector investment	None	State	Regional	District	Mandal	85	0.14	12.14286
C_{52}	Market incentives	None	Low	Medium	High	Very high	81	0.14	11.57143
C_{53}	User fees	None	Uniform flat rate	Single block rate	Increasing block rate	Increasing block rate	60	0.14	8.571429
C_{54}	Budget	None	Basic accounting	Annual	Tracked bi-annually	Tracked quarterly	60	0.14	8.571429
C_{55}	Asset values	None	Real Estate	Real estate	Real estate	Real estate	75	0.14	10.71429
				Equipment	Equipment	Equipment			
					Cash	Cash - Stocks			
C_{56}	Investment activities	None	Low	Medium	High	Very High	65	0.14	9.285714
C_{57}	Loss to corruption	Very High	High	Medium	Low	None	65	0.14	9.285714
f_5	*Score Economical and Financial Capacity*					$\sum C_{ij} w_j$		*1*	**70.14286**
6	**Energy Capacity**								
C_{61}	Primary source	None	Non-conventional	Conventional electricity	Electricity mid-voltage	Electricity high voltage	81	0.25	20.25
C_{62}	Alternative source	None	None	Generator < 10 HP	Generator < 50 HP	Generator > 50 HP	81	0.25	20.25
C_{63}	Dependence for service	Very low	Low	Medium	High	Very High	70	0.25	17.5
C_{64}	Outage rate	Very High	High	Medium	Low	Very low	75	0.25	18.75
f_6	*Score Energy Capacity*					$\sum C_{ij} w_j$		*1*	**76.75**
7	**Environmental and Ecological Capacity**								
C_{71}	Environment quality	Very low	Low	Medium	High	Very high	55	0.2	11
C_{72}	Size of resource system	Very low	Low	Medium	High	Very high	65	0.2	13
C_{73}	Predictability of resource dynamics	Very low	Low	Medium	High	Very high	60	0.2	12
C_{74}	Growth or replacement rate	Very Negati	Negative	Stable	Positive	Very Positive	60	0.2	12
C_{74}	Resource sensibility	Very low	Low	Medium	High	Very High	70	0.2	14
f_7	*Score Environmental Capacity*					$\sum C_{ij} w_j$		*1*	**62**
8	**Social and Cultural Capacity**								
C_{81}	Communal ownership	Very low	Low	Intermediate	High	Very high	65	0.2	13
C_{82}	Political stability	Very low	Low	Intermediate	High	Very high	70	0.2	14
C_{83}	Equity	Very low	Low	Intermediate	High	Very high	65	0.2	13
C_{84}	Leadership/entrepreneurship	Very low	Low	Intermediate	High	Very high	75	0.2	15
C_{85}	Participation of women	Very low	Low	Intermediate	High	Very high	65	0.2	13
f_8	*Score Social-Cultural Capacity*					$\sum C_{ij} w_j$		*1*	**68**

Appendix IV.J.2: Miryalaguda Mandal – Venkatadripallam

		Partitioned Scoring							
	Capacity Factors	**1-20**	**21-40**	**41-60**	**61-80**	**81-100**	**Score**	**Weight**	**CF score**
1	**Service Capacity**								
C_{11}	Effective service level	< 20 l/p/d	20 - 40 l/p/d	40 - 60 l/p/d	60 - 80 l/p/d	> 80 l/p/d	35	1	35
f_1	*Score Service Capacity*					$\sum C_{ij} w_j$		1	**35**
2	**Institutional Capacity**								
C_{21}	Body of legislation	None	Basic	Intermediate	Complete	Advanced	45	0.1667	7.5
C_{22}	Operational rules	None	Basic	Intermediate	Complete	Advanced	50	0.1667	8.333333
C_{23}	Administrative agencies	None	State	District	Mandal	Habitational	50	0.1667	8.333333
C_{24}	Administrative processes	None	Basic	Intermediate	Complete	Advanced	45	0.1667	7.5
C_{25}	Governance	None	State	District	Mandal	Habitational	65	0.1667	10.83333
C_{26}	Presence of NGOs	None	Low	Medium	High	Very High	31	0.1667	5.166667
f_2	*Score Institutional Capacity*					$\sum C_{ij} w_j$		1	**47.66667**
3	**Human Resources Capacity (service provider)**								
C_{31}	Professionals	None	None	Administrative supervisor	Administrative manager	Administrative manager	65	0.2	13
				Health Scientist	Health Scientist	Health Scientist			
					Engineer	Engineer			
						Lawyer			
						Public relations manager			
C_{32}	Skilled Labor	None	Mechanic	Maintenance technician	Maintenance technician	Maintenance technician	55	0.2	11
				Laboratory technician	Laboratory technician	Laboratory technician			
				Water systems operator	Water systems operator	Water systems operator			
					Health Inspector	Health Inspector			
					Administratrive assistant	Administratrive assistant			
					Water meter leader	Water meter leader			
						IT technician			
C_{33}	Unskilled Labor	Craftsman	Clerk	Clerk			85	0.2	17
			Mechanic assistant	Water meter reader					
				Water systems worker					
C_{34}	Illiterate	Caretaker	Caretaker				85	0.2	17
C_{35}	Access to Higher Education	None	State	Regional	District	Mandal	81	0.2	16.2
f_3	*Score Human Resources Capacity*					$\sum C_{ij} w_j$		1	**74.2**
4	**Technical Capacity**								
C_{41}	Operations	Water Use	Pumping Water	Pumping Water	Monitor water systems	Monitor water systems	65	0.2	13
				Control Water Quality	Control Water Quality	Control Water Quality			
					Control Pipes	Monitor pipes network			
						Monitor Treatment			
C_{42}	Maintenance	None	Clean water systems	Check water systems	Check/maintain water systems	Check/maintain water systems	35	0.2	7
			Minor repair	Major repair	Major repair	Check/maintain network			
					Maintain pipes	Check/maintain meter			
						Maintain IT systems			
C_{43}	Adaptation	None	Rarely	Occasionally	Usually	Frequently	30	0.2	6
C_{45}	Maintenance network	None	State	District	Mandal	Habitational	61	0.2	12.2
C_{45}	Distribution network	None	Regional Supplier	District Supplier	Mandal Supplier	Habitational Supplier	61	0.2	12.2
					District Approved	District Approved			
f_4	*Score Technical Capacity*					$\sum C_{ij} w_j$		1	**50.4**
5	**Economical and Financial Capacity**								
C_{51}	Private sector investment	None	State	Regional	District	Mandal	65	0.14	9.285714
C_{52}	Market incentives	None	Low	Medium	High	Very high	25	0.14	3.571429
C_{53}	User fees	None	Uniform flat rate	Single block rate	Increasing block rate	Increasing block rate	25	0.14	3.571429
C_{54}	Budget	None	Basic accounting	Annual	Tracked bi-annually	Tracked quarterly	35	0.14	5
C_{55}	Asset values	None	Real Estate	Real estate	Real estate	Real estate	50	0.14	7.142857
				Equipment	Equipment	Equipment			
					Cash	Cash - Stocks			
C_{56}	Investment activities	None	Low	Medium	High	Very High	40	0.14	5.714286
C_{57}	Loss to corruption	Very High	High	Medium	Low	None	45	0.14	6.428571
f_5	*Score Economical and Financial Capacity*					$\sum C_{ij} w_j$		1	**40.71429**
6	**Energy Capacity**								
C_{61}	Primary source	None	Non-conventional	Conventional electricity	Electricity mid-voltage	Electricity high voltage	55	0.25	13.75
C_{62}	Alternative source	None	None	Generator < 10 HP	Generator < 50 HP	Generator > 50 HP	45	0.25	11.25
C_{63}	Dependence for service	Very low	Low	Medium	High	Very High	45	0.25	11.25
C_{64}	Outage rate	Very High	High	Medium	Low	Very low	41	0.25	10.25
f_6	*Score Energy Capacity*					$\sum C_{ij} w_j$		1	**46.5**
7	**Environmental and Ecological Capacity**								
C_{71}	Environment quality	Very low	Low	Medium	High	Very high	40	0.2	8
C_{72}	Size of resource system	Very low	Low	Medium	High	Very high	50	0.2	10
C_{73}	Predictability of resource dynamics	Very low	Low	Medium	High	Very high	35	0.2	7
C_{74}	Growth or replacement rate	Very Negati	Negative	Stable	Positive	Very Positive	40	0.2	8
C_{74}	Resource sensibility	Very low	Low	Medium	High	Very High	35	0.2	7
f_7	*Score Environmental Capacity*					$\sum C_{ij} w_j$		1	**40**
8	**Social and Cultural Capacity**								
C_{81}	Communal ownership	Very low	Low	Intermediate	High	Very high	45	0.2	9
C_{82}	Political stability	Very low	Low	Intermediate	High	Very high	50	0.2	10
C_{83}	Equity	Very low	Low	Intermediate	High	Very high	41	0.2	8.2
C_{84}	Leadership/entrepreneurship	Very low	Low	Intermediate	High	Very high	41	0.2	8.2
C_{85}	Participation of women	Very low	Low	Intermediate	High	Very high	41	0.2	8.2
f_8	*Score Social-Cultural Capacity*					$\sum C_{ij} w_j$		1	**43.6**

Appendix IV.J.3: Miryalaguda Mandal – Zapthiveeragudem

		Partitioned Scoring							
	Capacity Factors	1-20	21-40	41-60	61-80	81-100	Score	Weight	CF score
1	Service Capacity								
C_{11}	Effective service level	< 20 l/p/d	20 - 40 l/p/d	40 - 60 l/p/d	60 - 80 l/p/d	> 80 l/p/d	45	1	45
f_1	Score Service Capacity					$\sum C_{ij} w_j$		1	45
2	Institutional Capacity								
C_{21}	Body of legislation	None	Basic	Intermediate	Complete	Advanced	50	0.1667	8.333333
C_{22}	Operational rules	None	Basic	Intermediate	Complete	Advanced	55	0.1667	9.166667
C_{23}	Administrative agencies	None	State	District	Mandal	Habitational	50	0.1667	8.333333
C_{24}	Administrative processes	None	Basic	Intermediate	Complete	Advanced	50	0.1667	8.333333
C_{25}	Governance	None	State	District	Mandal	Habitational	75	0.1667	12.5
C_{26}	Presence of NGOs	None	Low	Medium	High	Very High	50	0.1667	8.333333
f_2	Score Institutional Capacity					$\sum C_{ij} w_j$		1	55
3	Human Resources Capacity (service provider)								
C_{31}	Professionals	None	None	Administrative supervisor	Administrative manager	Administrative manager	65	0.2	13
				Health Scientist	Health Scientist	Health Scientist			
					Engineer	Engineer			
						Lawyer			
						Public relations manager			
C_{32}	Skilled Labor	None	Mechanic	Maintenance technician	Maintenance technician	Maintenance technician	60	0.2	12
				Laboratory technician	Laboratory technician	Laboratory technician			
				Water systems operator	Water systems operator	Water systems operator			
					Health Inspector	Health Inspector			
					Administratrive assistant	Administratrive assistant			
					Water meter leader	Water meter leader			
						IT technician			
C_{33}	Unskilled Labor	Craftsman	Clerk	Clerk			85	0.2	17
			Mechanic assistant	Water meter reader					
				Water systems worker					
C_{34}	Illiterate	Caretaker	Caretaker				85	0.2	17
C_{35}	Access to Higher Education	None	State	Regional	District	Mandal	81	0.2	16.2
f_3	Score Human Resources Capacity					$\sum C_{ij} w_j$		1	75.2
4	Technical Capacity								
C_{41}	Operations	Water Use	Pumping Water	Pumping Water	Monitor water systems	Monitor water systems	65	0.2	13
				Control Water Quality	Control Water Quality	Control Water Quality			
					Control Pipes	Monitor pipes network			
						Monitor Treatment			
C_{42}	Maintenance	None	Clean water systems	Check water systems	Check/maintain water systems	Check/maintain water systems	61	0.2	12.2
			Minor repair	Major repair	Major repair	Check/maintain network			
					Maintain pipes	Check/maintain meter			
						Maintain IT systems			
C_{43}	Adaptation	None	Rarely	Occasionally	Usually	Frequently	45	0.2	9
C_{45}	Maintenance network	None	State	District	Mandal	Habitational	61	0.2	12.2
C_{45}	Distribution network	None	Regional Supplier	District Supplier	Mandal Supplier	Habitational Supplier	81	0.2	16.2
					District Approved	District Approved			
f_4	Score Technical Capacity					$\sum C_{ij} w_j$		1	62.6
5	Economical and Financial Capacity								
C_{51}	Private sector investment	None	State	Regional	District	Mandal	55	0.14	7.857143
C_{52}	Market incentives	None	Low	Medium	High	Very high	41	0.14	5.857143
C_{53}	User fees	None	Uniform flat rate	Single block rate	Increasing block rate	Increasing block rate	50	0.14	7.142857
C_{54}	Budget	None	Basic accounting	Annual	Tracked bi-annually	Tracked quarterly	50	0.14	7.142857
C_{55}	Asset values	None	Real Estate	Real estate	Real estate	Real estate	65	0.14	9.285714
				Equipment	Equipment	Equipment			
					Cash	Cash - Stocks			
C_{56}	Investment activities	None	Low	Medium	High	Very High	41	0.14	5.857143
C_{57}	Loss to corruption	Very High	High	Medium	Low	None	55	0.14	7.857143
f_5	Score Economical and Financial Capacity					$\sum C_{ij} w_j$		1	51
6	Energy Capacity								
C_{61}	Primary source	None	Non-conventional	Conventional electricity	Electricity mid-voltage	Electricity high voltage	61	0.25	15.25
C_{62}	Alternative source	None	None	Generator < 10 HP	Generator < 50 HP	Generator > 50 HP	50	0.25	12.5
C_{63}	Dependence for service	Very low	Low	Medium	High	Very High	45	0.25	11.25
C_{64}	Outage rate	Very High	High	Medium	Low	Very low	50	0.25	12.5
f_6	Score Energy Capacity					$\sum C_{ij} w_j$		1	51.5
7	Environmental and Ecological Capacity								
C_{71}	Environment quality	Very low	Low	Medium	High	Very high	61	0.2	12.2
C_{72}	Size of resource system	Very low	Low	Medium	High	Very high	55	0.2	11
C_{73}	Predictability of resource dynamics	Very low	Low	Medium	High	Very high	50	0.2	10
C_{74}	Growth or replacement rate	Very Negati	Negative	Stable	Positive	Very Positive	50	0.2	10
C_{74}	Resource sensibility	Very low	Low	Medium	High	Very High	60	0.2	12
f_7	Score Environmental Capacity					$\sum C_{ij} w_j$		1	55.2
8	Social and Cultural Capacity								
C_{81}	Communal ownership	Very low	Low	Intermediate	High	Very high	70	0.2	14
C_{82}	Political stability	Very low	Low	Intermediate	High	Very high	55	0.2	11
C_{83}	Equity	Very low	Low	Intermediate	High	Very high	65	0.2	13
C_{84}	Leadership/entrepreneurship	Very low	Low	Intermediate	High	Very high	70	0.2	14
C_{85}	Participation of women	Very low	Low	Intermediate	High	Very high	70	0.2	14
f_8	Score Social-Cultural Capacity					$\sum C_{ij} w_j$		1	66

Appendix IV.J.4: Miryalaguda Mandal – Chinthapally

		Partitioned Scoring							
	Capacity Factors	**1-20**	**21-40**	**41-60**	**61-80**	**81-100**	**Weight**	**CF score**	**Score**
1	**Service Capacity**								
C_{11}	Effective service level	< 20 l/p/d	20 - 40 l/p/d	40 - 60 l/p/d	60 - 80 l/p/d	> 80 l/p/d	1	45	
f_1	*Score Service Capacity*					$\sum C_{ij} w_j$	*1*	**45**	
2	**Institutional Capacity**								
C_{21}	Body of legislation	None	Basic	Intermediate	Complete	Advanced	0.1667	60	
C_{22}	Operational rules	None	Basic	Intermediate	Complete	Advanced	0.1667	60	
C_{23}	Administrative agencies	None	State	District	Mandal	Habitational	0.1667	85	
C_{24}	Administrative processes	None	Basic	Intermediate	Complete	Advanced	0.1667	75	
C_{25}	Governance	None	State	District	Mandal	Habitational	0.1667	85	
C_{26}	Presence of NGOs	None	Low	Medium	High	Very High	0.1667	70	
f_2	*Score Institutional Capacity*					$\sum C_{ij} w_j$	*1*	**72.5**	
3	**Human Resources Capacity (service provider)**								
C_{31}	Professionals	None	None	Administrative supervisor	Administrative manager	Administrative manager	0.2	75	
				Health Scientist	Health Scientist	Health Scientist			
					Engineer	Engineer			
						Lawyer			
						Public relations manager			
C_{32}	Skilled Labor	None	Mechanic	Maintenance technician	Maintenance technician	Maintenance technician	0.2	70	
				Laboratory technician	Laboratory technician	Laboratory technician			
				Water systems operator	Water systems operator	Water systems operator			
					Health Inspector	Health Inspector			
					Administrative assistant	Administrative assistant			
					Water meter leader	Water meter leader			
						IT technician			
C_{33}	Unskilled Labor	Craftsman	Clerk	Clerk			0.2	100	
			Mechanic assistant	Water meter reader					
				Water systems worker					
C_{34}	Illiterate	Caretaker	Caretaker				0.2	100	
C_{35}	Access to Higher Education	None	State	Regional	District	Mandal	0.2	90	
f_3	*Score Human Resources Capacity*					$\sum C_{ij} w_j$	*1*	**87**	
4	**Technical Capacity**								
C_{41}	Operations	Water Use	Pumping Water	Pumping Water	Monitor water systems	Monitor water systems	0.2	81	
				Control Water Quality	Control Water Quality	Control Water Quality			
					Control Pipes	Monitor pipes network			
						Monitor Treatment			
C_{42}	Maintenance	None	Clean water systems	Check water systems	Check/maintain water systems	Check/maintain water systems	0.2	70	
			Minor repair	Major repair	Major repair	Check/maintain network			
					Maintain pipes	Check/maintain meter			
						Maintain IT systems			
C_{43}	Adaptation	None	Rarely	Occasionally	Usually	Frequently	0.2	70	
C_{45}	Maintenance network	None	State	District	Mandal	Habitational	0.2	81	
C_{45}	Distribution network	None	Regional Supplier	District Supplier	Mandal Supplier	Habitational Supplier	0.2	81	
					District Approved	District Approved			
f_4	*Score Technical Capacity*					$\sum C_{ij} w_j$	*1*	**76.6**	
5	**Economical and Financial Capacity**								
C_{51}	Private sector investment	None	State	Regional	District	Mandal	0.14	81	
C_{52}	Market incentives	None	Low	Medium	High	Very high	0.14	65	
C_{53}	User fees	None	Uniform flat rate	Single block rate	Increasing block rate	Increasing block rate	0.14	50	
C_{54}	Budget	None	Basic accounting	Annual	Tracked bi-annually	Tracked quarterly	0.14	40	
C_{55}	Asset values	None	Real Estate	Real estate	Real estate	Real estate	0.14	65	
				Equipment	Equipment	Equipment			
					Cash	Cash - Stocks			
C_{56}	Investment activities	None	Low	Medium	High	Very High	0.14	50	
C_{57}	Loss to corruption	Very High	High	Medium	Low	None	0.14	50	
f_5	*Score Economical and Financial Capacity*					$\sum C_{ij} w_j$	*1*	**57.28571**	
6	**Energy Capacity**								
C_{61}	Primary source	None	Non-conventional	Conventional electricity	Electricity mid-voltage	Electricity high voltage	0.25	60	
C_{62}	Alternative source	None	None	Generator < 10 HP	Generator < 50 HP	Generator > 50 HP	0.25	65	
C_{63}	Dependence for service	Very low	Low	Medium	High	Very High	0.25	65	
C_{64}	Outage rate	Very High	High	Medium	Low	Very low	0.25	25	
f_6	*Score Energy Capacity*					$\sum C_{ij} w_j$	*1*	**53.75**	
7	**Environmental and Ecological Capacity**								
C_{71}	Environment quality	Very low	Low	Medium	High	Very high	0.2	50	
C_{72}	Size of resource system	Very low	Low	Medium	High	Very high	0.2	70	
C_{73}	Predictability of resource dynamics	Very low	Low	Medium	High	Very high	0.2	50	
C_{74}	Growth or replacement rate	Very Negati	Negative	Stable	Positive	Very Positive	0.2	40	
C_{74}	Resource sensibility	Very low	Low	Medium	High	Very High	0.2	50	
f_7	*Score Environmental Capacity*					$\sum C_{ij} w_j$	*1*	**52**	
8	**Social and Cultural Capacity**								
C_{81}	Communal ownership	Very low	Low	Intermediate	High	Very high	0.2	45	
C_{82}	Political stability	Very low	Low	Intermediate	High	Very high	0.2	75	
C_{83}	Equity	Very low	Low	Intermediate	High	Very high	0.2	60	
C_{84}	Leadership/entrepreneurship	Very low	Low	Intermediate	High	Very high	0.2	90	
C_{85}	Participation of women	Very low	Low	Intermediate	High	Very high	0.2	60	
f_8	*Score Social-Cultural Capacity*					$\sum C_{ij} w_j$	*1*	**66**	

Appendix IV.K.1: Nakrekal Mandal – Nakrekal

		Partitioned Scoring							
	Capacity Factors	1-20	21-40	41-60	61-80	81-100	Score	Weight	CF score
1	Service Capacity								
C_{11}	Effective service level	< 20 l/p/d	20 - 40 l/p/d	40 - 60 l/p/d	60 - 80 l/p/d	> 80 l/p/d	61	1	61
f_1	Score Service Capacity					$\sum C_{ij} w_j$		1	61
2	Institutional Capacity								
C_{21}	Body of legislation	None	Basic	Intermediate	Complete	Advanced	50	0.1667	8.333333
C_{22}	Operational rules	None	Basic	Intermediate	Complete	Advanced	45	0.1667	7.5
C_{23}	Administrative agencies	None	State	District	Mandal	Habitational	50	0.1667	8.333333
C_{24}	Administrative processes	None	Basic	Intermediate	Complete	Advanced	35	0.1667	5.833333
C_{25}	Governance	None	State	District	Mandal	Habitational	61	0.1667	10.16667
C_{26}	Presence of NGOs	None	Low	Medium	High	Very High	15	0.1667	2.5
f_2	Score Institutional Capacity					$\sum C_{ij} w_j$		1	42.66667
3	Human Resources Capacity (service provider)								
C_{31}	Professionals	None	None	Administrative supervisor	Administrative manager	Administrative manager	61	0.2	12.2
				Health Scientist	Health Scientist	Health Scientist			
					Engineer	Engineer			
						Lawyer			
						Public relations manager			
C_{32}	Skilled Labor	None	Mechanic	Maintenance technician	Maintenance technician	Maintenance technician	45	0.2	9
				Laboratory technician	Laboratory technician	Laboratory technician			
				Water systems operator	Water systems operator	Water systems operator			
					Health Inspector	Health Inspector			
					Administratrive assistant	Administratrive assistant			
					Water meter leader	Water meter leader			
						IT technician			
C_{33}	Unskilled Labor	Craftsman	Clerk	Clerk			75	0.2	15
			Mechanic assistant	Water meter reader					
				Water systems worker					
C_{34}	Illiterate	Caretaker	Caretaker				75	0.2	15
C_{35}	Access to Higher Education	None	State	Regional	District	Mandal	65	0.2	13
f_3	Score Human Resources Capacity					$\sum C_{ij} w_j$		1	64.2
4	Technical Capacity								
C_{41}	Operations	Water Use	Pumping Water	Pumping Water	Monitor water systems	Monitor water systems	65	0.2	13
				Control Water Quality	Control Water Quality	Control Water Quality			
					Control Pipes	Monitor pipes network			
						Monitor Treatment			
C_{42}	Maintenance	None	Clean water systems	Check water systems	Check/maintain water systems	Check/maintain water systems	50	0.2	10
			Minor repair	Major repair	Major repair	Check/maintain network			
					Maintain pipes	Check/maintain meter			
						Maintain IT systems			
C_{43}	Adaptation	None	Rarely	Occasionally	Usually	Frequently	45	0.2	9
C_{45}	Maintenance network	None	State	District	Mandal	Habitational	61	0.2	12.2
C_{45}	Distribution network	None	Regional Supplier	District Supplier	Mandal Supplier	Habitational Supplier	55	0.2	11
					District Approved	District Approved			
f_4	Score Technical Capacity					$\sum C_{ij} w_j$		1	55.2
5	Economical and Financial Capacity								
C_{51}	Private sector investment	None	State	Regional	District	Mandal	75	0.14	10.71429
C_{52}	Market incentives	None	Low	Medium	High	Very high	40	0.14	5.714286
C_{53}	User fees	None	Uniform flat rate	Single block rate	Increasing block rate	Increasing block rate	30	0.14	4.285714
C_{54}	Budget	None	Basic accounting	Annual	Tracked bi-annually	Tracked quarterly	50	0.14	7.142857
C_{55}	Asset values	None	Real Estate	Real estate	Real estate	Real estate	50	0.14	7.142857
				Equipment	Equipment	Equipment			
					Cash	Cash - Stocks			
C_{56}	Investment activities	None	Low	Medium	High	Very High	50	0.14	7.142857
C_{57}	Loss to corruption	Very High	High	Medium	Low	None	60	0.14	8.571429
f_5	Score Economical and Financial Capacity					$\sum C_{ij} w_j$		1	50.71429
6	Energy Capacity								
C_{61}	Primary source	None	Non-conventional	Conventional electricity	Electricity mid-voltage	Electricity high voltage	61	0.25	15.25
C_{62}	Alternative source	None	None	Generator < 10 HP	Generator < 50 HP	Generator > 50 HP	55	0.25	13.75
C_{63}	Dependence for service	Very low	Low	Medium	High	Very High	45	0.25	11.25
C_{64}	Outage rate	Very High	High	Medium	Low	Very low	41	0.25	10.25
f_6	Score Energy Capacity					$\sum C_{ij} w_j$		1	50.5
7	Environmental and Ecological Capacity								
C_{71}	Environment quality	Very low	Low	Medium	High	Very high	45	0.2	9
C_{72}	Size of resource system	Very low	Low	Medium	High	Very high	50	0.2	10
C_{73}	Predictability of resource dynamics	Very low	Low	Medium	High	Very high	45	0.2	9
C_{74}	Growth or replacement rate	Very Negati	Negative	Stable	Positive	Very Positive	50	0.2	10
C_{74}	Resource sensibility	Very low	Low	Medium	High	Very High	50	0.2	10
f_7	Score Environmental Capacity					$\sum C_{ij} w_j$		1	48
8	Social and Cultural Capacity								
C_{81}	Communal ownership	Very low	Low	Intermediate	High	Very high	61	0.2	12.2
C_{82}	Political stability	Very low	Low	Intermediate	High	Very high	65	0.2	13
C_{83}	Equity	Very low	Low	Intermediate	High	Very high	65	0.2	13
C_{84}	Leadership/entrepreneurship	Very low	Low	Intermediate	High	Very high	50	0.2	10
C_{85}	Participation of women	Very low	Low	Intermediate	High	Very high	60	0.2	12
f_8	Score Social-Cultural Capacity					$\sum C_{ij} w_j$		1	60.2

Appendix IV.L.1: Nalgonda Mandal – Nalgonda Municipality

		Partitioned Scoring							
	Capacity Factors	**1-20**	**21-40**	**41-60**	**61-80**	**81-100**	**Score**	**Weight**	**CF score**
1	**Service Capacity**								
C_{11}	Effective service level	< 20 l/p/d	20 - 40 l/p/d	40 - 60 l/p/d	60 - 80 l/p/d	> 80 l/p/d	85	1	85
f_1	*Score Service Capacity*					$\sum C_{ij} w_j$		1	**85**
2	**Institutional Capacity**								
C_{21}	Body of legislation	None	Basic	Intermediate	Complete	Advanced	75	0.1667	12.5
C_{22}	Operational rules	None	Basic	Intermediate	Complete	Advanced	75	0.1667	12.5
C_{23}	Administrative agencies	None	State	District	Mandal	Habitational	81	0.1667	13.5
C_{24}	Administrative processes	None	Basic	Intermediate	Complete	Advanced	81	0.1667	13.5
C_{25}	Governance	None	State	District	Mandal	Habitational	85	0.1667	14.16667
C_{26}	Presence of NGOs	None	Low	Medium	High	Very High	50	0.1667	8.333333
f_2	*Score Institutional Capacity*					$\sum C_{ij} w_j$		1	**74.5**
3	**Human Resources Capacity (service provider)**								
C_{31}	Professionals	None	None	Administrative supervisor	Administrative manager	Administrative manager	85	0.2	17
				Health Scientist	Health Scientist	Health Scientist			
					Engineer	Engineer			
						Lawyer			
						Public relations manager			
C_{32}	Skilled Labor	None	Mechanic	Maintenance technician	Maintenance technician	Maintenance technician	85	0.2	17
				Laboratory technician	Laboratory technician	Laboratory technician			
				Water systems operator	Water systems operator	Water systems operator			
					Health Inspector	Health Inspector			
					Administratrive assistant	Administratrive assistant			
					Water meter leader	Water meter leader			
						IT technician			
C_{33}	Unskilled Labor	Craftsman	Clerk	Clerk			100	0.2	20
			Mechanic assistant	Water meter reader					
				Water systems worker					
C_{34}	Illiterate	Caretaker	Caretaker				100	0.2	20
C_{35}	Access to Higher Education	None	State	Regional	District	Mandal	95	0.2	19
f_3	*Score Human Resources Capacity*					$\sum C_{ij} w_j$		1	**93**
4	**Technical Capacity**								
C_{41}	Operations	Water Use	Pumping Water	Pumping Water	Monitor water systems	Monitor water systems	81	0.2	16.2
				Control Water Quality	Control Water Quality	Control Water Quality			
					Control Pipes	Monitor pipes network			
						Monitor Treatment			
C_{42}	Maintenance	None	Clean water systems	Check water systems	Check/maintain water systems	Check/maintain water systems	81	0.2	16.2
			Minor repair	Major repair	Major repair	Check/maintain network			
					Maintain pipes	Check/maintain meter			
						Maintain IT systems			
C_{43}	Adaptation	None	Rarely	Occasionally	Usually	Frequently	75	0.2	15
C_{45}	Maintenance network	None	State	District	Mandal	Habitational	70	0.2	14
C_{45}	Distribution network	None	Regional Supplier	District Supplier	Mandal Supplier	Habitational Supplier	85	0.2	17
					District Approved	District Approved			
f_4	*Score Technical Capacity*					$\sum C_{ij} w_j$		1	**78.4**
5	**Economical and Financial Capacity**								
C_{51}	Private sector investment	None	State	Regional	District	Mandal	81	0.14	11.57143
C_{52}	Market incentives	None	Low	Medium	High	Very high	70	0.14	10
C_{53}	User fees	None	Uniform flat rate	Single block rate	Increasing block rate	Increasing block rate	45	0.14	6.428571
C_{54}	Budget	None	Basic accounting	Annual	Tracked bi-annually	Tracked quarterly	65	0.14	9.285714
C_{55}	Asset values	None	Real Estate	Real estate	Real estate	Real estate	70	0.14	10
				Equipment	Equipment	Equipment			
					Cash	Cash - Stocks			
C_{56}	Investment activities	None	Low	Medium	High	Very High	65	0.14	9.285714
C_{57}	Loss to corruption	Very High	High	Medium	Low	None	45	0.14	6.428571
f_5	*Score Economical and Financial Capacity*					$\sum C_{ij} w_j$		1	**63**
6	**Energy Capacity**								
C_{61}	Primary source	None	Non-conventional	Conventional electricity	Electricity mid-voltage	Electricity high voltage	81	0.25	20.25
C_{62}	Alternative source	None	None	Generator < 10 HP	Generator < 50 HP	Generator > 50 HP	81	0.25	20.25
C_{63}	Dependence for service	Very low	Low	Medium	High	Very High	80	0.25	20
C_{64}	Outage rate	Very High	High	Medium	Low	Very low	65	0.25	16.25
f_6	*Score Energy Capacity*					$\sum C_{ij} w_j$		1	**76.75**
7	**Environmental and Ecological Capacity**								
C_{71}	Environment quality	Very low	Low	Medium	High	Very high	41	0.2	8.2
C_{72}	Size of resource system	Very low	Low	Medium	High	Very high	50	0.2	10
C_{73}	Predictability of resource dynamics	Very low	Low	Medium	High	Very high	65	0.2	13
C_{74}	Growth or replacement rate	Very Negati	Negative	Stable	Positive	Very Positive	50	0.2	10
C_{74}	Resource sensibility	Very low	Low	Medium	High	Very High	65	0.2	13
f_7	*Score Environmental Capacity*					$\sum C_{ij} w_j$		1	**54.2**
8	**Social and Cultural Capacity**								
C_{81}	Communal ownership	Very low	Low	Intermediate	High	Very high	65	0.2	13
C_{82}	Political stability	Very low	Low	Intermediate	High	Very high	65	0.2	13
C_{83}	Equity	Very low	Low	Intermediate	High	Very high	70	0.2	14
C_{84}	Leadership/entrepreneurship	Very low	Low	Intermediate	High	Very high	70	0.2	14
C_{85}	Participation of women	Very low	Low	Intermediate	High	Very high	75	0.2	15
f_8	*Score Social-Cultural Capacity*					$\sum C_{ij} w_j$		1	**69**

Appendix IV.L.2: Nalgonda Mandal – Panagal

		Partitioned Scoring							
	Capacity Factors	1-20	21-40	41-60	61-80	81-100	Score	Weight	CF score
1	Service Capacity								
C_{11}	Effective service level	< 20 l/p/d	20 - 40 l/p/d	40 - 60 l/p/d	60 - 80 l/p/d	> 80 l/p/d	55	1	55
f_1	Score Service Capacity					$\sum C_{ij} w_j$		1	**55**
2	Institutional Capacity								
C_{21}	Body of legislation	None	Basic	Intermediate	Complete	Advanced	50	0.1667	8.333333
C_{22}	Operational rules	None	Basic	Intermediate	Complete	Advanced	60	0.1667	10
C_{23}	Administrative agencies	None	State	District	Mandal	Habitational	60	0.1667	10
C_{24}	Administrative processes	None	Basic	Intermediate	Complete	Advanced	60	0.1667	10
C_{25}	Governance	None	State	District	Mandal	Habitational	65	0.1667	10.83333
C_{26}	Presence of NGOs	None	Low	Medium	High	Very High	30	0.1667	5
f_2	Score Institutional Capacity					$\sum C_{ij} w_j$		1	**54.16667**
3	Human Resources Capacity (service provider)								
C_{31}	Professionals	None	None	Administrative supervisor	Administrative manager	Administrative manager	45	0.2	9
				Health Scientist	Health Scientist	Health Scientist			
					Engineer	Engineer			
						Lawyer			
						Public relations manager			
C_{32}	Skilled Labor	None	Mechanic	Maintenance technician	Maintenance technician	Maintenance technician	50	0.2	10
				Laboratory technician	Laboratory technician	Laboratory technician			
				Water systems operator	Water systems operator	Water systems operator			
					Health Inspector	Health Inspector			
					Administratrive assistant	Administratrive assistant			
					Water meter leader	Water meter leader			
						IT technician			
C_{33}	Unskilled Labor	Craftsman	Clerk	Clerk			60	0.2	12
			Mechanic assistant	Water meter reader					
				Water systems worker					
C_{34}	Illiterate	Caretaker	Caretaker				75	0.2	15
C_{35}	Access to Higher Education	None	State	Regional	District	Mandal	81	0.2	16.2
f_3	Score Human Resources Capacity					$\sum C_{ij} w_j$		1	**62.2**
4	Technical Capacity								
C_{41}	Operations	Water Use	Pumping Water	Pumping Water	Monitor water systems	Monitor water systems	50	0.2	10
				Control Water Quality	Control Water Quality	Control Water Quality			
					Control Pipes	Monitor pipes network			
						Monitor Treatment			
C_{42}	Maintenance	None	Clean water systems	Check water systems	Check/maintain water systems	Check/maintain water systems	50	0.2	10
			Minor repair	Major repair	Major repair	Check/maintain network			
					Maintain pipes	Check/maintain meter			
						Maintain IT systems			
C_{43}	Adaptation	None	Rarely	Occasionally	Usually	Frequently	45	0.2	9
C_{45}	Maintenance network	None	State	District	Mandal	Habitational	65	0.2	13
C_{45}	Distribution network	None	Regional Supplier	District Supplier	Mandal Supplier	Habitational Supplier	70	0.2	14
					District Approved	District Approved			
f_4	Score Technical Capacity					$\sum C_{ij} w_j$		1	**56**
5	Economical and Financial Capacity								
C_{51}	Private sector investment	None	State	Regional	District	Mandal	81	0.14	11.57143
C_{52}	Market incentives	None	Low	Medium	High	Very high	50	0.14	7.142857
C_{53}	User fees	None	Uniform flat rate	Single block rate	Increasing block rate	Increasing block rate	40	0.14	5.714286
C_{54}	Budget	None	Basic accounting	Annual	Tracked bi-annually	Tracked quarterly	50	0.14	7.142857
C_{55}	Asset values	None	Real Estate	Real estate	Real estate	Real estate	50	0.14	7.142857
				Equipment	Equipment	Equipment			
					Cash	Cash - Stocks			
C_{56}	Investment activities	None	Low	Medium	High	Very High	40	0.14	5.714286
C_{57}	Loss to corruption	Very High	High	Medium	Low	None	50	0.14	7.142857
f_5	Score Economical and Financial Capacity					$\sum C_{ij} w_j$		1	**51.57143**
6	Energy Capacity								
C_{61}	Primary source	None	Non-conventional	Conventional electricity	Electricity mid-voltage	Electricity high voltage	65	0.25	16.25
C_{62}	Alternative source	None	None	Generator < 10 HP	Generator < 50 HP	Generator > 50 HP	45	0.25	11.25
C_{63}	Dependence for service	Very low	Low	Medium	High	Very High	50	0.25	12.5
C_{64}	Outage rate	Very High	High	Medium	Low	Very low	45	0.25	11.25
f_6	Score Energy Capacity					$\sum C_{ij} w_j$		1	**51.25**
7	Environmental and Ecological Capacity								
C_{71}	Environment quality	Very low	Low	Medium	High	Very high	55	0.2	11
C_{72}	Size of resource system	Very low	Low	Medium	High	Very high	60	0.2	12
C_{73}	Predictability of resource dynamics	Very low	Low	Medium	High	Very high	55	0.2	11
C_{74}	Growth or replacement rate	Very Negati	Negative	Stable	Positive	Very Positive	60	0.2	12
C_{74}	Resource sensibility	Very low	Low	Medium	High	Very High	65	0.2	13
f_7	Score Environmental Capacity					$\sum C_{ij} w_j$		1	**59**
8	Social and Cultural Capacity								
C_{81}	Communal ownership	Very low	Low	Intermediate	High	Very high	65	0.2	13
C_{82}	Political stability	Very low	Low	Intermediate	High	Very high	70	0.2	14
C_{83}	Equity	Very low	Low	Intermediate	High	Very high	70	0.2	14
C_{84}	Leadership/entrepreneurship	Very low	Low	Intermediate	High	Very high	60	0.2	12
C_{85}	Participation of women	Very low	Low	Intermediate	High	Very high	75	0.2	15
f_8	Score Social-Cultural Capacity					$\sum C_{ij} w_j$		1	**68**

Appendix IV.M.1: P. A. Pally Mandal – Chilkamarry

		Partitioned Scoring							
	Capacity Factors	1-20	21-40	41-60	61-80	81-100	Score	Weight	CF score
1	Service Capacity								
C_{11}	Effective service level	< 20 l/p/d	20 - 40 l/p/d	40 - 60 l/p/d	60 - 80 l/p/d	> 80 l/p/d	30	1	30
f_1	Score Service Capacity					$\sum C_{ij} w_j$		1	**30**
2	Institutional Capacity								
C_{21}	Body of legislation	None	Basic	Intermediate	Complete	Advanced	40	0.1667	6.666667
C_{22}	Operational rules	None	Basic	Intermediate	Complete	Advanced	35	0.1667	5.833333
C_{23}	Administrative agencies	None	State	District	Mandal	Habitational	40	0.1667	6.666667
C_{24}	Administrative processes	None	Basic	Intermediate	Complete	Advanced	35	0.1667	5.833333
C_{25}	Governance	None	State	District	Mandal	Habitational	61	0.1667	10.16667
C_{26}	Presence of NGOs	None	Low	Medium	High	Very High	21	0.1667	3.5
f_2	Score Institutional Capacity					$\sum C_{ij} w_j$		1	**38.66667**
3	Human Resources Capacity (service provider)								
C_{31}	Professionals	None	None	Administrative supervisor	Administrative manager	Administrative manager	35	0.2	7
				Health Scientist	Health Scientist	Health Scientist			
					Engineer	Engineer			
						Lawyer			
						Public relations manager			
C_{32}	Skilled Labor	None	Mechanic	Maintenance technician	Maintenance technician	Maintenance technician	35	0.2	7
				Laboratory technician	Laboratory technician	Laboratory technician			
				Water systems operator	Water systems operator	Water systems operator			
					Health Inspector	Health Inspector			
					Administratrive assistant	Administratrive assistant			
					Water meter leader	Water meter leader			
						IT technician			
C_{33}	Unskilled Labor	Craftsman	Clerk	Clerk			50	0.2	10
			Mechanic assistant	Water meter reader					
				Water systems worker					
C_{34}	Illiterate	Caretaker	Caretaker				60	0.2	12
C_{35}	Access to Higher Education	None	State	Regional	District	Mandal	61	0.2	12.2
f_3	Score Human Resources Capacity					$\sum C_{ij} w_j$		1	**48.2**
4	Technical Capacity								
C_{41}	Operations	Water Use	Pumping Water	Pumping Water	Monitor water systems	Monitor water systems	40	0.2	8
				Control Water Quality	Control Water Quality	Control Water Quality			
					Control Pipes	Monitor pipes network			
						Monitor Treatment			
C_{42}	Maintenance	None	Clean water systems	Check water systems	Check/maintain water systems	Check/maintain water systems	40	0.2	8
			Minor repair	Major repair	Major repair	Check/maintain network			
					Maintain pipes	Check/maintain meter			
						Maintain IT systems			
C_{43}	Adaptation	None	Rarely	Occasionally	Usually	Frequently	40	0.2	8
C_{45}	Maintenance network	None	State	District	Mandal	Habitational	55	0.2	11
C_{45}	Distribution network	None	Regional Supplier	District Supplier	Mandal Supplier	Habitational Supplier	60	0.2	12
					District Approved	District Approved			
f_4	Score Technical Capacity					$\sum C_{ij} w_j$		1	**47**
5	Economical and Financial Capacity								
C_{51}	Private sector investment	None	State	Regional	District	Mandal	61	0.14	8.714286
C_{52}	Market incentives	None	Low	Medium	High	Very high	40	0.14	5.714286
C_{53}	User fees	None	Uniform flat rate	Single block rate	Increasing block rate	Increasing block rate	21	0.14	3
C_{54}	Budget	None	Basic accounting	Annual	Tracked bi-annually	Tracked quarterly	30	0.14	4.285714
C_{55}	Asset values	None	Real Estate	Real estate	Real estate	Real estate	40	0.14	5.714286
				Equipment	Equipment	Equipment			
					Cash	Cash - Stocks			
C_{56}	Investment activities	None	Low	Medium	High	Very High	40	0.14	5.714286
C_{57}	Loss to corruption	Very High	High	Medium	Low	None	40	0.14	5.714286
f_5	Score Economical and Financial Capacity					$\sum C_{ij} w_j$		1	**38.85714**
6	Energy Capacity								
C_{61}	Primary source	None	Non-conventional	Conventional electricity	Electricity mid-voltage	Electricity high voltage	60	0.25	15
C_{62}	Alternative source	None	None	Generator < 10 HP	Generator < 50 HP	Generator > 50 HP	50	0.25	12.5
C_{63}	Dependence for service	Very low	Low	Medium	High	Very High	40	0.25	10
C_{64}	Outage rate	Very High	High	Medium	Low	Very low	41	0.25	10.25
f_6	Score Energy Capacity					$\sum C_{ij} w_j$		1	**47.75**
7	Environmental and Ecological Capacity								
C_{71}	Environment quality	Very low	Low	Medium	High	Very high	45	0.2	9
C_{72}	Size of resource system	Very low	Low	Medium	High	Very high	45	0.2	9
C_{73}	Predictability of resource dynamics	Very low	Low	Medium	High	Very high	45	0.2	9
C_{74}	Growth or replacement rate	Very Negati	Negative	Stable	Positive	Very Positive	60	0.2	12
C_{74}	Resource sensibility	Very low	Low	Medium	High	Very High	50	0.2	10
f_7	Score Environmental Capacity					$\sum C_{ij} w_j$		1	**49**
8	Social and Cultural Capacity								
C_{81}	Communal ownership	Very low	Low	Intermediate	High	Very high	40	0.2	8
C_{82}	Political stability	Very low	Low	Intermediate	High	Very high	35	0.2	7
C_{83}	Equity	Very low	Low	Intermediate	High	Very high	40	0.2	8
C_{84}	Leadership/entrepreneurship	Very low	Low	Intermediate	High	Very high	50	0.2	10
C_{85}	Participation of women	Very low	Low	Intermediate	High	Very high	35	0.2	7
f_8	Score Social-Cultural Capacity					$\sum C_{ij} w_j$		1	**40**

Appendix IV.N.1: Narayanpur Mandal – Vaillapally

		Partitioned Scoring							
	Capacity Factors	1-20	21-40	41-60	61-80	81-100	Score	Weight	CF score
1	Service Capacity								
C_{11}	Effective service level	< 20 l/p/d	20 - 40 l/p/d	40 - 60 l/p/d	60 - 80 l/p/d	> 80 l/p/d	61	1	61
f_1	Score Service Capacity					$\sum C_{ij} w_j$		1	61
2	Institutional Capacity								
C_{21}	Body of legislation	None	Basic	Intermediate	Complete	Advanced	50	0.1667	8.333333
C_{22}	Operational rules	None	Basic	Intermediate	Complete	Advanced	60	0.1667	10
C_{23}	Administrative agencies	None	State	District	Mandal	Habitational	55	0.1667	9.166667
C_{24}	Administrative processes	None	Basic	Intermediate	Complete	Advanced	50	0.1667	8.333333
C_{25}	Governance	None	State	District	Mandal	Habitational	81	0.1667	13.5
C_{26}	Presence of NGOs	None	Low	Medium	High	Very High	45	0.1667	7.5
f_2	Score Institutional Capacity					$\sum C_{ij} w_j$		1	56.83333
3	Human Resources Capacity (service provider)								
C_{31}	Professionals	None	None	Administrative supervisor	Administrative manager	Administrative manager	60	0.2	12
				Health Scientist	Health Scientist	Health Scientist			
					Engineer	Engineer			
						Lawyer			
						Public relations manager			
C_{32}	Skilled Labor	None	Mechanic	Maintenance technician	Maintenance technician	Maintenance technician	60	0.2	12
				Laboratory technician	Laboratory technician	Laboratory technician			
				Water systems operator	Water systems operator	Water systems operator			
					Health Inspector	Health Inspector			
					Administratrive assistant	Administratrive assistant			
					Water meter leader	Water meter leader			
						IT technician			
C_{33}	Unskilled Labor	Craftsman	Clerk	Clerk			80	0.2	16
			Mechanic assistant	Water meter reader					
				Water systems worker					
C_{34}	Illiterate	Caretaker	Caretaker				80	0.2	16
C_{35}	Access to Higher Education	None	State	Regional	District	Mandal	81	0.2	16.2
f_3	Score Human Resources Capacity					$\sum C_{ij} w_j$		1	72.2
4	Technical Capacity								
C_{41}	Operations	Water Use	Pumping Water	Pumping Water	Monitor water systems	Monitor water systems	65	0.2	13
				Control Water Quality	Control Water Quality	Control Water Quality			
					Control Pipes	Monitor pipes network			
						Monitor Treatment			
C_{42}	Maintenance	None	Clean water systems	Check water systems	Check/maintain water systems	Check/maintain water systems	55	0.2	11
			Minor repair	Major repair	Major repair	Check/maintain network			
					Maintain pipes	Check/maintain meter			
						Maintain IT systems			
C_{43}	Adaptation	None	Rarely	Occasionally	Usually	Frequently	55	0.2	11
C_{45}	Maintenance network	None	State	District	Mandal	Habitational	70	0.2	14
C_{45}	Distribution network	None	Regional Supplier	District Supplier	Mandal Supplier	Habitational Supplier	81	0.2	16.2
					District Approved	District Approved			
f_4	Score Technical Capacity					$\sum C_{ij} w_j$		1	65.2
5	Economical and Financial Capacity								
C_{51}	Private sector investment	None	State	Regional	District	Mandal	75	0.14	10.71429
C_{52}	Market incentives	None	Low	Medium	High	Very high	40	0.14	5.714286
C_{53}	User fees	None	Uniform flat rate	Single block rate	Increasing block rate	Increasing block rate	50	0.14	7.142857
C_{54}	Budget	None	Basic accounting	Annual	Tracked bi-annually	Tracked quarterly	50	0.14	7.142857
C_{55}	Asset values	None	Real Estate	Real estate	Real estate	Real estate	50	0.14	7.142857
				Equipment	Equipment	Equipment			
					Cash	Cash - Stocks			
C_{56}	Investment activities	None	Low	Medium	High	Very High	50	0.14	7.142857
C_{57}	Loss to corruption	Very High	High	Medium	Low	None	60	0.14	8.571429
f_5	Score Economical and Financial Capacity					$\sum C_{ij} w_j$		1	53.57143
6	Energy Capacity								
C_{61}	Primary source	None	Non-conventional	Conventional electricity	Electricity mid-voltage	Electricity high voltage	70	0.25	17.5
C_{62}	Alternative source	None	None	Generator < 10 HP	Generator < 50 HP	Generator > 50 HP	45	0.25	11.25
C_{63}	Dependence for service	Very low	Low	Medium	High	Very High	55	0.25	13.75
C_{64}	Outage rate	Very High	High	Medium	Low	Very low	41	0.25	10.25
f_6	Score Energy Capacity					$\sum C_{ij} w_j$		1	52.75
7	Environmental and Ecological Capacity								
C_{71}	Environment quality	Very low	Low	Medium	High	Very high	65	0.2	13
C_{72}	Size of resource system	Very low	Low	Medium	High	Very high	65	0.2	13
C_{73}	Predictability of resource dynamics	Very low	Low	Medium	High	Very high	60	0.2	12
C_{74}	Growth or replacement rate	Very Negati	Negative	Stable	Positive	Very Positive	55	0.2	11
C_{74}	Resource sensibility	Very low	Low	Medium	High	Very High	60	0.2	12
f_7	Score Environmental Capacity					$\sum C_{ij} w_j$		1	61
8	Social and Cultural Capacity								
C_{81}	Communal ownership	Very low	Low	Intermediate	High	Very high	65	0.2	13
C_{82}	Political stability	Very low	Low	Intermediate	High	Very high	65	0.2	13
C_{83}	Equity	Very low	Low	Intermediate	High	Very high	65	0.2	13
C_{84}	Leadership/entrepreneurship	Very low	Low	Intermediate	High	Very high	60	0.2	12
C_{85}	Participation of women	Very low	Low	Intermediate	High	Very high	70	0.2	14
f_8	Score Social-Cultural Capacity					$\sum C_{ij} w_j$		1	65

Appendix IV.O.1: Suryapet Mandal – Suryapet Municipality

		Partitioned Scoring							
	Capacity Factors	**1-20**	**21-40**	**41-60**	**61-80**	**81-100**	**Score**	**Weight**	**CF score**
1	**Service Capacity**								
C_{11}	Effective service level	< 20 l/p/d	20 - 40 l/p/d	40 - 60 l/p/d	60 - 80 l/p/d	> 80 l/p/d	50	1	50
f_1	*Score Service Capacity*					$\sum C_{ij} w_j$		*1*	**50**
2	**Institutional Capacity**								
C_{21}	Body of legislation	None	Basic	Intermediate	Complete	Advanced	65	0.1667	10.83333
C_{22}	Operational rules	None	Basic	Intermediate	Complete	Advanced	65	0.1667	10.83333
C_{23}	Administrative agencies	None	State	District	Mandal	Habitational	70	0.1667	11.66667
C_{24}	Administrative processes	None	Basic	Intermediate	Complete	Advanced	70	0.1667	11.66667
C_{25}	Governance	None	State	District	Mandal	Habitational	85	0.1667	14.16667
C_{26}	Presence of NGOs	None	Low	Medium	High	Very High	40	0.1667	6.666667
f_2	*Score Institutional Capacity*					$\sum C_{ij} w_j$		*1*	**65.83333**
3	**Human Resources Capacity (service provider)**								
C_{31}	Professionals	None	None	Administrative supervisor	Administrative manager	Administrative manager	80	0.2	16
				Health Scientist	Health Scientist	Health Scientist			
					Engineer	Engineer			
						Lawyer			
						Public relations manager			
C_{32}	Skilled Labor	None	Mechanic	Maintenance technician	Maintenance technician	Maintenance technician	80	0.2	16
				Laboratory technician	Laboratory technician	Laboratory technician			
				Water systems operator	Water systems operator	Water systems operator			
					Health Inspector	Health Inspector			
					Administratrive assistant	Administratrive assistant			
					Water meter leader	Water meter leader			
						IT technician			
C_{33}	Unskilled Labor	Craftsman	Clerk	Clerk			95	0.2	19
			Mechanic assistant	Water meter reader					
				Water systems worker					
C_{34}	Illiterate	Caretaker	Caretaker				95	0.2	19
C_{35}	Access to Higher Education	None	State	Regional	District	Mandal	90	0.2	18
f_3	*Score Human Resources Capacity*					$\sum C_{ij} w_j$		*1*	**88**
4	**Technical Capacity**								
C_{41}	Operations	Water Use	Pumping Water	Pumping Water	Monitor water systems	Monitor water systems	85	0.2	17
				Control Water Quality	Control Water Quality	Control Water Quality			
					Control Pipes	Monitor pipes network			
						Monitor Treatment			
C_{42}	Maintenance	None	Clean water systems	Check water systems	Check/maintain water systems	Check/maintain water systems	70	0.2	14
			Minor repair	Major repair	Major repair	Check/maintain network			
					Maintain pipes	Check/maintain meter			
						Maintain IT systems			
C_{43}	Adaptation	None	Rarely	Occasionally	Usually	Frequently	65	0.2	13
C_{45}	Maintenance network	None	State	District	Mandal	Habitational	75	0.2	15
C_{45}	Distribution network	None	Regional Supplier	District Supplier	Mandal Supplier	Habitational Supplier	75	0.2	15
					District Approved	District Approved			
f_4	*Score Technical Capacity*					$\sum C_{ij} w_j$		*1*	**74**
5	**Economical and Financial Capacity**								
C_{51}	Private sector investment	None	State	Regional	District	Mandal	81	0.14	11.57143
C_{52}	Market incentives	None	Low	Medium	High	Very high	70	0.14	10
C_{53}	User fees	None	Uniform flat rate	Single block rate	Increasing block rate	Increasing block rate	55	0.14	7.857143
C_{54}	Budget	None	Basic accounting	Annual	Tracked bi-annually	Tracked quarterly	60	0.14	8.571429
C_{55}	Asset values	None	Real Estate	Real estate	Real estate	Real estate	70	0.14	10
				Equipment	Equipment	Equipment			
					Cash	Cash - Stocks			
C_{56}	Investment activities	None	Low	Medium	High	Very High	65	0.14	9.285714
C_{57}	Loss to corruption	Very High	High	Medium	Low	None	61	0.14	8.714286
f_5	*Score Economical and Financial Capacity*					$\sum C_{ij} w_j$		*1*	**66**
6	**Energy Capacity**								
C_{61}	Primary source	None	Non-conventional	Conventional electricity	Electricity mid-voltage	Electricity high voltage	81	0.25	20.25
C_{62}	Alternative source	None	None	Generator < 10 HP	Generator < 50 HP	Generator > 50 HP	70	0.25	17.5
C_{63}	Dependence for service	Very low	Low	Medium	High	Very High	75	0.25	18.75
C_{64}	Outage rate	Very High	High	Medium	Low	Very low	45	0.25	11.25
f_6	*Score Energy Capacity*					$\sum C_{ij} w_j$		*1*	**67.75**
7	**Environmental and Ecological Capacity**								
C_{71}	Environment quality	Very low	Low	Medium	High	Very high	55	0.2	11
C_{72}	Size of resource system	Very low	Low	Medium	High	Very high	50	0.2	10
C_{73}	Predictability of resource dynamics	Very low	Low	Medium	High	Very high	45	0.2	9
C_{74}	Growth or replacement rate	Very Negati	Negative	Stable	Positive	Very Positive	55	0.2	11
C_{74}	Resource sensibility	Very low	Low	Medium	High	Very High	65	0.2	13
f_7	*Score Environmental Capacity*					$\sum C_{ij} w_j$		*1*	**54**
8	**Social and Cultural Capacity**								
C_{81}	Communal ownership	Very low	Low	Intermediate	High	Very high	60	0.2	12
C_{82}	Political stability	Very low	Low	Intermediate	High	Very high	75	0.2	15
C_{83}	Equity	Very low	Low	Intermediate	High	Very high	75	0.2	15
C_{84}	Leadership/entrepreneurship	Very low	Low	Intermediate	High	Very high	75	0.2	15
C_{85}	Participation of women	Very low	Low	Intermediate	High	Very high	60	0.2	12
f_8	*Score Social-Cultural Capacity*					$\sum C_{ij} w_j$		*1*	**69**

Appendix IV.P.1: Chandempet Mandal – Neradugommu

	Capacity Factors	Partitioned Scoring					Score	Weight	CF score
	Capacity Factors	1-20	21-40	41-60	61-80	81-100	Score	Weight	CF score
1	Service Capacity								
C_{11}	Effective service level	< 20 l/p/d	20 - 40 l/p/d	40 - 60 l/p/d	60 - 80 l/p/d	> 80 l/p/d	20	1	20
f_1	Score Service Capacity					$\sum C_{ij} w_j$		1	20
2	Institutional Capacity								
C_{21}	Body of legislation	None	Basic	Intermediate	Complete	Advanced	40	0.1667	6.666667
C_{22}	Operational rules	None	Basic	Intermediate	Complete	Advanced	35	0.1667	5.833333
C_{23}	Administrative agencies	None	State	District	Mandal	Habitational	45	0.1667	7.5
C_{24}	Administrative processes	None	Basic	Intermediate	Complete	Advanced	35	0.1667	5.833333
C_{25}	Governance	None	State	District	Mandal	Habitational	61	0.1667	10.16667
C_{26}	Presence of NGOs	None	Low	Medium	High	Very High	45	0.1667	7.5
f_2	Score Institutional Capacity					$\sum C_{ij} w_j$		1	43.5
3	Human Resources Capacity (service provider)								
C_{31}	Professionals	None	None	Administrative supervisor	Administrative manager	Administrative manager	41	0.2	8.2
				Health Scientist	Health Scientist	Health Scientist			
					Engineer	Engineer			
						Lawyer			
						Public relations manager			
C_{32}	Skilled Labor	None	Mechanic	Maintenance technician	Maintenance technician	Maintenance technician	35	0.2	7
				Laboratory technician	Laboratory technician	Laboratory technician			
				Water systems operator	Water systems operator	Water systems operator			
					Health Inspector	Health Inspector			
					Administratrive assistant	Administratrive assistant			
					Water meter leader	Water meter leader			
						IT technician			
C_{33}	Unskilled Labor	Craftsman	Clerk	Clerk			60	0.2	12
			Mechanic assistant	Water meter reader					
				Water systems worker					
C_{34}	Illiterate	Caretaker	Caretaker				60	0.2	12
C_{35}	Access to Higher Education	None	State	Regional	District	Mandal	61	0.2	12.2
f_3	Score Human Resources Capacity					$\sum C_{ij} w_j$		1	51.4
4	Technical Capacity								
C_{41}	Operations	Water Use	Pumping Water	Pumping Water	Monitor water systems	Monitor water systems	40	0.2	8
				Control Water Quality	Control Water Quality	Control Water Quality			
					Control Pipes	Monitor pipes network			
						Monitor Treatment			
C_{42}	Maintenance	None	Clean water systems	Check water systems	Check/maintain water systems	Check/maintain water systems	25	0.2	5
			Minor repair	Major repair	Major repair	Check/maintain network			
					Maintain pipes	Check/maintain meter			
						Maintain IT systems			
C_{43}	Adaptation	None	Rarely	Occasionally	Usually	Frequently	35	0.2	7
C_{45}	Maintenance network	None	State	District	Mandal	Habitational	55	0.2	11
C_{45}	Distribution network	None	Regional Supplier	District Supplier	Mandal Supplier	Habitational Supplier	55	0.2	11
					District Approved	District Approved			
f_4	Score Technical Capacity					$\sum C_{ij} w_j$		1	42
5	Economical and Financial Capacity								
C_{51}	Private sector investment	None	State	Regional	District	Mandal	50	0.14	7.142857
C_{52}	Market incentives	None	Low	Medium	High	Very high	35	0.14	5
C_{53}	User fees	None	Uniform flat rate	Single block rate	Increasing block rate	Increasing block rate	21	0.14	3
C_{54}	Budget	None	Basic accounting	Annual	Tracked bi-annually	Tracked quarterly	30	0.14	4.285714
C_{55}	Asset values	None	Real Estate	Real estate	Real estate	Real estate	41	0.14	5.857143
				Equipment	Equipment	Equipment			
					Cash	Cash - Stocks			
C_{56}	Investment activities	None	Low	Medium	High	Very High	30	0.14	4.285714
C_{57}	Loss to corruption	Very High	High	Medium	Low	None	35	0.14	5
f_5	Score Economical and Financial Capacity					$\sum C_{ij} w_j$		1	34.57143
6	Energy Capacity								
C_{61}	Primary source	None	Non-conventional	Conventional electricity	Electricity mid-voltage	Electricity high voltage	55	0.25	13.75
C_{62}	Alternative source	None	None	Generator < 10 HP	Generator < 50 HP	Generator > 50 HP	40	0.25	10
C_{63}	Dependence for service	Very low	Low	Medium	High	Very High	55	0.25	13.75
C_{64}	Outage rate	Very High	High	Medium	Low	Very low	25	0.25	6.25
f_6	Score Energy Capacity					$\sum C_{ij} w_j$		1	43.75
7	Environmental and Ecological Capacity								
C_{71}	Environment quality	Very low	Low	Medium	High	Very high	70	0.2	14
C_{72}	Size of resource system	Very low	Low	Medium	High	Very high	95	0.2	19
C_{73}	Predictability of resource dynamics	Very low	Low	Medium	High	Very high	65	0.2	13
C_{74}	Growth or replacement rate	Very Negati	Negative	Stable	Positive	Very Positive	80	0.2	16
C_{74}	Resource sensibility	Very low	Low	Medium	High	Very High	25	0.2	5
f_7	Score Environmental Capacity					$\sum C_{ij} w_j$		1	67
8	Social and Cultural Capacity								
C_{81}	Communal ownership	Very low	Low	Intermediate	High	Very high	40	0.2	8
C_{82}	Political stability	Very low	Low	Intermediate	High	Very high	35	0.2	7
C_{83}	Equity	Very low	Low	Intermediate	High	Very high	20	0.2	4
C_{84}	Leadership/entrepreneurship	Very low	Low	Intermediate	High	Very high	40	0.2	8
C_{85}	Participation of women	Very low	Low	Intermediate	High	Very high	35	0.2	7
f_8	Score Social-Cultural Capacity					$\sum C_{ij} w_j$		1	34

Appendix IV.P.2: Chandempet Mandal – Polepally

		Partitioned Scoring							
	Capacity Factors	**1-20**	**21-40**	**41-60**	**61-80**	**81-100**	**Score**	**Weight**	**CF score**
1	**Service Capacity**								
C_{11}	Effective service level	< 20 l/p/d	20 - 40 l/p/d	40 - 60 l/p/d	60 - 80 l/p/d	> 80 l/p/d	15	1	15
f_1	*Score Service Capacity*					$\sum C_{ij} w_j$		*1*	**15**
2	**Institutional Capacity**								
C_{21}	Body of legislation	None	Basic	Intermediate	Complete	Advanced	50	0.1667	8.333333
C_{22}	Operational rules	None	Basic	Intermediate	Complete	Advanced	50	0.1667	8.333333
C_{23}	Administrative agencies	None	State	District	Mandal	Habitational	41	0.1667	6.833333
C_{24}	Administrative processes	None	Basic	Intermediate	Complete	Advanced	35	0.1667	5.833333
C_{25}	Governance	None	State	District	Mandal	Habitational	61	0.1667	10.16667
C_{26}	Presence of NGOs	None	Low	Medium	High	Very High	50	0.1667	8.333333
f_2	*Score Institutional Capacity*					$\sum C_{ij} w_j$		*1*	**47.83333**
3	**Human Resources Capacity (service provider)**								
C_{31}	Professionals	None	None	Administrative supervisor	Administrative manager	Administrative manager	41	0.2	8.2
				Health Scientist	Health Scientist	Health Scientist			
					Engineer	Engineer			
						Lawyer			
						Public relations manager			
C_{32}	Skilled Labor	None	Mechanic	Maintenance technician	Maintenance technician	Maintenance technician	30	0.2	6
				Laboratory technician	Laboratory technician	Laboratory technician			
				Water systems operator	Water systems operator	Water systems operator			
					Health Inspector	Health Inspector			
					Administratrive assistant	Administratrive assistant			
					Water meter leader	Water meter leader			
						IT technician			
C_{33}	Unskilled Labor	Craftsman	Clerk	Clerk			50	0.2	10
			Mechanic assistant	Water meter reader					
				Water systems worker					
C_{34}	Illiterate	Caretaker	Caretaker				50	0.2	10
C_{35}	Access to Higher Education	None	State	Regional	District	Mandal	61	0.2	12.2
f_3	*Score Human Resources Capacity*					$\sum C_{ij} w_j$		*1*	**46.4**
4	**Technical Capacity**								
C_{41}	Operations	Water Use	Pumping Water	Pumping Water	Monitor water systems	Monitor water systems	40	0.2	8
				Control Water Quality	Control Water Quality	Control Water Quality			
					Control Pipes	Monitor pipes network			
						Monitor Treatment			
C_{42}	Maintenance	None	Clean water systems	Check water systems	Check/maintain water systems	Check/maintain water systems	30	0.2	6
			Minor repair	Major repair	Major repair	Check/maintain network			
					Maintain pipes	Check/maintain meter			
						Maintain IT systems			
C_{43}	Adaptation	None	Rarely	Occasionally	Usually	Frequently	15	0.2	3
C_{45}	Maintenance network	None	State	District	Mandal	Habitational	65	0.2	13
C_{45}	Distribution network	None	Regional Supplier	District Supplier	Mandal Supplier	Habitational Supplier	50	0.2	10
					District Approved	District Approved			
f_4	*Score Technical Capacity*					$\sum C_{ij} w_j$		*1*	**40**
5	**Economical and Financial Capacity**								
C_{51}	Private sector investment	None	State	Regional	District	Mandal	45	0.14	6.428571
C_{52}	Market incentives	None	Low	Medium	High	Very high	40	0.14	5.714286
C_{53}	User fees	None	Uniform flat rate	Single block rate	Increasing block rate	Increasing block rate	30	0.14	4.285714
C_{54}	Budget	None	Basic accounting	Annual	Tracked bi-annually	Tracked quarterly	30	0.14	4.285714
C_{55}	Asset values	None	Real Estate	Real estate	Real estate	Real estate	45	0.14	6.428571
				Equipment	Equipment	Equipment			
					Cash	Cash - Stocks			
C_{56}	Investment activities	None	Low	Medium	High	Very High	30	0.14	4.285714
C_{57}	Loss to corruption	Very High	High	Medium	Low	None	25	0.14	3.571429
f_5	*Score Economical and Financial Capacity*					$\sum C_{ij} w_j$		*1*	**35**
6	**Energy Capacity**								
C_{61}	Primary source	None	Non-conventional	Conventional electricity	Electricity mid-voltage	Electricity high voltage	60	0.25	15
C_{62}	Alternative source	None	None	Generator < 10 HP	Generator < 50 HP	Generator > 50 HP	40	0.25	10
C_{63}	Dependence for service	Very low	Low	Medium	High	Very High	60	0.25	15
C_{64}	Outage rate	Very High	High	Medium	Low	Very low	40	0.25	10
f_6	*Score Energy Capacity*					$\sum C_{ij} w_j$		*1*	**50**
7	**Environmental and Ecological Capacity**								
C_{71}	Environment quality	Very low	Low	Medium	High	Very high	65	0.2	13
C_{72}	Size of resource system	Very low	Low	Medium	High	Very high	85	0.2	17
C_{73}	Predictability of resource dynamics	Very low	Low	Medium	High	Very high	55	0.2	11
C_{74}	Growth or replacement rate	Very Negati	Negative	Stable	Positive	Very Positive	65	0.2	13
C_{74}	Resource sensibility	Very low	Low	Medium	High	Very High	40	0.2	8
f_7	*Score Environmental Capacity*					$\sum C_{ij} w_j$		*1*	**62**
8	**Social and Cultural Capacity**								
C_{81}	Communal ownership	Very low	Low	Intermediate	High	Very high	50	0.2	10
C_{82}	Political stability	Very low	Low	Intermediate	High	Very high	40	0.2	8
C_{83}	Equity	Very low	Low	Intermediate	High	Very high	20	0.2	4
C_{84}	Leadership/entrepreneurship	Very low	Low	Intermediate	High	Very high	40	0.2	8
C_{85}	Participation of women	Very low	Low	Intermediate	High	Very high	40	0.2	8
f_8	*Score Social-Cultural Capacity*					$\sum C_{ij} w_j$		1	**38**

Appendix IV.P.3: Chandempet Mandal – Timmapuram

		Partitioned Scoring							
	Capacity Factors	**1-20**	**21-40**	**41-60**	**61-80**	**81-100**	**Score**	**Weight**	**CF score**
1	**Service Capacity**								
C_{11}	Effective service level	< 20 l/p/d	20 - 40 l/p/d	40 - 60 l/p/d	60 - 80 l/p/d	> 80 l/p/d	27	1	27
f_1	*Score Service Capacity*					$\sum C_{ij} w_j$		1	**27**
2	**Institutional Capacity**								
C_{21}	Body of legislation	None	Basic	Intermediate	Complete	Advanced	30	0.1667	5
C_{22}	Operational rules	None	Basic	Intermediate	Complete	Advanced	30	0.1667	5
C_{23}	Administrative agencies	None	State	District	Mandal	Habitational	20	0.1667	3.333333
C_{24}	Administrative processes	None	Basic	Intermediate	Complete	Advanced	20	0.1667	3.333333
C_{25}	Governance	None	State	District	Mandal	Habitational	61	0.1667	10.16667
C_{26}	Presence of NGOs	None	Low	Medium	High	Very High	65	0.1667	10.83333
f_2	*Score Institutional Capacity*					$\sum C_{ij} w_j$		1	**37.66667**
3	**Human Resources Capacity (service provider)**								
C_{31}	Professionals	None	None	Administrative supervisor	Administrative manager	Administrative manager	20	0.2	4
				Health Scientist	Health Scientist	Health Scientist			
					Engineer	Engineer			
						Lawyer			
						Public relations manager			
C_{32}	Skilled Labor	None	Mechanic	Maintenance technician	Maintenance technician	Maintenance technician	40	0.2	8
				Laboratory technician	Laboratory technician	Laboratory technician			
				Water systems operator	Water systems operator	Water systems operator			
					Health Inspector	Health Inspector			
					Administratrive assistant	Administratrive assistant			
					Water meter leader	Water meter leader			
						IT technician			
C_{33}	Unskilled Labor	Craftsman	Clerk	Clerk			35	0.2	7
			Mechanic assistant	Water meter reader					
				Water systems worker					
C_{34}	Illiterate	Caretaker	Caretaker				60	0.2	12
C_{35}	Access to Higher Education	None	State	Regional	District	Mandal	61	0.2	12.2
f_3	*Score Human Resources Capacity*					$\sum C_{ij} w_j$		1	**43.2**
4	**Technical Capacity**								
C_{41}	Operations	Water Use	Pumping Water	Pumping Water	Monitor water systems	Monitor water systems	40	0.2	8
				Control Water Quality	Control Water Quality	Control Water Quality			
					Control Pipes	Monitor pipes network			
						Monitor Treatment			
C_{42}	Maintenance	None	Clean water systems	Check water systems	Check/maintain water systems	Check/maintain water systems	20	0.2	4
			Minor repair	Major repair	Major repair	Check/maintain network			
					Maintain pipes	Check/maintain meter			
						Maintain IT systems			
C_{43}	Adaptation	None	Rarely	Occasionally	Usually	Frequently	35	0.2	7
C_{45}	Maintenance network	None	State	District	Mandal	Habitational	65	0.2	13
C_{45}	Distribution network	None	Regional Supplier	District Supplier	Mandal Supplier	Habitational Supplier	61	0.2	12.2
					District Approved	District Approved			
f_4	*Score Technical Capacity*					$\sum C_{ij} w_j$		1	**44.2**
5	**Economical and Financial Capacity**								
C_{51}	Private sector investment	None	State	Regional	District	Mandal	41	0.14	5.857143
C_{52}	Market incentives	None	Low	Medium	High	Very high	25	0.14	3.571429
C_{53}	User fees	None	Uniform flat rate	Single block rate	Increasing block rate	Increasing block rate	21	0.14	3
C_{54}	Budget	None	Basic accounting	Annual	Tracked bi-annually	Tracked quarterly	21	0.14	3
C_{55}	Asset values	None	Real Estate	Real estate	Real estate	Real estate	41	0.14	5.857143
				Equipment	Equipment	Equipment			
					Cash	Cash - Stocks			
C_{56}	Investment activities	None	Low	Medium	High	Very High	21	0.14	3
C_{57}	Loss to corruption	Very High	High	Medium	Low	None	40	0.14	5.714286
f_5	*Score Economical and Financial Capacity*					$\sum C_{ij} w_j$		1	**30**
6	**Energy Capacity**								
C_{61}	Primary source	None	Non-conventional	Conventional electricity	Electricity mid-voltage	Electricity high voltage	45	0.25	11.25
C_{62}	Alternative source	None	None	Generator < 10 HP	Generator < 50 HP	Generator > 50 HP	30	0.25	7.5
C_{63}	Dependence for service	Very low	Low	Medium	High	Very High	45	0.25	11.25
C_{64}	Outage rate	Very High	High	Medium	Low	Very low	35	0.25	8.75
f_6	*Score Energy Capacity*					$\sum C_{ij} w_j$		1	**38.75**
7	**Environmental and Ecological Capacity**								
C_{71}	Environment quality	Very low	Low	Medium	High	Very high	65	0.2	13
C_{72}	Size of resource system	Very low	Low	Medium	High	Very high	85	0.2	17
C_{73}	Predictability of resource dynamics	Very low	Low	Medium	High	Very high	50	0.2	10
C_{74}	Growth or replacement rate	Very Negati	Negative	Stable	Positive	Very Positive	80	0.2	16
C_{74}	Resource sensibility	Very low	Low	Medium	High	Very High	40	0.2	8
f_7	*Score Environmental Capacity*					$\sum C_{ij} w_j$		1	**64**
8	**Social and Cultural Capacity**								
C_{81}	Communal ownership	Very low	Low	Intermediate	High	Very high	40	0.2	8
C_{82}	Political stability	Very low	Low	Intermediate	High	Very high	40	0.2	8
C_{83}	Equity	Very low	Low	Intermediate	High	Very high	10	0.2	2
C_{84}	Leadership/entrepreneurship	Very low	Low	Intermediate	High	Very high	25	0.2	5
C_{85}	Participation of women	Very low	Low	Intermediate	High	Very high	30	0.2	6
f_8	*Score Social-Cultural Capacity*					$\sum C_{ij} w_j$		1	**29**

Appendix V.A: Aggregate Community Capacity Grade – Bhongir Mandal

Grade	Institutional	Human Resources	Technical	Economic and Financial	Energy	Environmental and Ecological	Social and Cultural
A	• Strong local, Mandal, and District level regulation • Local governance, minimal supervision • Integrated government agencies • High legislative standards for water quality	• Heavy social capital • Several higher educational institutions • Training or mentoring facilities and programs • Illiterates trained as operators or caretakers	• Capable of complex water unit operations • Experts with tech maintenance • Reliance network is close to point of use • Source is nearby point of use	• Strong market • Maintains accurate budget • Very little corruption • Users pay towards system use	• Primary source powers groundwater pumps and filters • Alternative source capable of drawing groundwater • Low dependence • Very low outage	• No natural or manmade pollutants in water • High groundwater level, rainfall • High resource conscience • Waste and wastewater curbing plans	• Sense of communal ownership exists • Low political rift • No segregation or affirmative action necessary • Women are leaders, not just participators
B	• Strong Mandal & District level regulation • Local governance, Mandal supervision • Legislative standards • Communication between institutional agencies • NGO presence	• Medium Social capital • Few higher educational institutions • Illiterates trained as operators or caretakers	• Capable of operating medium-level water technology • Familiar with tech maintenance • Reliance network is in neighboring Mandal • Source is far from point of use	• Strong market • Maintains annual budget • Some corruption • Users pay towards system use, but collection rate is not high	• Primary source varies over course of day • Alternative source capable of drawing groundwater • Medium dependence • Outage no more than 8 hours per day	• Some natural pollutants • No manmade pollutants in water • Resource supply > demand • Resource conscience • Some waste curbing plans	• Sense of communal ownership exists • Some political rift • Some segregation or affirmative action • Women participate in central activities • Motivated leaders
C	• District-level regulation • Little governance structure, relies on District officers • No standards or legislation • No communication between agencies	• Low social capital • Basic schools exist • Apprenticeship in water management comes from agriculture experience	• Capable of operating low-level water technology • Maintains system without familiarity • Reliance network is farther than immediate neighbor	• Market exists • Maintains annual budget • Frequent corruption • Users pay towards system use, but collection rate is very low	• Primary source varies over course of day • Alternative source can only power lights • High dependence • Outage no more than 16 hours/day, predictable	• Some natural pollutants & manmade pollutants in water • Resource supply = demand • No resource conscience • No waste cleanup	• Little sense of communal ownership • High political rift • Heavy segregation or affirmative action • Women participate in menial activities • Leaders participate sometimes
D	• Little or no regulation • Little or no governance, relies on District intervention • No standards or legislation • NGO intervention seen as necessary	• Low social capital • Basic schools exist, but no teachers • Apprenticeship in water management comes from agriculture experience	• Operates low-level water technology without background • No system maintenance • Reliance network is farther than immediate neighbor	• No market • Uncertain budget • Frequent corruption • No collection of user fees • Low asset values • Investors wary, little entrepreneurship	• Primary source no more than 6 hours a day • No alternative • Very high outage, inconsistent and unpredictable	• High natural pollutants & manmade pollutants in water • Resource supply < demand • No resource conscience • No waste cleanup	• No sense of communal ownership • High political rift • Heavy segregation or affirmative action • Women do not participate • Poor leadership

Appendix V.B: Aggregate Community Capacity Grade – Alair Mandal

Grade	Institutional	Human Resources	Technical	Economic and Financial	Energy	Environmental and Ecological	Social and Cultural
A	• Strong local, Mandal, and District level regulation • Local governance, minimal supervision • Integrated government agencies • High legislative standards for water quality	• Heavy social capital • Several higher educational institutions • Training or mentoring facilities and programs • Illiterates trained as operators or caretakers	• Capable of complex water unit operations • Experts with tech maintenance • Reliance network is close to point of use • Source is nearby point of use	• Strong market • Maintains accurate budget • Very little corruption • Users pay towards system use	• Primary source powers groundwater pumps and filters • Alternative source capable of drawing groundwater • Low dependence • Very low outage	• No natural or manmade pollutants in water • High groundwater level, rainfall • High resource conscience • Waste and wastewater curbing plans	• Sense of communal ownership exists • Low political rift • No segregation or affirmative action necessary • Women are leaders, not just participators
B	• Strong Mandal & District level regulation • Local governance, Mandal supervision • Legislative standards • Communication between institutional agencies • NGO presence	• Medium Social capital • Few higher educational institutions • Illiterates trained as operators or caretakers	• Capable of operating medium-level water technology • Familiar with tech maintenance • Reliance network is in neighboring Mandal • Source is far from point of use	• Strong market • Maintains annual budget • Some corruption • Users pay towards system use, but collection rate is not high	• Primary source varies over course of day • Alternative source capable of drawing groundwater • Medium dependence • Outage no more than 8 hours per day	• Some natural pollutants • No manmade pollutants in water • Resource supply > demand • Resource conscience • Some waste curbing plans	• Sense of communal ownership exists • Some political rift • Some segregation or affirmative action • Women participate in central activities • Motivated leaders
C	• District-level regulation • Little governance structure, relies on District officers • No standards or legislation • No communication between agencies	• Low social capital • Basic schools exist • Apprenticeship in water management comes from agriculture experience	• Capable of operating low-level water technology • Maintains system without familiarity • Reliance network is farther than immediate neighbor	• Market exists • Maintains annual budget • Frequent corruption • Users pay towards system use, but collection rate is very low	• Primary source varies over course of day • Alternative source can only power lights • High dependence • Outage no more than 16 hours/day, predictable	• Some natural pollutants & manmade pollutants in water • Resource supply = demand • No resource conscience • No waste cleanup	• Little sense of communal ownership • High political rift • Heavy segregation or affirmative action • Women participate in menial activities • Leaders participate sometimes
D	• Little or no regulation • Little or no governance, relies on District intervention • No standards or legislation • NGO intervention seen as necessary	• Low social capital • Basic schools exist, but no teachers • Apprenticeship in water management comes from agriculture experience	• Operates low-level water technology without background • No system maintenance • Reliance network is farther than immediate neighbor	• No market • Uncertain budget • Frequent corruption • No collection of user fees • Low asset values • Investors wary, little entrepreneurship	• Primary source no more than 6 hours a day • No alternative • Very high outage, inconsistent and unpredictable	• High natural pollutants & manmade pollutants in water • Resource supply < demand • No resource conscience • No waste cleanup	• No sense of communal ownership • High political rift • Heavy segregation or affirmative action • Women do not participate • Poor leadership

Appendix V.C: Aggregate Community Capacity Grade – Yadagirigutta Mandal

Grade	Institutional	Human Resources	Technical	Economic and Financial	Energy	Environmental and Ecological	Social and Cultural
A	• Strong local, Mandal, and District level regulation • Local governance, minimal supervision • Integrated government agencies • High legislative standards for water quality	• Heavy social capital • Several higher educational institutions • Training or mentoring facilities and programs • Illiterates trained as operators or caretakers	• Capable of complex water unit operations • Experts with tech maintenance • Reliance network is close to point of use • Source is nearby point of use	• Strong market • Maintains accurate budget • Very little corruption • Users pay towards system use	• Primary source powers groundwater pumps and filters • Alternative source capable of drawing groundwater • Low dependence • Very low outage	• No natural or manmade pollutants in water • High groundwater level, rainfall • High resource conscience • Waste and wastewater curbing plans	• Sense of communal ownership exists • Low political rift • No segregation or affirmative action necessary • Women are leaders, not just participators
B	• Strong Mandal & District level regulation • Local governance, Mandal supervision • Legislative standards • Communication between institutional agencies • NGO presence	• Medium Social capital • Few higher educational institutions • Illiterates trained as operators or caretakers	• Capable of operating medium-level water technology • Familiar with tech maintenance • Reliance network is in neighboring Mandal • Source is far from point of use	• Strong market • Maintains annual budget • Some corruption • Users pay towards system use, but collection rate is not high	• Primary source varies over course of day • Alternative source capable of drawing groundwater • Medium dependence • Outage no more than 8 hours per day	• Some natural pollutants • No manmade pollutants in water • Resource supply > demand • Resource conscience • Some waste curbing plans	• Sense of communal ownership exists • Some political rift • Some segregation or affirmative action • Women participate in central activities • Motivated leaders
C	• District-level regulation • Little governance structure, relies on District officers • No standards or legislation • No communication between agencies	• Low social capital • Basic schools exist • Apprenticeship in water management comes from agriculture experience	• Capable of operating low-level water technology • Maintains system without familiarity • Reliance network is farther than immediate neighbor	• Market exists • Maintains annual budget • Frequent corruption • Users pay towards system use, but collection rate is very low	• Primary source varies over course of day • Alternative source can only power lights • High dependence • Outage no more than 16 hours/day, predictable	• Some natural pollutants & manmade pollutants in water • Resource supply = demand • No resource conscience • No waste cleanup	• Little sense of communal ownership • High political rift • Heavy segregation or affirmative action • Women participate in menial activities • Leaders participate sometimes
D	• Little or no regulation • Little or no governance, relies on District intervention • No standards or legislation • NGO intervention seen as necessary	• Low social capital • Basic schools exist, but no teachers • Apprenticeship in water management comes from agriculture experience	• Operates low-level water technology without background • No system maintenance • Reliance network is farther than immediate neighbor	• No market • Uncertain budget • Frequent corruption • No collection of user fees • Low asset values • Investors wary, little entrepreneurship	• Primary source no more than 6 hours a day • No alternative • Very high outage, inconsistent and unpredictable	• High natural pollutants & manmade pollutants in water • Resource supply < demand • No resource conscience • No waste cleanup	• No sense of communal ownership • High political rift • Heavy segregation or affirmative action • Women do not participate • Poor leadership

Appendix V.D: Aggregate Community Capacity Grade – Voligonda Mandal

Grade	Institutional	Human Resources	Technical	Economic and Financial	Energy	Environmental and Ecological	Social and Cultural
A	• Strong local, Mandal, and District level regulation • Local governance, minimal supervision • Integrated government agencies • High legislative standards for water quality	• Heavy social capital • Several higher educational institutions • Training or mentoring facilities and programs • Illiterates trained as operators or caretakers	• Capable of complex water unit operations • Experts with tech maintenance • Reliance network is close to point of use • Source is nearby point of use	• Strong market • Maintains accurate budget • Very little corruption • Users pay towards system use	• Primary source powers groundwater pumps and filters • Alternative source capable of drawing groundwater • Low dependence • Very low outage	• No natural or manmade pollutants in water • High groundwater level, rainfall • High resource conscience • Waste and wastewater curbing plans	• Sense of communal ownership exists • Low political rift • No segregation or affirmative action necessary • Women are leaders, not just participators
B	• Strong Mandal & District level regulation • Local governance, Mandal supervision • Legislative standards • Communication between institutional agencies • NGO presence	• Medium Social capital • Few higher educational institutions • Illiterates trained as operators or caretakers	• Capable of operating medium-level water technology • Familiar with tech maintenance • Reliance network is in neighboring Mandal • Source is far from point of use	• Strong market • Maintains annual budget • Some corruption • Users pay towards system use, but collection rate is not high	• Primary source varies over course of day • Alternative source capable of drawing groundwater • Medium dependence • Outage no more than 8 hours per day	• Some natural pollutants • No manmade pollutants in water • Resource supply > demand • Resource conscience • Some waste curbing plans	• Sense of communal ownership exists • Some political rift • Some segregation or affirmative action • Women participate in central activities • Motivated leaders
C	• District-level regulation • Little governance structure, relies on District officers • No standards or legislation • No communication between agencies	• Low social capital • Basic schools exist • Apprenticeship in water management comes from agriculture experience	• Capable of operating low-level water technology • Maintains system without familiarity • Reliance network is farther than immediate neighbor	• Market exists • Maintains annual budget • Frequent corruption • Users pay towards system use, but collection rate is very low	• Primary source varies over course of day • Alternative source can only power lights • High dependence • Outage no more than 16 hours/day, predictable	• Some natural pollutants & manmade pollutants in water • Resource supply = demand • No resource conscience • No waste cleanup	• Little sense of communal ownership • High political rift • Heavy segregation or affirmative action • Women participate in menial activities • Leaders participate sometimes
D	• Little or no regulation • Little or no governance, relies on District intervention • No standards or legislation • NGO intervention seen as necessary	• Low social capital • Basic schools exist, but no teachers • Apprenticeship in water management comes from agriculture experience	• Operates low-level water technology without background • No system maintenance • Reliance network is farther than immediate neighbor	• No market • Uncertain budget • Frequent corruption • No collection of user fees • Low asset values • Investors wary, little entrepreneurship	• Primary source no more than 6 hours a day • No alternative • Very high outage, inconsistent and unpredictable	• High natural pollutants & manmade pollutants in water • Resource supply < demand • No resource conscience • No waste cleanup	• No sense of communal ownership • High political rift • Heavy segregation or affirmative action • Women do not participate • Poor leadership

Appendix V.E: Aggregate Community Capacity Grade – Mothkur Mandal

Grade	Institutional	Human Resources	Technical	Economic and Financial	Energy	Environmental and Ecological	Social and Cultural
A	• Strong local, Mandal, and District level regulation • Local governance, minimal supervision • Integrated government agencies • High legislative standards for water quality	• Heavy social capital • Several higher educational institutions • Training or mentoring facilities and programs • Illiterates trained as operators or caretakers	• Capable of complex water unit operations • Experts with tech maintenance • Reliance network is close to point of use • Source is nearby point of use	• Strong market • Maintains accurate budget • Very little corruption • Users pay towards system use	• Primary source powers groundwater pumps and filters • Alternative source capable of drawing groundwater • Low dependence • Very low outage	• No natural or manmade pollutants in water • High groundwater level, rainfall • High resource conscience • Waste and wastewater curbing plans	• Sense of communal ownership exists • Low political rift • No segregation or affirmative action necessary • Women are leaders, not just participators
B	• Strong Mandal & District level regulation • Local governance, Mandal supervision • Legislative standards • Communication between institutional agencies • NGO presence	• Medium Social capital • Few higher educational institutions • Illiterates trained as operators or caretakers	• Capable of operating medium-level water technology • Familiar with tech maintenance • Reliance network is in neighboring Mandal • Source is far from point of use	• Strong market • Maintains annual budget • Some corruption • Users pay towards system use, but collection rate is not high	• Primary source varies over course of day • Alternative source capable of drawing groundwater • Medium dependence • Outage no more than 8 hours per day	• Some natural pollutants • No manmade pollutants in water • Resource supply > demand • Resource conscience • Some waste curbing plans	• Sense of communal ownership exists • Some political rift • Some segregation or affirmative action • Women participate in central activities • Motivated leaders
C	• District-level regulation • Little governance structure, relies on District officers • No standards or legislation • No communication between agencies	• Low social capital • Basic schools exist • Apprenticeship in water management comes from agriculture experience	• Capable of operating low-level water technology • Maintains system without familiarity • Reliance network is farther than immediate neighbor	• Market exists • Maintains annual budget • Frequent corruption • Users pay towards system use, but collection rate is very low	• Primary source varies over course of day • Alternative source can only power lights • High dependence • Outage no more than 16 hours/day, predictable	• Some natural pollutants & manmade pollutants in water • Resource supply = demand • No resource conscience • No waste cleanup	• Little sense of communal ownership • High political rift • Heavy segregation or affirmative action • Women participate in menial activities • Leaders participate sometimes
D	• Little or no regulation • Little or no governance, relies on District intervention • No standards or legislation • NGO intervention seen as necessary	• Low social capital • Basic schools exist, but no teachers • Apprenticeship in water management comes from agriculture experience	• Operates low-level water technology without background • No system maintenance • Reliance network is farther than immediate neighbor	• No market • Uncertain budget • Frequent corruption • No collection of user fees • Low asset values • Investors wary, little entrepreneurship	• Primary source no more than 6 hours a day • No alternative • Very high outage, inconsistent and unpredictable	• High natural pollutants & manmade pollutants in water • Resource supply < demand • No resource conscience • No waste cleanup	• No sense of communal ownership • High political rift • Heavy segregation or affirmative action • Women do not participate • Poor leadership

Appendix V.F: Aggregate Community Capacity Grade – Choutuppal Mandal

Grade	Institutional	Human Resources	Technical	Economic and Financial	Energy	Environmental and Ecological	Social and Cultural
A	• Strong local, Mandal, and District level regulation • Local governance, minimal supervision • Integrated government agencies • High legislative standards for water quality	• Heavy social capital • Several higher educational institutions • Training or mentoring facilities and programs • Illiterates trained as operators or caretakers	• Capable of complex water unit operations • Experts with tech maintenance • Reliance network is close to point of use • Source is nearby point of use	• Strong market • Maintains accurate budget • Very little corruption • Users pay towards system use	• Primary source powers groundwater pumps and filters • Alternative source capable of drawing groundwater • Low dependence • Very low outage	• No natural or manmade pollutants in water • High groundwater level, rainfall • High resource conscience • Waste and wastewater curbing plans	• Sense of communal ownership exists • Low political rift • No segregation or affirmative action necessary • Women are leaders, not just participators
B	• Strong Mandal & District level regulation • Local governance, Mandal supervision • Legislative standards • Communication between institutional agencies • NGO presence	• Medium Social capital • Few higher educational institutions • Illiterates trained as operators or caretakers	• Capable of operating medium-level water technology • Familiar with tech maintenance • Reliance network is in neighboring Mandal • Source is far from point of use	• Strong market • Maintains annual budget • Some corruption • Users pay towards system use, but collection rate is not high	• Primary source varies over course of day • Alternative source capable of drawing groundwater • Medium dependence • Outage no more than 8 hours per day	• Some natural pollutants • No manmade pollutants in water • Resource supply > demand • Resource conscience • Some waste curbing plans	• Sense of communal ownership exists • Some political rift • Some segregation or affirmative action • Women participate in central activities • Motivated leaders
C	• District-level regulation • Little governance structure, relies on District officers • No standards or legislation • No communication between agencies	• Low social capital • Basic schools exist • Apprenticeship in water management comes from agriculture experience	• Capable of operating low-level water technology • Maintains system without familiarity • Reliance network is farther than immediate neighbor	• Market exists • Maintains annual budget • Frequent corruption • Users pay towards system use, but collection rate is very low	• Primary source varies over course of day • Alternative source can only power lights • High dependence • Outage no more than 16 hours/day, predictable	• Some natural pollutants & manmade pollutants in water • Resource supply = demand • No resource conscience • No waste cleanup	• Little sense of communal ownership • High political rift • Heavy segregation or affirmative action • Women participate in menial activities • Leaders participate sometimes
D	• Little or no regulation • Little or no governance, relies on District intervention • No standards or legislation • NGO intervention seen as necessary	• Low social capital • Basic schools exist, but no teachers • Apprenticeship in water management comes from agriculture experience	• Operates low-level water technology without background • No system maintenance • Reliance network is farther than immediate neighbor	• No market • Uncertain budget • Frequent corruption • No collection of user fees • Low asset values • Investors wary, little entrepreneurship	• Primary source no more than 6 hours a day • No alternative • Very high outage, inconsistent and unpredictable	• High natural pollutants & manmade pollutants in water • Resource supply < demand • No resource conscience • No waste cleanup	• No sense of communal ownership • High political rift • Heavy segregation or affirmative action • Women do not participate • Poor leadership

Appendix V.G: Aggregate Community Capacity Grade – Devarkonda Mandal

Grade	Institutional	Human Resources	Technical	Economic and Financial	Energy	Environmental and Ecological	Social and Cultural
A	• Strong local, Mandal, and District level regulation • Local governance, minimal supervision • Integrated government agencies • High legislative standards for water quality	• Heavy social capital • Several higher educational institutions • Training or mentoring facilities and programs • Illiterates trained as operators or caretakers	• Capable of complex water unit operations • Experts with tech maintenance • Reliance network is close to point of use • Source is nearby point of use	• Strong market • Maintains accurate budget • Very little corruption • Users pay towards system use	• Primary source powers groundwater pumps and filters • Alternative source capable of drawing groundwater • Low dependence • Very low outage	• No natural or manmade pollutants in water • High groundwater level, rainfall • High resource conscience • Waste and wastewater curbing plans	• Sense of communal ownership exists • Low political rift • No segregation or affirmative action necessary • Women are leaders, not just participators
B	• Strong Mandal & District level regulation • Local governance, Mandal supervision • Legislative standards • Communication between institutional agencies • NGO presence	• Medium Social capital • Few higher educational institutions • Illiterates trained as operators or caretakers	• Capable of operating medium-level water technology • Familiar with tech maintenance • Reliance network is in neighboring Mandal • Source is far from point of use	• Strong market • Maintains annual budget • Some corruption • Users pay towards system use, but collection rate is not high	• Primary source varies over course of day • Alternative source capable of drawing groundwater • Medium dependence • Outage no more than 8 hours per day	• Some natural pollutants • No manmade pollutants in water • Resource supply > demand • Resource conscience • Some waste curbing plans	• Sense of communal ownership exists • Some political rift • Some segregation or affirmative action • Women participate in central activities • Motivated leaders
C	• District-level regulation • Little governance structure, relies on District officers • No standards or legislation • No communication between agencies	• Low social capital • Basic schools exist • Apprenticeship in water management comes from agriculture experience	• Capable of operating low-level water technology • Maintains system without familiarity • Reliance network is farther than immediate neighbor	• Market exists • Maintains annual budget • Frequent corruption • Users pay towards system use, but collection rate is very low	• Primary source varies over course of day • Alternative source can only power lights • High dependence • Outage no more than 16 hours/day, predictable	• Some natural pollutants & manmade pollutants in water • Resource supply = demand • No resource conscience • No waste cleanup	• Little sense of communal ownership • High political rift • Heavy segregation or affirmative action • Women participate in menial activities • Leaders participate sometimes
D	• Little or no regulation • Little or no governance, relies on District intervention • No standards or legislation • NGO intervention seen as necessary	• Low social capital • Basic schools exist, but no teachers • Apprenticeship in water management comes from agriculture experience	• Operates low-level water technology without background • No system maintenance • Reliance network is farther than immediate neighbor	• No market • Uncertain budget • Frequent corruption • No collection of user fees • Low asset values • Investors wary, little entrepreneurship	• Primary source no more than 6 hours a day • No alternative • Very high outage, inconsistent and unpredictable	• High natural pollutants & manmade pollutants in water • Resource supply < demand • No resource conscience • No waste cleanup	• No sense of communal ownership • High political rift • Heavy segregation or affirmative action • Women do not participate • Poor leadership

Appendix V.H: Aggregate Community Capacity Grade – Huzurnagar Mandal

Grade	Institutional	Human Resources	Technical	Economic and Financial	Energy	Environmental and Ecological	Social and Cultural
A	• Strong local, Mandal, and District level regulation • Local governance, minimal supervision • Integrated government agencies • High legislative standards for water quality	• Heavy social capital • Several higher educational institutions • Training or mentoring facilities and programs • Illiterates trained as operators or caretakers	• Capable of complex water unit operations • Experts with tech maintenance • Reliance network is close to point of use • Source is nearby point of use	• Strong market • Maintains accurate budget • Very little corruption • Users pay towards system use	• Primary source powers groundwater pumps and filters • Alternative source capable of drawing groundwater • Low dependence • Very low outage	• No natural or manmade pollutants in water • High groundwater level, rainfall • High resource conscience • Waste and wastewater curbing plans	• Sense of communal ownership exists • Low political rift • No segregation or affirmative action necessary • Women are leaders, not just participators
B	• Strong Mandal & District level regulation • Local governance, Mandal supervision • Legislative standards • Communication between institutional agencies • NGO presence	• Medium Social capital • Few higher educational institutions • Illiterates trained as operators or caretakers	• Capable of operating medium-level water technology • Familiar with tech maintenance • Reliance network is in neighboring Mandal • Source is far from point of use	• Strong market • Maintains annual budget • Some corruption • Users pay towards system use, but collection rate is not high	• Primary source varies over course of day • Alternative source capable of drawing groundwater • Medium dependence • Outage no more than 8 hours per day	• Some natural pollutants • No manmade pollutants in water • Resource supply > demand • Resource conscience • Some waste curbing plans	• Sense of communal ownership exists • Some political rift • Some segregation or affirmative action • Women participate in central activities • Motivated leaders
C	• District-level regulation • Little governance structure, relies on District officers • No standards or legislation • No communication between agencies	• Low social capital • Basic schools exist • Apprenticeship in water management comes from agriculture experience	• Capable of operating low-level water technology • Maintains system without familiarity • Reliance network is farther than immediate neighbor	• Market exists • Maintains annual budget • Frequent corruption • Users pay towards system use, but collection rate is very low	• Primary source varies over course of day • Alternative source can only power lights • High dependence • Outage no more than 16 hours/day, predictable	• Some natural pollutants & manmade pollutants in water • Resource supply = demand • No resource conscience • No waste cleanup	• Little sense of communal ownership • High political rift • Heavy segregation or affirmative action • Women participate in menial activities • Leaders participate sometimes
D	• Little or no regulation • Little or no governance, relies on District intervention • No standards or legislation • NGO intervention seen as necessary	• Low social capital • Basic schools exist, but no teachers • Apprenticeship in water management comes from agriculture experience	• Operates low-level water technology without background • No system maintenance • Reliance network is farther than immediate neighbor	• No market • Uncertain budget • Frequent corruption • No collection of user fees • Low asset values • Investors wary, little entrepreneurship	• Primary source no more than 6 hours a day • No alternative • Very high outage, inconsistent and unpredictable	• High natural pollutants & manmade pollutants in water • Resource supply < demand • No resource conscience • No waste cleanup	• No sense of communal ownership • High political rift • Heavy segregation or affirmative action • Women do not participate • Poor leadership

Appendix V.I: Aggregate Community Capacity Grade – Marriguda Mandal

Grade	Institutional	Human Resources	Technical	Economic and Financial	Energy	Environmental and Ecological	Social and Cultural
A	• Strong local, Mandal, and District level regulation • Local governance, minimal supervision • Integrated government agencies • High legislative standards for water quality	• Heavy social capital • Several higher educational institutions • Training or mentoring facilities and programs • Illiterates trained as operators or caretakers	• Capable of complex water unit operations • Experts with tech maintenance • Reliance network is close to point of use • Source is nearby point of use	• Strong market • Maintains accurate budget • Very little corruption • Users pay towards system use	• Primary source powers groundwater pumps and filters • Alternative source capable of drawing groundwater • Low dependence • Very low outage	• No natural or manmade pollutants in water • High groundwater level, rainfall • High resource conscience • Waste and wastewater curbing plans	• Sense of communal ownership exists • Low political rift • No segregation or affirmative action necessary • Women are leaders, not just participators
B	• Strong Mandal & District level regulation • Local governance, Mandal supervision • Legislative standards • Communication between institutional agencies • NGO presence	• Medium Social capital • Few higher educational institutions • Illiterates trained as operators or caretakers	• Capable of operating medium-level water technology • Familiar with tech maintenance • Reliance network is in neighboring Mandal • Source is far from point of use	• Strong market • Maintains annual budget • Some corruption • Users pay towards system use, but collection rate is not high	• Primary source varies over course of day • Alternative source capable of drawing groundwater • Medium dependence • Outage no more than 8 hours per day	• Some natural pollutants • No manmade pollutants in water • Resource supply > demand • Resource conscience • Some waste curbing plans	• Sense of communal ownership exists • Some political rift • Some segregation or affirmative action • Women participate in central activities • Motivated leaders
C	• District-level regulation • Little governance structure, relies on District officers • No standards or legislation • No communication between agencies	• Low social capital • Basic schools exist • Apprenticeship in water management comes from agriculture experience	• Capable of operating low-level water technology • Maintains system without familiarity • Reliance network is farther than immediate neighbor	• Market exists • Maintains annual budget • Frequent corruption • Users pay towards system use, but collection rate is very low	• Primary source varies over course of day • Alternative source can only power lights • High dependence • Outage no more than 16 hours/day, predictable	• Some natural pollutants & manmade pollutants in water • Resource supply = demand • No resource conscience • No waste cleanup	• Little sense of communal ownership • High political rift • Heavy segregation or affirmative action • Women participate in menial activities • Leaders participate sometimes
D	• Little or no regulation • Little or no governance, relies on District intervention • No standards or legislation • NGO intervention seen as necessary	• Low social capital • Basic schools exist, but no teachers • Apprenticeship in water management comes from agriculture experience	• Operates low-level water technology without background • No system maintenance • Reliance network is farther than immediate neighbor	• No market • Uncertain budget • Frequent corruption • No collection of user fees • Low asset values • Investors wary, little entrepreneurship	• Primary source no more than 6 hours a day • No alternative • Very high outage, inconsistent and unpredictable	• High natural pollutants & manmade pollutants in water • Resource supply < demand • No resource conscience • No waste cleanup	• No sense of communal ownership • High political rift • Heavy segregation or affirmative action • Women do not participate • Poor leadership

Appendix V.J: Aggregate Community Capacity Grade – Miryalaguda Mandal

Grade	Institutional	Human Resources	Technical	Economic and Financial	Energy	Environmental and Ecological	Social and Cultural
A	• Strong local, Mandal, and District level regulation • Local governance, minimal supervision • Integrated government agencies • High legislative standards for water quality	• Heavy social capital • Several higher educational institutions • Training or mentoring facilities and programs • Illiterates trained as operators or caretakers	• Capable of complex water unit operations • Experts with tech maintenance • Reliance network is close to point of use • Source is nearby point of use	• Strong market • Maintains accurate budget • Very little corruption • Users pay towards system use	• Primary source powers groundwater pumps and filters • Alternative source capable of drawing groundwater • Low dependence • Very low outage	• No natural or manmade pollutants in water • High groundwater level, rainfall • High resource conscience • Waste and wastewater curbing plans	• Sense of communal ownership exists • Low political rift • No segregation or affirmative action necessary • Women are leaders, not just participators
B	• Strong Mandal & District level regulation • Local governance, Mandal supervision • Legislative standards • Communication between institutional agencies • NGO presence	• Medium Social capital • Few higher educational institutions • Illiterates trained as operators or caretakers	• Capable of operating medium-level water technology • Familiar with tech maintenance • Reliance network is in neighboring Mandal • Source is far from point of use	• Strong market • Maintains annual budget • Some corruption • Users pay towards system use, but collection rate is not high	• Primary source varies over course of day • Alternative source capable of drawing groundwater • Medium dependence • Outage no more than 8 hours per day	• Some natural pollutants • No manmade pollutants in water • Resource supply > demand • Resource conscience • Some waste curbing plans	• Sense of communal ownership exists • Some political rift • Some segregation or affirmative action • Women participate in central activities • Motivated leaders
C	• District-level regulation • Little governance structure, relies on District officers • No standards or legislation • No communication between agencies	• Low social capital • Basic schools exist • Apprenticeship in water management comes from agriculture experience	• Capable of operating low-level water technology • Maintains system without familiarity • Reliance network is farther than immediate neighbor	• Market exists • Maintains annual budget • Frequent corruption • Users pay towards system use, but collection rate is very low	• Primary source varies over course of day • Alternative source can only power lights • High dependence • Outage no more than 16 hours/day, predictable	• Some natural pollutants & manmade pollutants in water • Resource supply = demand • No resource conscience • No waste cleanup	• Little sense of communal ownership • High political rift • Heavy segregation or affirmative action • Women participate in menial activities • Leaders participate sometimes
D	• Little or no regulation • Little or no governance, relies on District intervention • No standards or legislation • NGO intervention seen as necessary	• Low social capital • Basic schools exist, but no teachers • Apprenticeship in water management comes from agriculture experience	• Operates low-level water technology without background • No system maintenance • Reliance network is farther than immediate neighbor	• No market • Uncertain budget • Frequent corruption • No collection of user fees • Low asset values • Investors wary, little entrepreneurship	• Primary source no more than 6 hours a day • No alternative • Very high outage, inconsistent and unpredictable	• High natural pollutants & manmade pollutants in water • Resource supply < demand • No resource conscience • No waste cleanup	• No sense of communal ownership • High political rift • Heavy segregation or affirmative action • Women do not participate • Poor leadership

Appendix V.K: Aggregate Community Capacity Grade – Nakrekal Mandal

Grade	Institutional	Human Resources	Technical	Economic and Financial	Energy	Environmental and Ecological	Social and Cultural
A	• Strong local, Mandal, and District level regulation • Local governance, minimal supervision • Integrated government agencies • High legislative standards for water quality	• Heavy social capital • Several higher educational institutions • Training or mentoring facilities and programs • Illiterates trained as operators or caretakers	• Capable of complex water unit operations • Experts with tech maintenance • Reliance network is close to point of use • Source is nearby point of use	• Strong market • Maintains accurate budget • Very little corruption • Users pay towards system use	• Primary source powers groundwater pumps and filters • Alternative source capable of drawing groundwater • Low dependence • Very low outage	• No natural or manmade pollutants in water • High groundwater level, rainfall • High resource conscience • Waste and wastewater curbing plans	• Sense of communal ownership exists • Low political rift • No segregation or affirmative action necessary • Women are leaders, not just participators
B	• Strong Mandal & District level regulation • Local governance, Mandal supervision • Legislative standards • Communication between institutional agencies • NGO presence	• Medium Social capital • Few higher educational institutions • Illiterates trained as operators or caretakers	• Capable of operating medium-level water technology • Familiar with tech maintenance • Reliance network is in neighboring Mandal • Source is far from point of use	• Strong market • Maintains annual budget • Some corruption • Users pay towards system use, but collection rate is not high	• Primary source varies over course of day • Alternative source capable of drawing groundwater • Medium dependence • Outage no more than 8 hours per day	• Some natural pollutants • No manmade pollutants in water • Resource supply > demand • Resource conscience • Some waste curbing plans	• Sense of communal ownership exists • Some political rift • Some segregation or affirmative action • Women participate in central activities • Motivated leaders
C	• District-level regulation • Little governance structure, relies on District officers • No standards or legislation • No communication between agencies	• Low social capital • Basic schools exist • Apprenticeship in water management comes from agriculture experience	• Capable of operating low-level water technology • Maintains system without familiarity • Reliance network is farther than immediate neighbor	• Market exists • Maintains annual budget • Frequent corruption • Users pay towards system use, but collection rate is very low	• Primary source varies over course of day • Alternative source can only power lights • High dependence • Outage no more than 16 hours/day, predictable	• Some natural pollutants & manmade pollutants in water • Resource supply = demand • No resource conscience • No waste cleanup	• Little sense of communal ownership • High political rift • Heavy segregation or affirmative action • Women participate in menial activities • Leaders participate sometimes
D	• Little or no regulation • Little or no governance, relies on District intervention • No standards or legislation • NGO intervention seen as necessary	• Low social capital • Basic schools exist, but no teachers • Apprenticeship in water management comes from agriculture experience	• Operates low-level water technology without background • No system maintenance • Reliance network is farther than immediate neighbor	• No market • Uncertain budget • Frequent corruption • No collection of user fees • Low asset values • Investors wary, little entrepreneurship	• Primary source no more than 6 hours a day • No alternative • Very high outage, inconsistent and unpredictable	• High natural pollutants & manmade pollutants in water • Resource supply < demand • No resource conscience • No waste cleanup	• No sense of communal ownership • High political rift • Heavy segregation or affirmative action • Women do not participate • Poor leadership

Appendix V.L: Aggregate Community Capacity Grade – Nalgonda Mandal

Grade	Institutional	Human Resources	Technical	Economic and Financial	Energy	Environmental and Ecological	Social and Cultural
A	• Strong local, Mandal, and District level regulation • Local governance, minimal supervision • Integrated government agencies • High legislative standards for water quality	• Heavy social capital • Several higher educational institutions • Training or mentoring facilities and programs • Illiterates trained as operators or caretakers	• Capable of complex water unit operations • Experts with tech maintenance • Reliance network is close to point of use • Source is nearby point of use	• Strong market • Maintains accurate budget • Very little corruption • Users pay towards system use	• Primary source powers groundwater pumps and filters • Alternative source capable of drawing groundwater • Low dependence • Very low outage	• No natural or manmade pollutants in water • High groundwater level, rainfall • High resource conscience • Waste and wastewater curbing plans	• Sense of communal ownership exists • Low political rift • No segregation or affirmative action necessary • Women are leaders, not just participators
B	• Strong Mandal & District level regulation • Local governance, Mandal supervision • Legislative standards • Communication between institutional agencies • NGO presence	• Medium Social capital • Few higher educational institutions • Illiterates trained as operators or caretakers	• Capable of operating medium-level water technology • Familiar with tech maintenance • Reliance network is in neighboring Mandal • Source is far from point of use	• Strong market • Maintains annual budget • Some corruption • Users pay towards system use, but collection rate is not high	• Primary source varies over course of day • Alternative source capable of drawing groundwater • Medium dependence • Outage no more than 8 hours per day	• Some natural pollutants • No manmade pollutants in water • Resource supply > demand • Resource conscience • Some waste curbing plans	• Sense of communal ownership exists • Some political rift • Some segregation or affirmative action • Women participate in central activities • Motivated leaders
C	• District-level regulation • Little governance structure, relies on District officers • No standards or legislation • No communication between agencies	• Low social capital • Basic schools exist • Apprenticeship in water management comes from agriculture experience	• Capable of operating low-level water technology • Maintains system without familiarity • Reliance network is farther than immediate neighbor	• Market exists • Maintains annual budget • Frequent corruption • Users pay towards system use, but collection rate is very low	• Primary source varies over course of day • Alternative source can only power lights • High dependence • Outage no more than 16 hours/day, predictable	• Some natural pollutants & manmade pollutants in water • Resource supply = demand • No resource conscience • No waste cleanup	• Little sense of communal ownership • High political rift • Heavy segregation or affirmative action • Women participate in menial activities • Leaders participate sometimes
D	• Little or no regulation • Little or no governance, relies on District intervention • No standards or legislation • NGO intervention seen as necessary	• Low social capital • Basic schools exist, but no teachers • Apprenticeship in water management comes from agriculture experience	• Operates low-level water technology without background • No system maintenance • Reliance network is farther than immediate neighbor	• No market • Uncertain budget • Frequent corruption • No collection of user fees • Low asset values • Investors wary, little entrepreneurship	• Primary source no more than 6 hours a day • No alternative • Very high outage, inconsistent and unpredictable	• High natural pollutants & manmade pollutants in water • Resource supply < demand • No resource conscience • No waste cleanup	• No sense of communal ownership • High political rift • Heavy segregation or affirmative action • Women do not participate • Poor leadership

Appendix V.M: Aggregate Community Capacity Grade – P.A.Pally

Grade	Institutional	Human Resources	Technical	Economic and Financial	Energy	Environmental and Ecological	Social and Cultural
A	• Strong local, Mandal, and District level regulation • Local governance, minimal supervision • Integrated government agencies • High legislative standards for water quality	• Heavy social capital • Several higher educational institutions • Training or mentoring facilities and programs • Illiterates trained as operators or caretakers	• Capable of complex water unit operations • Experts with tech maintenance • Reliance network is close to point of use • Source is nearby point of use	• Strong market • Maintains accurate budget • Very little corruption • Users pay towards system use	• Primary source powers groundwater pumps and filters • Alternative source capable of drawing groundwater • Low dependence • Very low outage	• No natural or manmade pollutants in water • High groundwater level, rainfall • High resource conscience • Waste and wastewater curbing plans	• Sense of communal ownership exists • Low political rift • No segregation or affirmative action necessary • Women are leaders, not just participators
B	• Strong Mandal & District level regulation • Local governance, Mandal supervision • Legislative standards • Communication between institutional agencies • NGO presence	• Medium Social capital • Few higher educational institutions • Illiterates trained as operators or caretakers	• Capable of operating medium-level water technology • Familiar with tech maintenance • Reliance network is in neighboring Mandal • Source is far from point of use	• Strong market • Maintains annual budget • Some corruption • Users pay towards system use, but collection rate is not high	• Primary source varies over course of day • Alternative source capable of drawing groundwater • Medium dependence • Outage no more than 8 hours per day	• Some natural pollutants • No manmade pollutants in water • Resource supply > demand • Resource conscience • Some waste curbing plans	• Sense of communal ownership exists • Some political rift • Some segregation or affirmative action • Women participate in central activities • Motivated leaders
C	• District-level regulation • Little governance structure, relies on District officers • No standards or legislation • No communication between agencies	• Low social capital • Basic schools exist • Apprenticeship in water management comes from agriculture experience	• Capable of operating low-level water technology • Maintains system without familiarity • Reliance network is farther than immediate neighbor	• Market exists • Maintains annual budget • Frequent corruption • Users pay towards system use, but collection rate is very low	• Primary source varies over course of day • Alternative source can only power lights • High dependence • Outage no more than 16 hours/day, predictable	• Some natural pollutants & manmade pollutants in water • Resource supply = demand • No resource conscience • No waste cleanup	• Little sense of communal ownership • High political rift • Heavy segregation or affirmative action • Women participate in menial activities • Leaders participate sometimes
D	• Little or no regulation • Little or no governance, relies on District intervention • No standards or legislation • NGO intervention seen as necessary	• Low social capital • Basic schools exist, but no teachers • Apprenticeship in water management comes from agriculture experience	• Operates low-level water technology without background • No system maintenance • Reliance network is farther than immediate neighbor	• No market • Uncertain budget • Frequent corruption • No collection of user fees • Low asset values • Investors wary, little entrepreneurship	• Primary source no more than 6 hours a day • No alternative • Very high outage, inconsistent and unpredictable	• High natural pollutants & manmade pollutants in water • Resource supply < demand • No resource conscience • No waste cleanup	• No sense of communal ownership • High political rift • Heavy segregation or affirmative action • Women do not participate • Poor leadership

Appendix V.N: Aggregate Community Capacity Grade – Naryanpur Mandal

Grade	Institutional	Human Resources	Technical	Economic and Financial	Energy	Environmental and Ecological	Social and Cultural
A	• Strong local, Mandal, and District level regulation • Local governance, minimal supervision • Integrated government agencies • High legislative standards for water quality	• Heavy social capital • Several higher educational institutions • Training or mentoring facilities and programs • Illiterates trained as operators or caretakers	• Capable of complex water unit operations • Experts with tech maintenance • Reliance network is close to point of use • Source is nearby point of use	• Strong market • Maintains accurate budget • Very little corruption • Users pay towards system use	• Primary source powers groundwater pumps and filters • Alternative source capable of drawing groundwater • Low dependence • Very low outage	• No natural or manmade pollutants in water • High groundwater level, rainfall • High resource conscience • Waste and wastewater curbing plans	• Sense of communal ownership exists • Low political rift • No segregation or affirmative action necessary • Women are leaders, not just participators
B	• Strong Mandal & District level regulation • Local governance, Mandal supervision • Legislative standards • Communication between institutional agencies • NGO presence	• Medium Social capital • Few higher educational institutions • Illiterates trained as operators or caretakers	• Capable of operating medium-level water technology • Familiar with tech maintenance • Reliance network is in neighboring Mandal • Source is far from point of use	• Strong market • Maintains annual budget • Some corruption • Users pay towards system use, but collection rate is not high	• Primary source varies over course of day • Alternative source capable of drawing groundwater • Medium dependence • Outage no more than 8 hours per day	• Some natural pollutants • No manmade pollutants in water • Resource supply > demand • Resource conscience • Some waste curbing plans	• Sense of communal ownership exists • Some political rift • Some segregation or affirmative action • Women participate in central activities • Motivated leaders
C	• District-level regulation • Little governance structure, relies on District officers • No standards or legislation • No communication between agencies	• Low social capital • Basic schools exist • Apprenticeship in water management comes from agriculture experience	• Capable of operating low-level water technology • Maintains system without familiarity • Reliance network is farther than immediate neighbor	• Market exists • Maintains annual budget • Frequent corruption • Users pay towards system use, but collection rate is very low	• Primary source varies over course of day • Alternative source can only power lights • High dependence • Outage no more than 16 hours/day, predictable	• Some natural pollutants & manmade pollutants in water • Resource supply = demand • No resource conscience • No waste cleanup	• Little sense of communal ownership • High political rift • Heavy segregation or affirmative action • Women participate in menial activities • Leaders participate sometimes
D	• Little or no regulation • Little or no governance, relies on District intervention • No standards or legislation • NGO intervention seen as necessary	• Low social capital • Basic schools exist, but no teachers • Apprenticeship in water management comes from agriculture experience	• Operates low-level water technology without background • No system maintenance • Reliance network is farther than immediate neighbor	• No market • Uncertain budget • Frequent corruption • No collection of user fees • Low asset values • Investors wary, little entrepreneurship	• Primary source no more than 6 hours a day • No alternative • Very high outage, inconsistent and unpredictable	• High natural pollutants & manmade pollutants in water • Resource supply < demand • No resource conscience • No waste cleanup	• No sense of communal ownership • High political rift • Heavy segregation or affirmative action • Women do not participate • Poor leadership

Appendix V.O: Aggregate Community Capacity Grade – Suryapet Mandal

Grade	Institutional	Human Resources	Technical	Economic and Financial	Energy	Environmental and Ecological	Social and Cultural
A	• Strong local, Mandal, and District level regulation • Local governance, minimal supervision • Integrated government agencies • High legislative standards for water quality	• Heavy social capital • Several higher educational institutions • Training or mentoring facilities and programs • Illiterates trained as operators or caretakers	• Capable of complex water unit operations • Experts with tech maintenance • Reliance network is close to point of use • Source is nearby point of use	• Strong market • Maintains accurate budget • Very little corruption • Users pay towards system use	• Primary source powers groundwater pumps and filters • Alternative source capable of drawing groundwater • Low dependence • Very low outage	• No natural or manmade pollutants in water • High groundwater level, rainfall • High resource conscience • Waste and wastewater curbing plans	• Sense of communal ownership exists • Low political rift • No segregation or affirmative action necessary • Women are leaders, not just participators
B	• Strong Mandal & District level regulation • Local governance, Mandal supervision • Legislative standards • Communication between institutional agencies • NGO presence	• Medium Social capital • Few higher educational institutions • Illiterates trained as operators or caretakers	• Capable of operating medium-level water technology • Familiar with tech maintenance • Reliance network is in neighboring Mandal • Source is far from point of use	• Strong market • Maintains annual budget • Some corruption • Users pay towards system use, but collection rate is not high	• Primary source varies over course of day • Alternative source capable of drawing groundwater • Medium dependence • Outage no more than 8 hours per day	• Some natural pollutants • No manmade pollutants in water • Resource supply > demand • Resource conscience • Some waste curbing plans	• Sense of communal ownership exists • Some political rift • Some segregation or affirmative action • Women participate in central activities • Motivated leaders
C	• District-level regulation • Little governance structure, relies on District officers • No standards or legislation • No communication between agencies	• Low social capital • Basic schools exist • Apprenticeship in water management comes from agriculture experience	• Capable of operating low-level water technology • Maintains system without familiarity • Reliance network is farther than immediate neighbor	• Market exists • Maintains annual budget • Frequent corruption • Users pay towards system use, but collection rate is very low	• Primary source varies over course of day • Alternative source can only power lights • High dependence • Outage no more than 16 hours/day, predictable	• Some natural pollutants & manmade pollutants in water • Resource supply = demand • No resource conscience • No waste cleanup	• Little sense of communal ownership • High political rift • Heavy segregation or affirmative action • Women participate in menial activities • Leaders participate sometimes
D	• Little or no regulation • Little or no governance, relies on District intervention • No standards or legislation • NGO intervention seen as necessary	• Low social capital • Basic schools exist, but no teachers • Apprenticeship in water management comes from agriculture experience	• Operates low-level water technology without background • No system maintenance • Reliance network is farther than immediate neighbor	• No market • Uncertain budget • Frequent corruption • No collection of user fees • Low asset values • Investors wary, little entrepreneurship	• Primary source no more than 6 hours a day • No alternative • Very high outage, inconsistent and unpredictable	• High natural pollutants & manmade pollutants in water • Resource supply < demand • No resource conscience • No waste cleanup	• No sense of communal ownership • High political rift • Heavy segregation or affirmative action • Women do not participate • Poor leadership

Appendix V.P: Aggregate Community Capacity Grade – Chandempet Mandal

Grade	Institutional	Human Resources	Technical	Economic and Financial	Energy	Environmental and Ecological	Social and Cultural
A	• Strong local, Mandal, and District level regulation • Local governance, minimal supervision • Integrated government agencies • High legislative standards for water quality	• Heavy social capital • Several higher educational institutions • Training or mentoring facilities and programs • Illiterates trained as operators or caretakers	• Capable of complex water unit operations • Experts with tech maintenance • Reliance network is close to point of use • Source is nearby point of use	• Strong market • Maintains accurate budget • Very little corruption • Users pay towards system use	• Primary source powers groundwater pumps and filters • Alternative source capable of drawing groundwater • Low dependence • Very low outage	• No natural or manmade pollutants in water • High groundwater level, rainfall • High resource conscience • Waste and wastewater curbing plans	• Sense of communal ownership exists • Low political rift • No segregation or affirmative action necessary • Women are leaders, not just participators
B	• Strong Mandal & District level regulation • Local governance, Mandal supervision • Legislative standards • Communication between institutional agencies • NGO presence	• Medium Social capital • Few higher educational institutions • Illiterates trained as operators or caretakers	• Capable of operating medium-level water technology • Familiar with tech maintenance • Reliance network is in neighboring Mandal • Source is far from point of use	• Strong market • Maintains annual budget • Some corruption • Users pay towards system use, but collection rate is not high	• Primary source varies over course of day • Alternative source capable of drawing groundwater • Medium dependence • Outage no more than 8 hours per day	• Some natural pollutants • No manmade pollutants in water • Resource supply > demand • Resource conscience • Some waste curbing plans	• Sense of communal ownership exists • Some political rift • Some segregation or affirmative action • Women participate in central activities • Motivated leaders
C	• District-level regulation • Little governance structure, relies on District officers • No standards or legislation • No communication between agencies	• Low social capital • Basic schools exist • Apprenticeship in water management comes from agriculture experience	• Capable of operating low-level water technology • Maintains system without familiarity • Reliance network is farther than immediate neighbor	• Market exists • Maintains annual budget • Frequent corruption • Users pay towards system use, but collection rate is very low	• Primary source varies over course of day • Alternative source can only power lights • High dependence • Outage no more than 16 hours/day, predictable	• Some natural pollutants & manmade pollutants in water • Resource supply = demand • No resource conscience • No waste cleanup	• Little sense of communal ownership • High political rift • Heavy segregation or affirmative action • Women participate in menial activities • Leaders participate sometimes
D	• Little or no regulation • Little or no governance, relies on District intervention • No standards or legislation • NGO intervention seen as necessary	• Low social capital • Basic schools exist, but no teachers • Apprenticeship in water management comes from agriculture experience	• Operates low-level water technology without background • No system maintenance • Reliance network is farther than immediate neighbor	• No market • Uncertain budget • Frequent corruption • No collection of user fees • Low asset values • Investors wary, little entrepreneurship	• Primary source no more than 6 hours a day • No alternative • Very high outage, inconsistent and unpredictable	• High natural pollutants & manmade pollutants in water • Resource supply < demand • No resource conscience • No waste cleanup	• No sense of communal ownership • High political rift • Heavy segregation or affirmative action • Women do not participate • Poor leadership