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Cost of Providing Sustainable Water, Sanitation and Hygiene (WASH) Services: An initial assessment of LCCA in Andhra Pradesh

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ABSTRACT

Water, sanitation and hygiene (WASH) services levels remain stubbornly low in rural India despite high levels of public expenditure during recent decades. In many areas, this is a result of service levels slipping back for reasons that include inadequate protection of water sources (both quantity and quality) and relatively more attention being given to capital expenditure than expenditure on operational and capital maintenance. Using information in the public domain and data from a pilot study, this paper argues that adoption of life-cycle cost approaches (LCCA) could play a significant role in rectifying this situation by providing a framework for identifying and plugging gaps in the present pattern of expenditure. It is argued also that LCCA will provide a sound basis for operationalising the WASH Guidelines released by the Rajiv Gandhi National Drinking Water Mission in 2009. These guidelines signal a commendable shift away from viewing the provision of WASH services as primarily an engineering challenge to one that requires activities that include source protection, institution building and long-term support, and pro-poor planning, all of which need to be budgeted for by WASH service providers and/or users. Preliminary findings indicate that LCCA can be used to assess the actual life-cycle costs of sustainable, equitable and efficient WASH services delivery. The challenge now is to investigate how best LCCA can be mainstreamed into WASH planning and other governance processes.

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* WASHCost is an action research project supported by IRC, The Netherlands in four countries (India, Ghana, Mozambique and Burkino Faso). The five-year WASHCost project (2008-2012) aims at improving sustainability, cost efficiency and equity of WASH service delivery in rural and peri-urban areas by identifying the factors influencing costs at each stage of the WASH service delivery life cycle. The WASHCost project proposes to play a lead role in bringing about the transformation, working with Local and National Governments, resource centres, academic institutions, NGOs and international organizations in rural and peri-urban areas. For more information see www.washcost.info.

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I Background

Despite apparently huge investments in India (more than $ 27,625 million[1] in the last 60 years) (GoI, 2008)and numerous policy promises, the objective of providing access to water and sanitation to the entire population has yet to be achieved. According to Government publications 94 percent of the rural population in India have access to safe drinking water through 4 million hand pumps and 0.2 million-piped water schemes (GoI, 2008). In the case of the urban population the coverage is believed to be about 91 percent. However, the systems often provide irregular and scanty water supplies at the point of use. Besides, the appalling sanitation conditions in most rural and peri-urban areas are unacceptable and cause severe health hazards (Reddy and Dev, 2006).

Problems are compounded due to poor efficiency of the systems. A recent study of World Bank (2008) clearly brings out the inefficiencies in drinking water systems across states in India. Systems are often run below the designed capacities in terms of length of service (supply hours) and quantity of water supplied. While the need for financial sustainability is widely recognised (Reddy, 2010), until recently resource and asset sustainability has received less attention at the policy level. As a result, the costs of providing water do not take account of the source protection or of system rehabilitation costs while calculating the unit costs. In the absence of appropriate costing and subsequently limited investments in the water and sanitation sector, slippage has become a common phenomenon (Reddy, et. al., 2009). That is service levels deteriorate or fluctuate between *full coverage* and *partial coverage* or unsafe resource situations. Costing of water and sanitation schemes do not include cost components like source protection, capital maintenance, etc that ensure sustainability of service delivery.

The latest guidelines (GoI, 2009) recognise the importance of source sustainability by allocating 20 percent of the allocated funds to source protection mechanisms. The guidelines emphasise the shift away from the conventional normative approach of ser-

[1] These figures are summation over years in current prices. Given the purchasing power parity index of INR vs US$ the value of these investments is six time more.

vice levels measured in litres per capita per day (LPCD) and move towards water security at the household level which includes equity aspects and the development of village and district water security plans (GoI, 2009). In order to ensure water security across locations and socioeconomic groups, water quality (20 percent), operation and maintenance (10 percent) and impacts of natural calamities / climate change (5 percent) get substantial allocations (within the given budget) along with increased supply or access (38 percent). These are guidelines for the new projects to be implemented with the support from central as well as state funding.

The guidelines propose the devolution of resources and responsibilities to local bodies (GPs) whereas the line departments would play a facilitating role. While the guidelines propose to address some of the critical issues in the sector, operationalising them remains a question mark.

At the implementation level these allocations need to be disaggregated in to different components to deal with locational specificities instead of providing blanket allocations for source sustainability along with access. That is, the present structure of costing, which is infrastucture focused, needs to be altered in order to ensure sustainable service delivery. These allocations and other aspects of the guidelines need to be mainstreamed into WASH governance processes that involve active stakeholder participation and take explicit account of the specific challenges of improving and maintaining WASH service levels in any given habitation or area.

This paper describes the LCCA concept and associated methodology and illustrates how it can be used by analysing data from a pilot study in three habitations in Andhra Pradesh. Some preliminary findings are presented that will be investigated further as LCCA is used to analyse data as part of a much larger ongoing study.

II Concepts and Framework

Life-cycle Cost Approach (LCCA)

The terminology used to describe LCCA is defined in Box 1. Life-cycle costs (LCC) represent the aggregate costs of ensuring delivery of adequate, equitable and sustainable WASH services to a population in a specified area. These costs include the construction and maintenance of systems in the short and longer term, taking into account the need for hardware and software, operation and maintenance, the cost of capital, source protection, and the need for direct and indirect support, including training, planning and institutional pro-poor support. The delivery of sustainable services also requires that financial systems are in place to ensure that infrastructure can be replaced at the end of its useful life and to extend delivery systems in response to increases in demand (Lundin, 2002).

Box1. LCCA terminology

Life-cycle costs (LCC) *represent the aggregate costs of ensuring delivery of adequate, equitable and sustainable WASH services to a population in a specified area*

Life-cycle costs approaches (LCCA) *seek to raise awareness of the importance of life-cycle costs in achieving adequate, equitable and sustainable WASH services delivery, to make reliable cost information readily available to service providers and users and to mainstream the use of LCC in WASH governance processes at every level.*

Sustainability *means environmental, institutional, social and financial sustainability. Environmental sustainability mainly deals with source protection and safety in the long run (10-15 years).*

Equity *means service delivery to poor, marginalized and unreached sections of the community. That is ensuring equity in access and delivery through appropriate system designing and institutional arrangements.*

Cost efficiency *means provision of WASH services in most cost effective manner. That is investments are optimum and ensure value for money*

WASH slippage *is defined as the occurrence of a certain level of WASH services that has fallen back in a defined period of time to a lower level of services.*

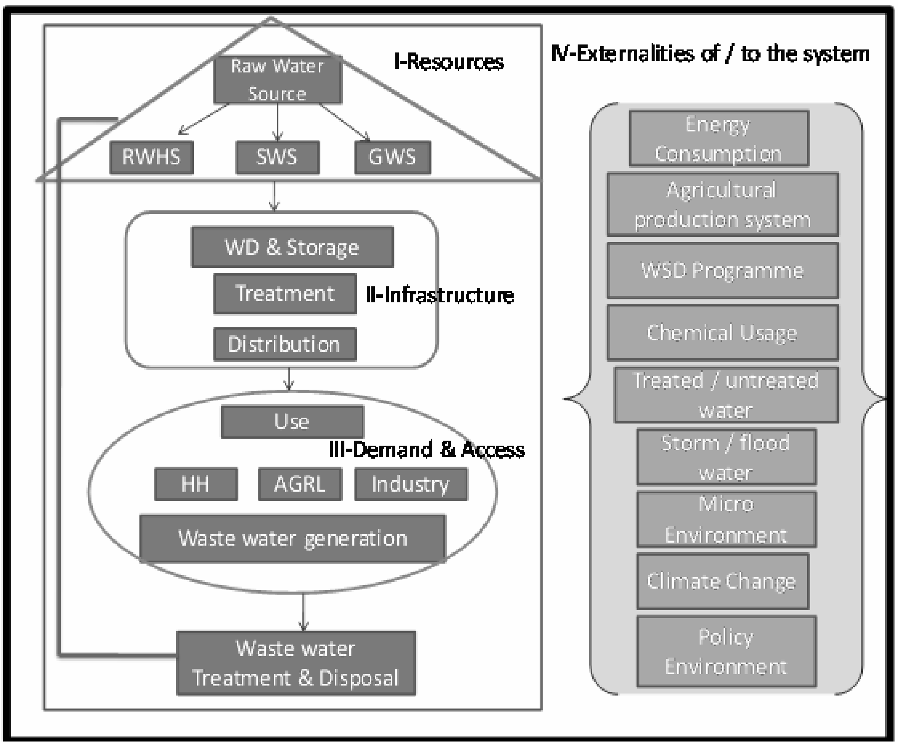
Collecting and understanding these costs is a primary aim of the WASHCost project. However, the LCCA goes beyond achieving the technical ability to quantify and make costs readily available. The LCCA seeks to influence sector understanding of why life-cycle costs assessment is central to improved service delivery and to influence the behaviour of sector stakeholders, so that life-cycle unit costs are mainstreamed into WASH governance processes at all institutional levels from local to national to international. WASHCost therefore aims to increase the ability and willingness of decision makers (both users and those involved in service planning, budgeting and delivery) to make informed and relevant choices between different types and levels of WASH service. A significant element of the LCCA is an understanding that costs can only be compared and properly assessed when they are related to particular levels of service. WASHCost specifically aims to draw attention to the LCC of pro-poor WASH services delivery, including water for small-scale productive uses.

LCCA can also be described as a comprehensive tool that is often used in project evaluation, especially in the context of environmental sustainability of various investments leading to products or services. Though the basic principles of LCCA are nearly a century old its systematic use is only about 25-30 years old (Salem, 1999). LCCA is an economic assessment or project appraisal tool that can be applied at any phase of the project life-cycle. LCCA takes the whole chain and spread of activities including the externalities . Such a systems perspective is valid not only for the environmental dimension but also for social and economic dimensions (Salem, 1999). Despite its comprehensiveness and usefulness in project design, its level of use is quite low, even in developed countries like the USA (Arditi and Messiha, 1996 as quoted in Salem, 1999).

Table 1: Life-cycle cost components of WASH Services

Cost Component	**Resources:** Costs involved for sustainable provision of water resources of required quantity and quality. Also includes the costs of source protection and developing and implementing. Costs involved to protect water resources from disposal of black and grey waste water and storm water.	**Infrastructure:** Costs incurred by service providers when constructing, operating and maintaining water supply and sanitation infrastructure	**Demand/Access:** Costs incurred by users (domestic, municipal, commercial, industrial, MUS, livestock etc) who routinely access / utilise formal, informal and private water supply systems / sanitation services to meet normal demands.
CapEx: Capital expenditure on both hardware and software	Water supply and Sanitation	Water supply and Sanitation	Water supply, Sanitation and Hygiene
OpEx: Operation costs including minor maintenance	Water supply and Sanitation	Water supply and Sanitation	Water supply, Sanitation and Hygiene
CapManEx: Capital management expenditure on renewal and rehabilitation	Water supply and Sanitation	Water supply and Sanitation	Water supply, Sanitation and Hygiene
CoC: Cost of capital	Water supply and Sanitation	Water supply and Sanitation	Water supply, Sanitation and Hygiene
ExDS: Expenditure on Direct support (e.g. IEC, support to PRIs, household expenditure, etc)	Water supply, Sanitation and Hygiene	Water, supply Sanitation and Hygiene	Water supply, Sanitation and Hygiene
IDSCost: Indirect support costs (e.g. governance overhead costs, etc)	Water supply, Sanitation and Hygiene	Water supply, Sanitation and Hygiene	Water supply, Sanitation and Hygiene

Chart 1: LCCA System Boundaries for Rural Water Supplies



Source: Adopted with modification from Lundin (2002)

Life-cycle costs could also be presented in the RIDA (Resources, Infrastructure and Demand / Access) format for better clarity and understanding, especially among policy groups. Various cost components are defined and grouped under different categories. The costing structure, thus is more comprehensive than the standard costing used in calculating the unit costs at the department level (Table 1). On the other hand, the RIDA format simplifies it. In fact, RIDA could be seen as a critical sub-set of LCCA (Chart 1).

The comprehensive nature of LCCA's makes it necessary to define the system boundaries. The choice of system boundaries depends on the nature and type of project (for a review see Lundin, 2002). The life-cycle (or functional) boundaries define the processes to be included in the system *i.e.,* where upstream and downstream cut-offs are set. For the rural water systems four sets / levels of system boundaries can be identified (Chart 1). Resource boundaries (level 1) are defined to ensure source sustainability and the aim to provide sustainable service delivery. The assessment at this level helps in understanding potential environmental benefits / costs and understanding environmental sustainability of a water system.

The second set of system boundaries pertains to infrastructure usually linked to the management agency or service provider. This offers a more complete view of the system in terms of technologies, design efficiencies, planning (viz., recognising that increased household water supply leads to increased volumes of wastewater), etc. Often the agencies, though aware, are usually constrained by financial and legislative obligations and tend to override options that allow a move towards environmental sustainability. Such a perspective may limit the potential of the agency to identify major environmental impacts or improvements through the life cycle. The third set deals with the demand / access issues that are often dealt with at the community / institutional / household. These pertain to access, competing demands (domestic, agriculture, industry, etc), water use practices, sanitation and hygiene practices, etc. Often this set gets marginal attention, if not ignored, at the project planning level. This set reflects and determines the adoptability to the system in terms of capacities (technologies), affordability (finance), awareness (quality, health, etc), attitudes (cultural), etc. The fourth set represents the externalities and/or drivers of the system that are closely linked and surrounding the main system but beyond the scope of the present study as capturing of these aspects is complex.

Components of Life Cycle Cost Model:

A fully developed life-cycle cost model will include various components that represent resources, infrastructure and demand / access sets. The cost components include not only the construction and operational costs but also the asset renewal, financing and indirect costs such IEC (Information, Education and Communication). The basic LCCA functional form includes the following components.

$$[LCC]_{th} = f\{ [CapExhw]_{th};\ [CapExsw]_{th};\ [CapManEx]_{th};\ [CoC]_{th};\ [ExDS]_{th};\ [\ [Ex$$

—1

Where;

LCC_{th}	=	Life-cycle costs of WASH services in year t and habitation h.
$CapExhw_{th}$	=	Capital expediture on hardware (initial construction cost) in year t and habitation h.
$CapExsw_{th}$	=	Capital Expenditure on software in year t and habitation h.
$CapManEx_{th}$	=	Capital management expenditure (rehabilitation cost) in year t and habitation h
CoC_{th}	=	Cost on capital in year t and habitation h
$ExDS_{th}$	=	Direct support costs in year t and habitation h
$ExIDS_{th}$	=	Indirect support costs in year t and habitation h
$OpEx_{th}$	=	Annual operation and maintenance cost in year t and habitation h.

These costs are essential to ensure WASH service delivery in the short to medium run. However, some of these costs are difficult to quantify, especially the direct and indirect costs. All the expenditures, except OpEx, are cumulative over the years and hence these costs are summation over the years i.e., from the beginning of the scheme till the latest year (2008) or for the time period chosen for the assessment. Here we are assessing the costs that have occurred over a period of time for providing the present level of services. As these investments took place in the past we need to arrive at the present value of these investments in order to make the investments comparable with the investments in new schemes, especially in those where life-cycle assessment is adopted. Accordingly, equation 1 can be written as:

$$[\![LCC]\!]_{th} = f\{pvf([\![\mathrm{CapExhw}]\!]_{th};\ [\![\mathrm{CapExsw}]\!]_{th};\ [\![\mathrm{CapManEx}]\!]_{th};\ [\![\mathrm{CoCap}]\!]_{th};\ [\![\mathrm{DsCost}]\!]_{th};$$
–2

Where; pvf = Present or real value factor at time t and in habitation h.

r	=	rate of inflation.
t	=	time period.

The published rate of inflation for each year is the appropriate means for estimating the present or real value. Other alternatives like effective interest rate (rate of interest-inflation), etc., could also be used. Once the whole life costs are estimated, unit costs and annualised costs can be worked out using the population, household, etc., at the habitation level[2] .

III Description of Pilot Study

Methods and tools

It is argued that the applicability of LCCA in water and sanitation projects is limited in scope in the context of developing countries, as the all pervasive social and political drivers are not adequately considered in the present LCCA tools (McConville, 2006). LCCA is also data intensive, often making it difficult to use for development work. In this paper, we argue to the contrary (i.e. that LCCA can and should also be used effectively in a developmental context and we demonstrate that sufficient data can be obtained at least in India). A life-cycle evaluation of development projects must incorporate diverse factors in a practical manner with a judicious mix of quantitative and qualitative tools.

[2] Another element could be the risk based LCCA.This eliment though relavent for WASH sector, we are not using it in the present paper due to the small sample (See Reddy, et. al., 2010).

The present study proposes a combination of natural, socio, economic and political aspects that influence WASH service delivery over the life stages of the schemes. This could be achieved through a combination of methods and tools for understanding the dynamics of service delivery.

As a first step a number of well-proven tools were adapted and tested in the sample habitations on a pilot basis. The sample habitations were selected on the basis of agro-climatic zones in Andhra Pradesh, as these zones reflect the natural criteria like rainfall, water quality, water source and scarcity to a large extent. A stratified sampling design has been adopted in each of the nine Agro Climatic Zones. Habitation is considered as a sampling unit for the survey. Depending upon the status of WASH (Water, Sanitation and Hygiene) services, each habitation is classified by the Department of Rural Water Supply and Sanitation (RWSS) as Fully Covered (FC), Partially Covered (PC) or Not Safe Source (NSS). The three sample habitations namely, Tekulapalle, Ankushapur and Malreddyguda are located in Ranga Reddy District of South Telangana Agro climatic zone of Andhra Pradesh. These three habitations represent each of the three WASH service status of FC, PC and NSS. As the project is scaled up, more variety of habitations like surface water sources, multi village schemes, etc will be covered.

Both qualitative and quantitative research tools were used to elicit information at secondary as well as primary levels. Qualitative and quantitative methods were used as complements rather than substitutes. For this purpose number of formats and check lists were used. Qualitative methods such as Rapid Rural Appraisal (RRA), Qualitative Information Systems (QIS), etc., were adopted in particular to elicit from the WASH service users. Quantitative information was collected from the Department, Gram Panchayat, Households, Communities, key informants, etc., and ground truthed, updated and gap-filled as necessary.

Two formats were used to collect information on expenditure or costs associated with resources and infrastructure over the years from the Department and the village Panchayat. The expenditure on direct support (ExDS) and indirect support (ExIDS) were also gathered from the records. Further the Operation and Maintenance costs incurred by the department as well as the Panchayat were gathered from the records at the district and habitation level. At the Panchayat level Focused Group Discussions (FGDs) were held to track information (keeping the secondary data as background) on WASH services specifically focusing on: (1) particulars of drinking water scheme (s); (2) details of household connections; (3) historical data on source(s); (4) Operation and Maintenance costs, etc. A rapid survey was conducted using a questionnaire covering the entire population covering the information pertaining to religion, population, educational status, availability of WASH facilities. The field work was carried out over a period of three months from December 2008 till February 2009.

Description of the sample habitations

The three study villages were located in rural areas of Ranga Reddy District approximately between 40-75 kms from Hyderabad. Malreddyguda is the smallest village followed by Tekulapalle and Ankushapur. The social composition indicated[3] that backward communities dominate in all the sample habitations. Tekulapalle has the highest proportion of scheduled caste population followed by Ankushapur. There is only one SC family in Malreddyguda. The average household size is 4.2 that ranges from 4.5 in Tekulapalle to 3.9 in Malreddyguda. The proportion of female population ranges between 47 and 50 percent. Average household income ranges between Rs. 12557 (US$250) in Malreddyguda to Rs. 32066 (US$ 640) in Tekulapalle. More than 80 percent of the households are poor (below Rs. 20000 per year) in Ankushapur and Malreddyguda while 49 percent in Tekulapalle fall under this category. But, in Ankushapur the households are wealthy, as the land prices have gone up substantially in recent years and most of the households received large amounts through selling their lands. However this was not counted as annual income. Literacy levels in the habitations are comparable with the state average i.e., about 60 percent. However, the proportion of population that moves beyond school education is less than 16 percent. Dropout rates are quite high in all the habitations due to poor economic status, non availability of the schools, household responsibilities or economic compulsions, etc. Educational institutions like anganwadi, primary and secondary Schools are functioning in all the sample habitations.

Livestock is another important component of domestic water demand in the rural areas. In all the habitations the magnitude of livestock is on the decline over a period of time due to shortage of labour, non availability of fodder and gradual shift to mechanization of agriculture. Livestock depends more on village water supply system for drinking water especially during summer months.

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[3] Social composition mainly consists of SC; BC and OC communities. SC= Scheduled caste. These communities are at the lowest rung of the social ladder and have constitutional provision of reservations in educational institutions and public sector jobs (15 percent). BC= Backward castes. These communities are at the middle of the social ladder. These communities have reservation in educational institutions and public sector jobs. However, the extent of reservation varies from state to state depending on the proportion of the community in the state population. OC = Other Castes. These are at the highest rung of the social ladder.

Status of Water and Sanitation in the three study areas

Groundwater is the main source of drinking water in all the habitations and source sustainability is a major problem. All the habitations depend on multiple sources like open wells, hand pumps, bore wells, public stand posts, private taps, etc (Table 2). All these sources are included in the cost estimates. The general coverage or access to public water distribution infrastructure is fairly good though the quality of infrastructure is poor. There are different delivery systems such as open wells, hand pumps, public stand posts and house connections that have been constructed over a period of time. Box 2 presents the time line of system construction during the last three decades for one of the study areas, namely, Ankushapur.

Table 2: Type and Number of Water Sources in the Sample Habitations

Name of the Habitation	No. of HH	Open wells	Hand pumps	Public stand posts	OHSR/ Sump	Household Connections
Tekulapalle	550	4	11	19	1 + 1 sump	232 (42)
Ankushapur	520	4	15	53	1+2 sumps	460 (88)
Malreddyguda	175	3	6	14	1	27 (15)

Note: Figures in brackets are the respective percentages to the total households.

Source: Based on the information collected from the sample habitations.

Despite continuous capital expenditure on WASH infrastructure (as illustrated in Box 2)[4] water services are not reliable, especially during the summer period, in some of the habitations as there is severe water shortage in Malreddyguda and Tekulapalle (Fig. 1). These investments are were made mainly to deal with population expansion, improved service levels and rehabilitation and capital management. Ankushapur has 88 percent coverage in terms of house connections followed by Tekulapalle (42 percent) and Malreddyguda (15 percent). Hand pumps are the predominant source in Malreddyguda. In Tekulapalle more than 20 percent of the households depend on other sources like ponds, streams, etc. Sometimes the villagers go even to agricultural wells for fetching water. Reasons for low coverage in Malreddyguda can be attributed to the non safe source (water is used only for other domestic purposes) and the poor economic conditions, while in Tekulapalle the service levels are so poor that even the households having connections do not receive adequate water due to pressure problems discouraging other members to go for household connections. In Ankushapur most of the stand posts are removed and the panchayat is encouraging the households to go for individual tap connections.

[4] We have presented the time line for one habitation only to save space.

Box 2: Time Line of WASH Investments (CapEX and CapManEx): Ankushapur

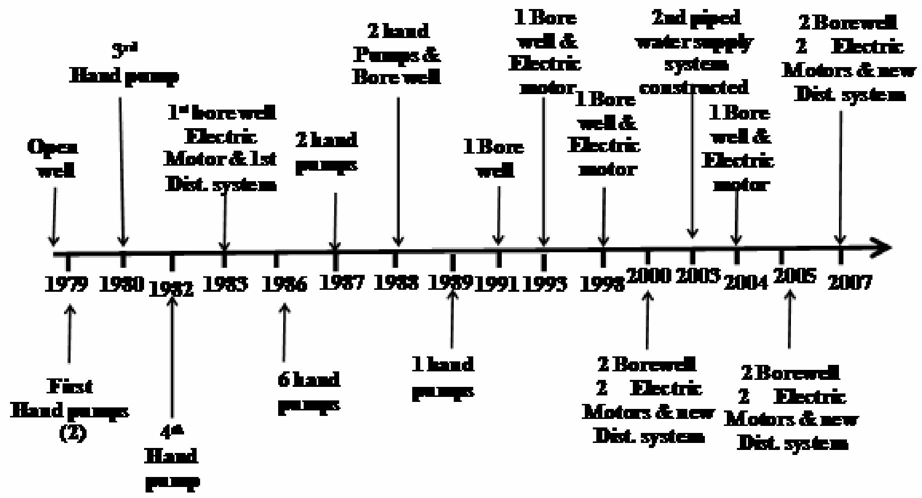
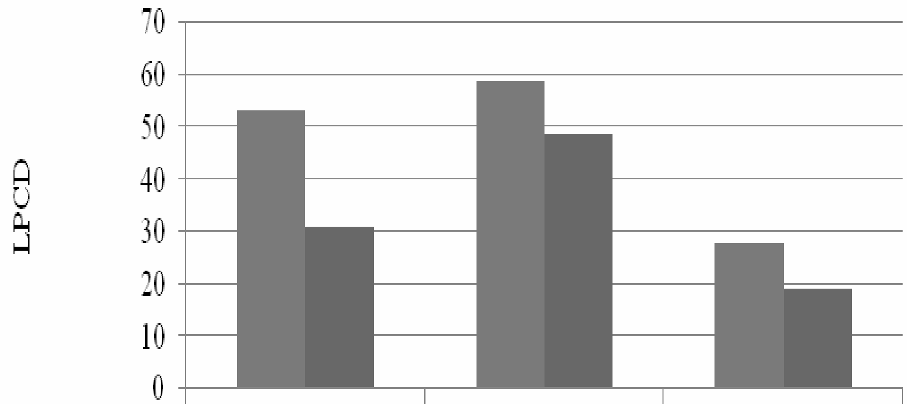


Figure 1: Per Capita Water Use (all sources) during Summer and Non-Summer Months in the sample Habitations

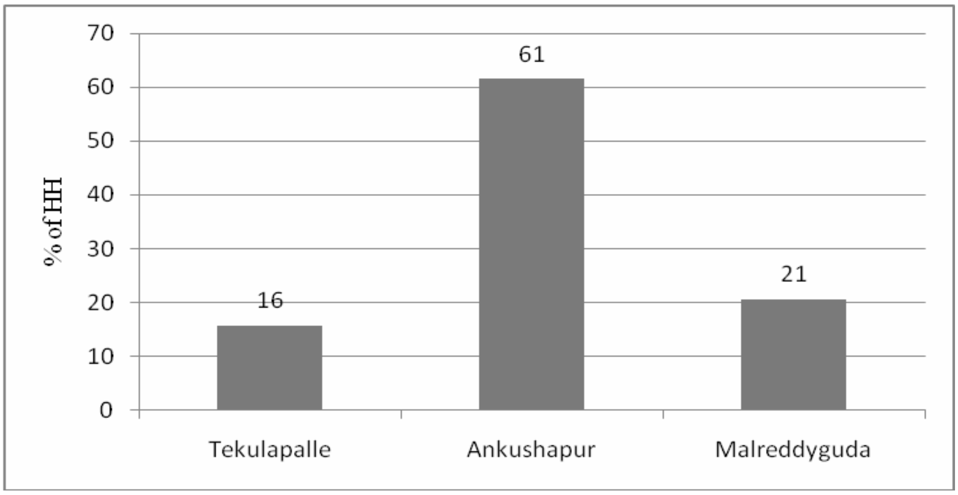


	Tekulapalle	Ankushapur	Malreddyguda
Summer	53	59	28
Non-summer	31	49	19

Source: Based on the rapid survey of the households in the Habitations

Sanitation and Hygiene:
Sanitation and hygiene practices in the sample habitations revealed that households having individual sanitary latrines (ISLs) vary between 61 percent in Ankushapur to 16 percent in Tekulapalle (Fig. 2). These toilets were mostly constructed with Government subsidy. Despite the subsidy and awareness provided through the Govt programmes sanitation is poor and requires intensive efforts both from Government and community side. In Malreddyguda, lack of space within the house is one of the reasons for not constructing the latrines while in Tekulapalle awareness levels are so low that the constructed toilets are not being used. Ankushapur is relatively better, as majority of the households have toilets and they are using them too.

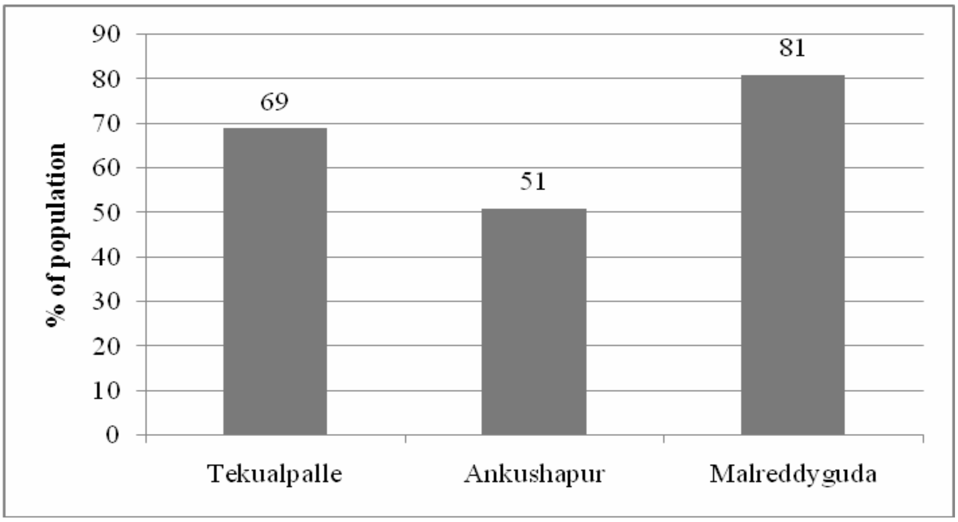
Figure 2: Percentage of Households with Sanitation Facility in the Sample Habitations



Source: Based on the rapid survey of the households in the Habitations.

The sanitary latrines in Ankushapur were in good condition and they are being used by most of the households. Whereas in Malreddyguda only 44 percent of the latrines are in good condition and majority of these are not in use. Most of the toilets in Malreddyguda are used for storing fodder or fuel wood and in some cases for bathing. Despite the availability of water in the majority of the latrines in all the sample habitations their use is low in Malreddyguda and Tekulapalle. This could be attributed to low awareness and cultural practices. Of the respondents who are using, women and children use toilets more often when compared to men in all the survey areas. Men, women and children reported washing their hands after every use of toilets either with soap or ash/dust or other materials.

Figure 3: Proportion of people using Open Defecation in the sample Habitations



Source: Based on the rapid survey of the households in the Habitations.

Open defecation is high (81 percent) in Malreddyguda and lower (51 percent) in Ankushapur (Fig. 3). Except in Ankushapur, as per the perceptions of the people, open defecation is a common practice. In Tekulapalle an adolescent girl died due to electric shock when she went to defecate in a farmer's field. Similarly in Malreddyguda three old age persons died while defecating on road side due to accidents. Despite these incidents open defecation is common and the reasons for non-construction of toilets were non availability of space to construct, lack of water and non affordability, etc. The extent of open defecation is marginally higher among male members when compared to women and children in all the sample habitations (WASHCost India, 2009).

V Provision of Sustained Water and Sanitation: Costs and Constraints

The sample habitations, as mentioned earlier, represent three different water supply status officially viz., fully covered (FC: Tekulapalle), partially covered (PC: Ankushapur) and not safe source (NSS: Malreddyguda). The time span of the schemes also vary across the habitations, i.e., between 30 and 39 years (see Box 2). Timelines of WASH capital expenditure (CapEx) in the three habitations indicates that the pattern and frequency of capital expenditure vary across habitations. Ankushapur has more infrastructure when compared to Tekulapalle, given that both are of similar size. The investments in Malreddyguda are not only less dense but also old when compared to other two habitations. Both Ankushapur and Tekulapalle have some recent and new investments. These investments, though frequent, are ad hoc and irregular.

As this capital expenditure took place in the past, the present value of these investments is estimated using the average inflation rate during the last 30-40 years. The average inflation rate is estimated at 7 percent per year. The present value of the investments in the water supply segment includes all the investments that have been made in the villages over the period from the date of initiating the water supply scheme in the respective villages. The disaggregate costs include number of components and all of them, except the expenditure on indirect support (ExIDS) are estimated for all the three habitations[5] . These components are grouped under the broad categories of life cycle costs viz., CapEx hardware, CapEx software, CapManEx, Cost of capital, OpEx, Indirect and direct support costs, etc. It may be noted some of the costs like cost of capital are not available from the water supply and sanitation department. A review of budget documents indicated that no direct loans were taken by the department, though there is a possibility that the State budget allocations include borrowed money. It was reported by the RWSS officials that about 15 percent of the budget allocations to the department are from borrowed funds. Therefore we have used this assumption at the habitation level. The interest rate on the borrowed capital is also assumed at 6.25 percent, which is the interest rate charged by the housing development corporation (HUDCO), the major fancier of WASH projects in rural areas. It is difficult to separate out the indirect support costs like expenditure on general departmental activities, as there are no separate budget heads for these overhead costs. Hence the proportion of budgetary allocations towards the national and state level institutions (including planning commission, premier research institutions, etc) could be taken as expenditure on indirect support. These cost estimates are being worked out and hence not included in the present case. The life-cycle costs are estimated on per household (using present number of households) basis for the entire span of the systems, i.e., depending on the time span of the scheme the actual costs are cumulated over 30 years, 35 years and 39 years respectively for Tekulapalle, Ankushapur and Malreddyguda. Note that these estimates include the household level expenditure on buying water and time spent on fetching water but they do not include the household level investments on private overhead tanks, motors, bore wells, etc due to the absence of accurate data. These investments range between US$ 1-1000[6] .

Per household costs (investments) of water supply range between US $306 (Rs. 15300) and US$361 (Rs. 18050) among the test bed habitations (Fig. 4). When these costs are annualised over 30 years period Tekulapalle, which is a fully covered habitation (officially),

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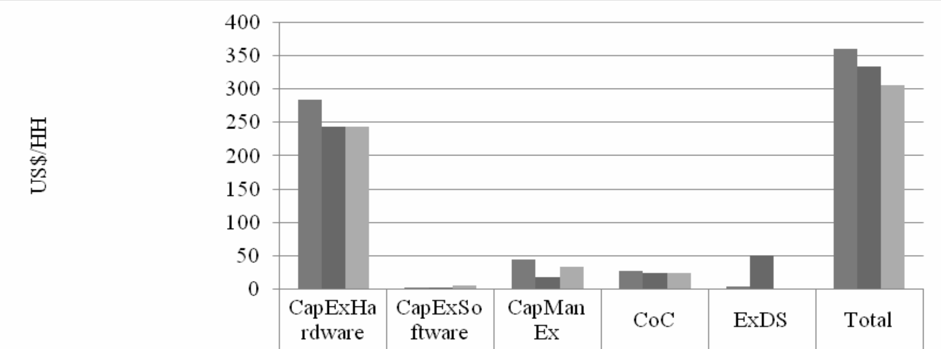
[5] We are in the process of estimating these costs, which will be included in the next round.

[6] These are based on the discussions with the households in the three villages. These costs are covered in the next round of field work.

has shown the highest per household costs ($ 39) followed by the partially covered habitation of Ankushpur ($34) and the oldest and not safe source habitation of Malreddyguda ($ 27) (for details see WASHCost India, 2010). As observed from the preceding sections these costs do not reflect the real situation. For the service levels, as per people's perceptions as well as technical information, are much better in Ankushpur when compared to other habitations (for more details see WASHCost India, 2010). This could be due to the reason that well failure is absent in Ankushapur where as it is quite high in the other two habitations. On the other hand, water infrastructure is quite old in Malreddyguda when compared to the other two habitations. This is reflected in the disaggregated costs at the habitation level. Most of these costs are in terms of CapEx Hardware (about 90 percent) followed by CapManEx and CapEx Software and Indirect costs. CapManEx accounts for about 12 percent of the total costs in Tekulapalle and Malreddyguda when compared to 5 percent in Ankushapur. The high CapManEx in Tekulapalle is due to the replacement of collapsed wells. In fact, the CapManEx is not part of the planning exercise of resource allocation. CapExSoft and ExDS are negligible in the sample habitations.

Figure 4: Present Value of Disaggregated LCC (all sources) of Drinking Water in the Sample Habitations over the Time span of the Schemes (US$/HH)

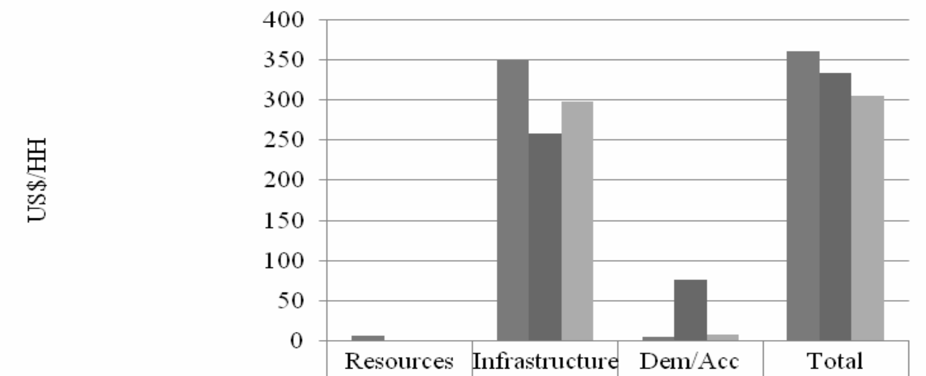


	CapExHardware	CapExSoftware	CapManEx	CoC	ExDS	Total
Tekulapalle (FC/35)	285	2.30	44	27	3.35	361
Ankushapur (PC/30)	243	1.5	17	23	50.33	335
Malreddyguda(NSS/39)	243	5.1	34	23	0.52	306

Source: Estimates based on the data collected from the RWSS department.

The investment pattern is more revealing when the investments are worked out under RIDA format. In the RIDA format investments on sources like creating and protecting / strengthening water bodies like tanks or streams / canal systems, etc are included in the resource category, while infrastructure costs like drilling bore holes, constructions of over head tanks, underground reservoirs, distribution systems, etc are included in infrastructure. Expenditure on awareness building, IEC and household investments on water are included under the Demand / Access category. The cost of infrastructure ranges between 77 and 98 percent of the total costs in all the three habitations (Fig. 5). In fact, it is 97.5 percent in Tekulapalle and Malreddyguda, while it is 90 percent in Ankushapur. On the other hand, investments in resource protection by the RWSS Dept are nil in the case of Ankushapur and Malreddyguda. Here resource protection mechanisms might have included groundwater replenishing mechanisms like percolation tanks, water harvesting structures, etc. These activities have been funded by DRD under watershed development programmes but with the aim of improving availability and access to water for agricultural uses. In the case of demand / access expenditure was negligible except in the case of Ankushapur where allocations were to the tune of 10 percent. Further, the resource protection dimension is totally missing in the investments. The marginal allocations in Tekulapalle were towards converting two dug wells in to recharge structures. The approach is supply driven, as the demand management received scant attention in two of the habitations. The better performance of Ankushapur (despite being a partially covered village) could be attributed to the 10 percent allocations towards demand / access apart from number of other factors. The demand / access costs are in the form of active stakeholder participation, costs of IEC, institutional development and capacity building; development of skills needed as part of developing and sustaining community-level organisations, O&M activities, etc. The other factors include governance structures with the habitation that are functional and effective in Ankushapur (WASHCost India, 2010).

Figure 5: Present Value of Disaggregated LCC in RIDA Format for Drinking Water in the sample Habitations over the Time span of the schemes (US$/HH)



	Resources	Infrastructure	Dem/Acc	Total
Tekulapalle (FC/35)	6	350	5	361
Ankushapur (PC/30)	0	259	76	335
Malreddyguda (NSS/39)	0	299	7	306

Source: Estimates based on the data collected from the RWSS department.

Despite the availability of public water systems in the sample habitations, hand pumps continue to play an important role in supplementing the service levels, especially during scarcity periods like summer. Hand pumps are being installed since 1970 in these habitations. The total number of hand pumps installed till now range from 15 in Ankushapur to 6 in Malreddyguda depending on the size of the habitation but many of these are either defunct or in a poor state of repair. Hand pump costs vary between US$ 755 (Rs. 37750) and US$ 1138 (Rs. 56900) per unit. This could be due to the differences in geo-hydrology of the habitations. Per household costs are estimated using the actual number of households in the habitation as well as the normative service potential of the hand pump (i.e., 250 persons). On the basis of actual number of households the costs range between US$13 (Rs. 650) in Malreddyguda and US$ 22 (Rs. 1100) in Ankushapur (Table 3).

Table 3: Present Value of Capital Cost of Public Hand Pumps in Sample Habitations over the Time span of the Schemes (in US$)

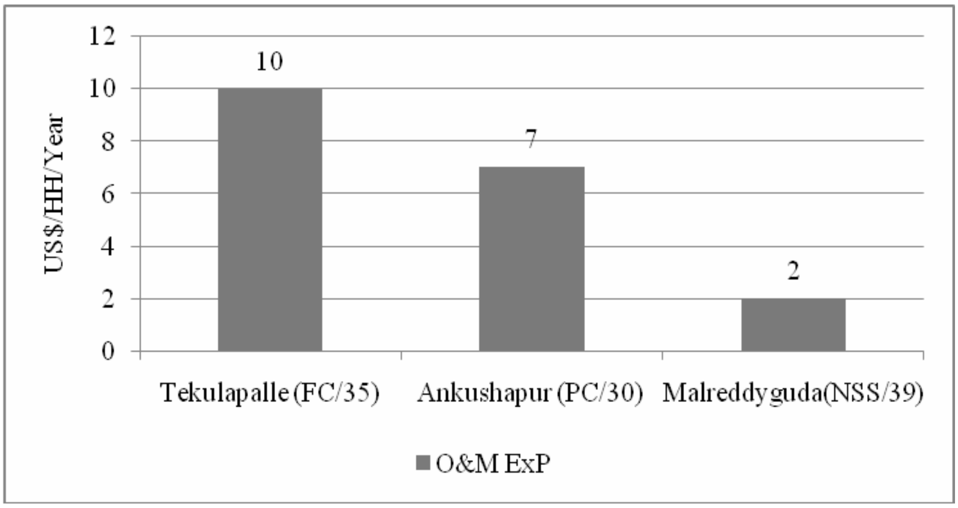
Habitation	No. of HP*	Total Cost	Cost /HH@	Cost/HP	Cost/HH+
Takulapalle	11	10896	21	991	20
Malreddyguda	6	6827	13	1138	23
Ankushapur	15	11318	22	755	15

Source: Estimates based on the data collected from the RWSS department.
Note: * One hand pump in Tekulapalle; two each in Malreddyguda and Ankushapur are not working at present. @ Cost per existing number of households at present.+ Assuming each Hand Pump serves 250 persons or 50 households.

Operation and Maintenance (OpEx) Costs

The operation and maintenance expenditure (OpEx) is the annual recurring cost which varies widely across the sample habitations. OpEx are collected for the latest year data are available at the habitation level. OpEx not only reflects the extent of dependence on energy for pumping for example but also for ongoing, regular maintenance, which is linked to the age of the system, but also efficiency in managing the systems. Due to poor and improper resource allocations to the village panchayats, they are not in a position to pay electricity charges for pumping water. In the absence of any mandatory laws panchayats find it convenient to not pay the electricity charges not least because they know that electricity supplies will not be cut in the case of non-payment. In some cases, however, the electricity department directly takes the money from village panchayat allocations whenever funds are available. This is one of the main issues in decentralised water governance. Therefore, in the absence of systematic and accurate data at the habitation level, we have estimated the electricity charges using the Horse Power (HP) of the motor, number of pumping hours per day and cost per unit of electricity at the habitation level in order to maintain uniformity across habitations.

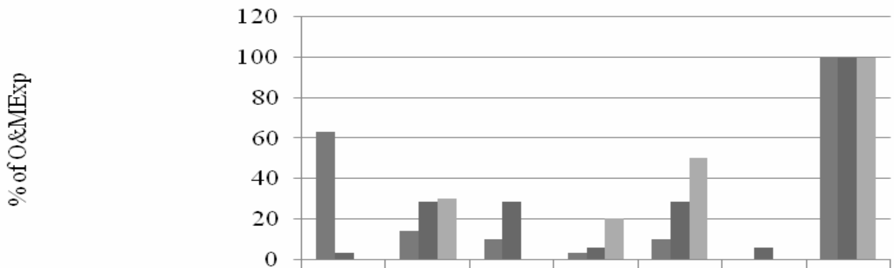
Figure 6: OpEx Costs on Drinking Water in the Sample Habitations (US$/HH)



Source: Estimates based on the data collected from the village panchayat.

The systems in Malreddyguda incur lowest OpEx , followed by Ankushapur and Tekulapalle (Fig. 6). The low O&M in Malreddyguda could be due to the reason that the systems are not maintained properly as the households do not depend much on this water. Tekulapalle has the highest OpEx, which is due to the high costs of spares (Fig. 7). These costs could be the consequence of high well failure due to the hydro-geological conditions in this habitation. This is also reflected in the high CapManEx costs. On the other hand, hand pumps get standard allocations of US$ 12 (Rs. 600) per pump per year in all the habitations irrespective of their condition and use. While the share of spares and tools account for 63 percent in Tekulapalle, salaries paid to operators (operator costs) account for 30 percent in Malreddyguda and 29 percent in Ankushapur (Fig. 7). Chemicals, on the other hand, account for 20 percent in Ankushapur, while electricity charges range between 10 and 50 percent across habitations. Electricity charges are the single largest component in Malreddy guda, while it is one of single largest components in Ankushapur. Operator (salary) costs are the second largest component in Malreddyguda.

Figure 7: Composition of O & M Expenditure (percentages)



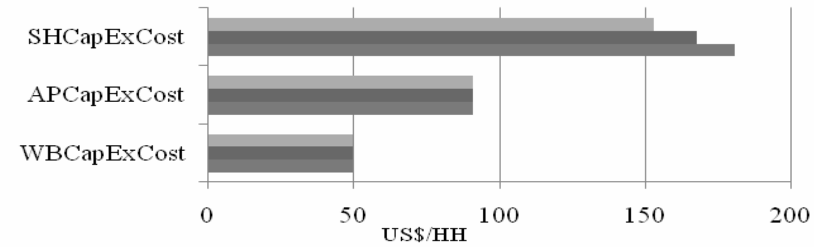
	Spares	Operator	Chemicals	Hand Pumps	Electricity	Misc.	O&M ExP
Tekulapalle (FC/35)	63	14	10	3	10	0	100
Ankushapur (PC/30)	3	29	29	6	29	6	100
Malreddyguda(NSS/39)	0	30	0	20	50	0	100

Source: Estimates based on the data collected from the village panchayat.

Disaggregated costs: A Comparative Picture

The costs presented in Figure 7 are the real life time costs over the years in each habitation. How do these costs compare with the one-time normative costs or cost estimates based on normative costs or stand scheduled rates? The main methodological difference between the real life time costs and normative cost estimates is that some of the specific costs like CapManEx are not included in the normative approach. Though our estimates are also not the actual life-cycle costs in the real sense, they include various costs that are not part of normative costs. But these costs might have been instrumental in ensuring certain level of service delivery. On the other hand, the actual service delivery levels are far from satisfactory in all the habitations due to the absence of life-cycle planning, cost estimation, governance, etc. In the life cycle planning source protection, source sustainability, pro-poor service delivery, etc., are important components. Unless supported through proper planning, design, execution and promotion of appropriate governance structures, source sustainability can't be achieved through allocating additional funds to cover life-cycle costs. Some of these costs are part of our cost estimates though any such interventions are not normally undertaken in a planned or systematic manner. Another difference is that our estimates are cumulative over time without taking the life span of a particular system. This may tend to overestimate the costs. Therefore, the real life-cycle costs are adjusted to the life span. For this purpose we have used the lifespan norms of various components provided by the department (for details see WASHCost India, 2010).

Figure 8: Comparative Capital Costs of Different Agencies under the Assumption of Economic and Useful Life Span for the Schemes



	WBCapExCost	APCapExCost	SHCapExCost
Malreddyguda(NSS/39)	50	91	153
Ankushapur (PC/30)	50	91	168
Tekulapalle (FC/35)	50	91	181

Source: SH= Sample Habitations; AP= Andhra Pradesh State and WB= World Bank. Estimates based on the data collected from the village panchayat; World Bank (2008) and The Department of RWSS, Government of Andhra Pradesh.

The life-cycle capital costs in the sample habitations (SH CapEx) are about 50 percent higher when compared to Andhra Pradesh State RWSS CapEx (APCapEx) and about 3 times more when compared to the World Bank CapEx (WBCapEx) estimates when economic / useful life span is assumed for the schemes in the sample habitations (Fig. 8). These differences are mainly due to the differences in approaches and methods of calculation. While in the case of sample habitations the costs include all the schemes and investments that have occurred due to expansion of the village boundaries over the period, the APCapEx takes only the population expansion during the next 20 years. The SHCapEx includes investments on source protection, source replacement costs (well failure), etc., which are not included in the other two estimates. Similarly the differences between APCapEx and WBCapEx are due to the reason that the cost estimates of the former are based on the estimate for one single village scheme while in the later case the estimate is based on a sample of 982 single village schemes. The method of estimation in the case of World Bank is similar to that of ours, as they have taken the historical costs and brought them to the present / current value. In the case of APCapEx the estimates are for a proposed new scheme. And in both the cases the estimates are single point. Besides, in both the cases, resource protection costs and rehabilitation costs (CapManEx) are not included. In the case of sample habitations CapManEx are included, but not the resource protection costs. The costs of the World Bank include the infrastructure costs and the costs of agency that is implementing the scheme where only infrastructure costs are included in the case of APCapEx. It may be noted that our estimates could be under estimates when compared to supply levels, as the supply levels are below norms in some habitations. Whereas the other estimates are linked to normative service levels.

One of the reasons for high costs in the sample habitations is that the investments have taken place in a piecemeal and on ad hoc basis, as can be observed from the time line of infrastructure investments. Investments take place (almost every year) as and when funds are available, irrespective of the situation. This is closely linked to fund availability and the need based supply sided approach. The schemes were neither planned scientifically nor comprehensively. Marginal funds were spent on planning and designing of the schemes in the initial stages, which is termed as capital expenditure on soft ware (CapExSoft). There was no scope for resource allocation towards source protection and sustainability. Nevertheless these costs were incurred in a non-systematic manner due to well failures, construction of additional storage tanks, etc. These costs do not find place even in the new and revised estimates, as these are not estimated so far and hence planners are neither aware nor have any idea regarding the extent of these costs. As the cost estimates for the sample habitations indicated that the capital management costs (CapManEx) range between 5 to 12 percent of the total costs. Further, there was no emphasis on support activities during the post scheme period in two of the three habitations. These costs are part of the Expenditure on Direct Support (ExDS). While CapManEx does not figure in any of the official cost estimates, the CapExSoft and ExDS are part of the costing, these costs are not realised at the implementation level.

The aforementioned additional costs along with source sustainability costs get substantial allocations in the new guidelines (GoI, 2009). But these guidelines do not have any basis for cost estimates. In the absence of all the relevant costs either at the planning level or implementation level the cost estimates, normative or actual, allocations tend to be under estimates. Resource allocations, based on the existing norms, at central level or donor or funding agency level are at sub-optimal levels. Such sub-optimal allocations are very well reflected in the service delivery at the habitation level. For instance, despite huge investments and a full coverage status of Tekulapalle, the service quality is poor in terms of adequacy and equity. On the other hand, Ankushapur, which is a partially covered habitation, has better quality service due to some allocations towards ExDS coupled with a whole range of other factors (e.g. pro-activeness of the Panchayat see next section).

The service quality is also linked to bio-physical attributes of the habitation. In all the habitations deep bore wells are installed with submersible pumps with varying capacities. But the functioning of these bore wells and their life span varies considerably across habitations. Same is the case with hand pumps, some are connected to shallow groundwater table and some are connected to fairly deeper groundwater table. Based on the number of sources that were invested in and their current functional status we have calculated the probability of source failure in the sample habitations. Failure is defined as: "the source is not functional due to natural causes or reasons viz., collapse of bore wells due to geohydrological factors (Tekulapalle) or drying up of groundwater aquifers due to over exploitation or due to the absence of source protection mechanisms like percolation tanks, water harvesting structures, etc". The extent of source failure in the case of bore wells is the highest (83 percent) in Malreddyguda followed by 64 percent in Tekulapalle (Table 5). These difference remain even where the failures are annualised. Where as it is zero in the case of Ankushapur. The extent of hand pump failure is also the highest in Malreddyguda. These differences in the functioning of sources may explain the high costs coupled with poor service delivery in Tekulapalle and Malreddyguda. Along with low probability of source failure, Ankushapur has also invested in direct support costs, which has a direct bearing on resource governance and service delivery. These hypotheses can be tested in a statistically appropriate manner when sample size (number of habitations) increase.

Table 5: Extent of Source Failure in the Sample Habitations over the Time span of the Schemes

Village / Habitation	Hand Pumps			Drinking water Bore well Sources		
	Total	Working	Probability of source failure	Total	Working	Probability of source failure
Tekulapalle	11	10	09	11	4	64 (1.83)
Ankushapur	15	13	13	12	12	00
Malreddyguda	6	4	33	6	1	83 (2.13)

Note: Figures in brackets are annualised for the time span

Source: Based on the data collected at the Habitation Level.

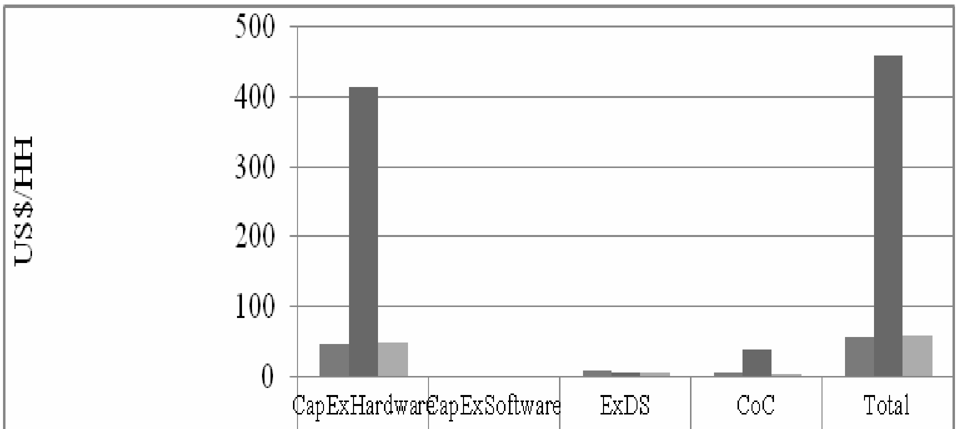
Rural Sanitation Costs

The main cost components of rural sanitation that are available and considered here include household and community level investments. At the household level the main investment is in the form of Individual Sanitary Latrines (ISLs). Besides, households also spend on hygiene practices like , boiling water, hand wash, etc. In majority of the cases the household investments are part of or due to the promotional activities of the department like subsidies, incentives, etc. In the case of ISLs the contribution of households is only 10 percent of the total costs and the remaining amount is provided by the department as subsidy. The cost estimates, however, include the total cost of

ISLs. At the community level the major investment includes public or common toilets at schools, public places, anganwadis, drainage systems, solid and liquid waste disposal systems, training and awareness programmes, etc. All these components are grouped under life-cycle cost components in the RIDA format as well.

The supply side philosophy is also evident in the case of sanitation sub-sector. Almost the entire amounts were spent on CapExHardware. All other cost components are either absent or negligible (Fig. 9). Support costs that are more important in sanitation are negligible. While the present per household total investments on sanitation are much lower, the total sanitation costs could be much higher when all the components of sanitation are covered. This is reflected in the Ankushapur case where the total costs crossed US$400 (Rs. 20,000) due to the recently laid underground drainage (UGD) system @ Rs 10 million. When analysed in the RIDA format, the infrastructure takes almost 99 percent of the total investments (Fig. 10). The influence of sector reforms, which suggest that at least 10 percent allocations towards support costs, appears to be limited in the test bed habitations. The new guidelines, in fact, propose to allocate more than a quarter of the funds towards support costs.

Figure 9: Present Value of Disaggregated Life Cycle Sanitation Costs in the Sample Habitations over the Time span of the Schemes



	CapExHardware	CapExSoftware	ExDS	CoC	Total
Tekulapalle (FC/35)	46	0.1	6.6	4	57
Ankushapur(PC/30)	414	0.2	6.2	39	459
Malreddyguda (NSS/34)	47	0.2	6.0	4	57

Source: Estimates based on the data collected from the village panchayat.

Figure 10: Present Value of Disaggregated Life Cycle Sanitation Costs in RIDA Frame in the Sample Habitations over the Time span of the Schemes

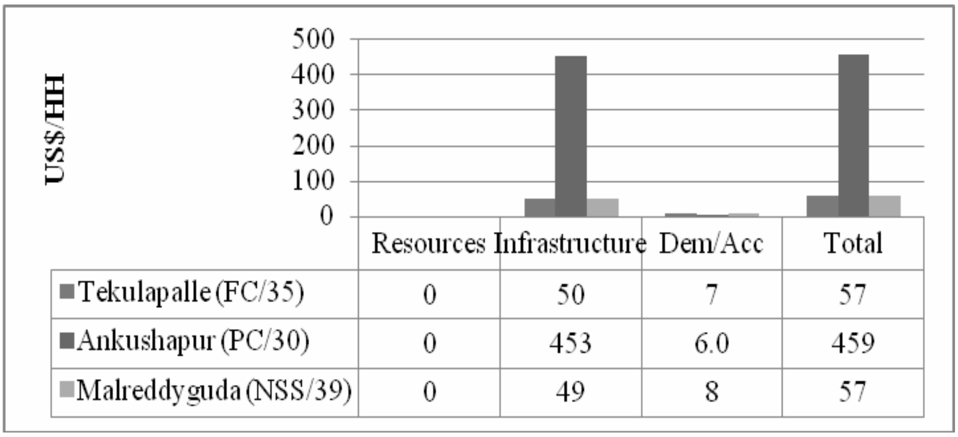
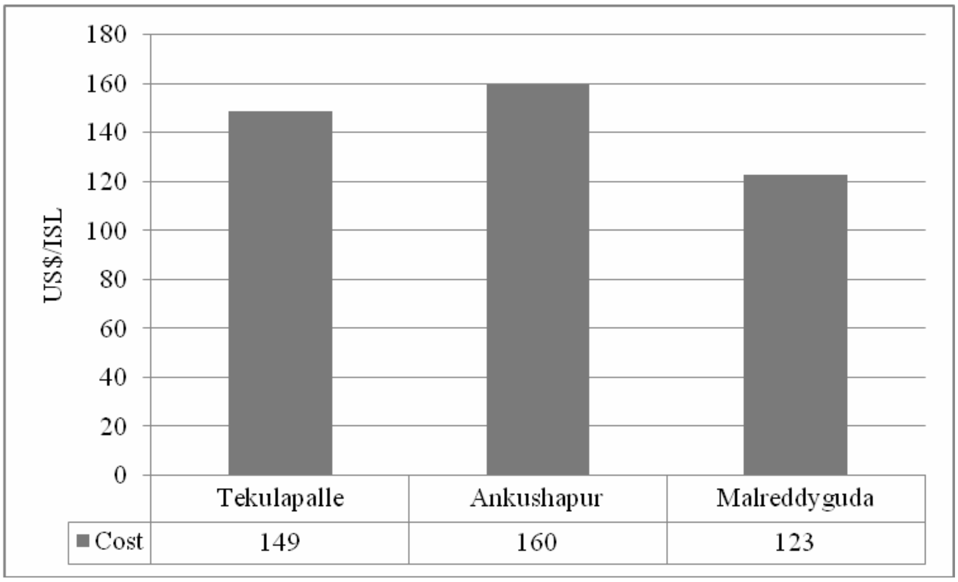


Figure 11: Average Cost of Toilet (ISL) in the Sample Habitations (US$).



Source: Based on the information collected at the Habitation level.

Sanitation costs presented here are not the full coverage costs, as they reflect only the actual cost at the existing level of service coverage. While it is 70-80 percent coverage in Ankushapur, it is much less in the other two habitations. Assuming that each household will have its own ISL at full coverage, the cost will be about US$65 (Rs 3050) per household. But the actual costs are much higher. The cost of toilet ranges from US$ 123 to US$ 160 depending on the location (Fig. 11). Of these costs, about 20 percent goes towards labour costs (pits + mason), 70-75 percent towards materials (cement + sand + metal + rings + pipes + bends + steel + Slab, etc) and the remaining (5 to 7 percent) towards pan (GoAP, 2009). The cost variations across the habitations could be due to the variations in transport and labour costs. And the experience of Ankushapur suggests that laying of underground drainage system cost about US$380 (Rs. 19000) per household. Together with other costs (software, support costs, etc) the per household costs could be in the range of US$500 (Rs. 25000) for sanitation alone. The costs would be much less in the case of other options like open drainage and also in the absence of subsidy towards ISL, etc. In any case, this initial analysis indicates that the cost of providing sanitation is at least equal, if not higher, to that of providing drinking water. This suggest that specific and targeted efforts are required at the policy and planning level towards sanitation rather than tagging it with water supply.

VI Water and Sanitation Governance

At any point in time there is a considerable gap between assets created and service available to the rural population. In order to overcome this, the new guidelines emphasise the transfer of management and financial responsibility to the lowest level i.e., the Panchayati Raj Institutions (PRIs) in line with the 73rd constitutional amendment. 'Swajaladhara' guidelines suggested the formation of Village Water and Sanitation Committee (VWSC) under the Gram Panchayat (GoI, 2002). The decentralised water governance is expected to get higher quality of services by minimizing capital and maintenance costs through competitive selection of service providers among existing public and private agencies. The vision statement of Government of Andhra Pradesh (GoAP) endorses the decentralisation of WASH services and handed over the schemes to village panchayats for maintenance. The department has undertaken several state-wide capacity building initiatives to members of Panchayati Raj Institutions / Local Bodies / Local Communities on all aspects of rural water supply and its related issues with an objective of enabling them to take up planning, implementation and operation and maintenance activities. All these efforts are expected to strengthen accountability and transparency, especially in operation and maintenance of WASH infrastructure for providing improved services in terms of quality, quantity, sustainability and equity.

The evidence from the sample habitations suggests that water governance structures are more or less absent, sometimes by design and sometimes by default. In most of the cases, the institutional structures that are suggested in the guidelines are absent. For, the decentralised governance reforms are implemented only in limited number of habitations that are covered under specific programmes like sector reforms. The involvement of Gram Panchayat in the O & M of the systems in the sample habitations is not effective in the absence of required capacities and guidelines. For instance, there is no clarity at the habitation level regarding electricity charges for running the water systems. In some cases, electricity charges are being taken by the electricity department whenever funds to the village panchayat are released. Similarly, pricing of house connections is left to the discretion of the village presidents. As a result, adopting a water pricing regime depends on whether pricing is politically correct or not from the president perception. The non-payment of electricity charges at the habitation level adds to relaxed attitude of the presidents towards pricing.

Despite the importance of planning and demand / access components in sustaining WASH services, the actual allocations are nearly absent in the sample habitations. As of now only the household expenditure on WASH services take a major share of this component. Planning phase in the WASH schemes is marginal. The only planning that can be observed is the recurring capital investments with limited impact on the sustainability of the service delivery. While such unplanned capital expenditure is adding to the cost of provision it hardly enhances the quality of service. On the other hand, sanitation and hygiene require more focus on demand / access aspects rather than infrastructure aspects. The evidence from the sample habitations reiterates the standard supply sided philosophy in sanitation as well. This is mainly due to the absence of comprehensive planning apart from tagging of sanitation and hygiene to water supply. That is, mainstreaming of sanitation and hygiene at the policy, planning and implementation levels is essential rather than linking it to the water.

The LCCA when adopted for costing requires effective decentralisation of WASH sector even at the planning level, in order to achieve water security at the household level i.e., source sustainability, pro-poor service delivery, efficient allocation of financial resources- capital and O&M costs. Comprehensive planning incorporating all the above aspects is central to and makes LCCA effective. Source sustainability or source protection aspects could be dealt effectively through proper planning along with the devolution of functions, functionaries and funds to the village panchayats. Together, they facilitate a fairly comprehensive (at least a pragmatic IWRM) for WASH service delivery. This calls for a rethinking and paradigm shift at the planning level. LCC approach could be adapted and mainstreamed into improved WASH governance processes given appropriate awareness, capacity building, guidelines, etc at the community level.

VII Conclusions

The cost estimates based on the LCCA framework indicated that the expenditure on the systems were substantially more than the norms. In all the cases, despite the methodological differences between different cost estimates, expenditure on WASH services in the sample habitations were higher mainly due to the expenditure on rehabilitation and other expansion costs that were not included while planning the schemes. Most important among them are the capital management (CapManEx) costs, which account for 5 to 12 percent across the sample habitations. There is heavy bias in favour of CapEx (Hardware) and infrastructure investments and against support costs and demand / access components. Often the investments are found to be ad hoc and piecemeal without any comprehensive planning. Investments are made whenever there are funds available and / or whenever there is a need or crisis.

Despite the huge investments over the last three decades along with the annual operation and maintenance expenditure the schemes fail to provide sustainable WASH services (especially drinking water) in the sample habitations. The official coverage status of the habitations does not hold good, especially at the household level. Achieving household level water security is one of the stated objectives of the proposed central guidelines.

The LCCA framework adopted in the sample habitations identifies gaps in the present pattern of planning and investment. LCCA is about life-cycle thinking and planning. Once the comprehensive planning is in place and investment priorities are identified, then investments can take place in a building block approach as against the *ad hoc* investments at present. Preliminary findings from the WASHCost project indicate that LCCA can be used to assess the actual life-cycle costs of sustainable, equitable and efficient WASH services delivery. The challenge now is to investigate how best LCCA can be mainstreamed into WASH planning and other governance processes. Though LCCA framework is not fully adopted in the present study due to the small sample, it provided insights in understanding the disaggregate costs and their linkage with sustainability dimensions. The analysis clearly brings out the need for establishing the linkages between costs and service levels in a robust manner across different systems and agro-climatic conditions.

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