

INTERNSHIP REPORT

ECONOMICS OF WATER SUPPLY TO OFF-GRID HABITATIONS IN THE NILGIRIS DISTRICT OF TAMIL NADU

By

SHANMITHA RAGHU

Under the Guidance and Supervision of

T BALACHANDER

Programme Coordinator

At the

Keystone Foundation, Kotagiri

The Nilgiris

June – September 2016

ACKNOWLEDGEMENTS

In my desire to write this project report, I have in no way any claim to come out with a perfect piece of work. Any errors and shortcomings in this report remain open to all criticisms and suggestions which could present me with new sources of inspiration as I develop in my ability to read and learn.

This report would not have been possible without the contribution and collaboration of others. My sincere gratitude to:

The Directors of Keystone Foundation, Kotagiri for giving the opportunity to be a part of the study.

Arghyam Foundation for their support by granting funds to the Water project at the Keystone Foundation that helped to undertake the study with enough time and resources.

T Balachander, Programme Coordinator, Keystone Foundation for his unwavering support and consistent guidance. I am highly indebted for all the valuable inputs given to complete the study with satisfaction.

Catarina Fonseca, Senior Programme Officer, IRC for the quick response and guidance by referring us to the relevant reference materials for the study.

Ratna Reddy, Director, Livelihoods & Natural Resource Management Institute, Hyderabad and Research Director, WASHCost (India) Project, Centre for Economic and Social Studies for his generosity in sending us a book which served as a manual guide for the study.

Cristian Gonzalez, University of Fribourg for sharing his programming tool 'Water Supply Costing Processor' which could further widen the scope of the study.

Venkatachalam, Madras Institute of Development Studies (MIDS), Chennai for helping us to get the concepts and terminologies clear.

Beemarajan, Assistant Junior Engineer TWAD, Kotagiri for his patience in giving detailed information about the roles of the Water Board along with references to relevant officials in other government offices.

Kasinathan, acting Assistant Director and Srinivasan, Block Development Officer of Town Panchayat, Ooty for their instant help to access information at block level.

Raghu, President; Sukumaran, Panchayat Secretary; Senthil, Office Assistant and other staff members of Hubbathalai Panchayat, Coonoor Block, The Nilgiris for their immense help in sharing all the necessary data needed for the study.

Rest of the Water team at Keystone Foundation B Babu [field guide], H Gokul and N Selvi who generously spared their valuable time in familiarising the field of study and for their encouragement and support at all times.

A special note of thanks to Wilfred William, System Administrator, Keystone Foundation for his cordial and eagerness to help with the technical aspects whenever approached.

I deeply thank the administration and all other staff at Keystone Foundation who have extended a helping hand in times of need which made my internship a pleasant experience.

FOREWORD

Water Supply in the Nilgiris, whether in urban centers or in rural areas, is a topic of much discussion and debate. The seemingly abundant water resources in the region, thanks largely to high amounts of rainfall, create a mirage of plenty. The reality however is that while some pockets in the area do enjoy plentiful water supply throughout the year, for a large majority, one poor monsoon is enough to push them into a water scarcity situation in the ensuing summer.

Keystone in a study conducted a decade ago, found that a majority of habitations surveyed across the Nilgiris district were dependent on springs for water supply. The water would be conveyed via gravity to storage tanks and then distributed to households. In 2015, a survey of 5 village panchayats in Coonoor taluk of the Nilgiris district, revealed that only one fourth of the habitations depended exclusively on springs for water supply. A majority of the habitations were now dependent on open wells that tapped ground water from small hill wetlands.

This shift in the period of a decade is reflected by the investments made by the Tamil Nadu Water Supply and Drainage Board (TWAD) and Panchayats in mainly promoting open wells with electric motor based pumping as answer to rural water supply needs.

At the government level there is no inventory of either the hill wetlands or springs to be able to look at the potential for future 'development' or to monitor the impact of large scale ground water use. Such a situation is true where other partners of the Springs Initiative are working, be it in other parts of the Western Ghats, Himalayas or the Eastern Ghats. While the springs are already being inventoried in each of these areas, wetlands seem to be unique to the Nilgiris region.

On the face of it, a shift from a gravity based system to one reliant on electric power for pumping seems to be a costlier option. However given the growing demand for water as well as the historic large scale land use changes in the region which have impacted the water resources of the region negatively, it is not surprising that open wells are being looked at as 'the solution'.

This study attempts to develop a methodology to compare the costs of providing water supply to remote rural habitations using springs and open wells in the Nilgiris. The focus is more on reviewing existing methodologies, adapting them to the local context and testing them out with a few sample cases. The resultant methodology as well as case-specific findings would build the base for further exploration by Keystone and other partners.

T Balachander

Programme Coordinator

Keystone Foundation

INTRODUCTION

There are over a million springs across India (Springs Initiative). A spring is the flow of water on to the Earth's surface as a result of aquifer being filled to its optimal level. Natural springs serves as a safe source of drinking water for all communities, animals, birds, trees, plants and also used for other livelihood activities. There is a rich diverse ecosystem around each springs. Most of the springs originate from the mountain regions which flow to the downstream settlements through gravity enriching the ecosystem along its way thereby ensuring the continuity of ecosystems.

The Nilgiris is a water abundant region with average annual rainfall of 1691mm and where groundwater is the major source for water supply with depth of 5-10m water level (TWAD, 2016). The spring water that was supplied throughout the year met all the water needs of people for domestic consumption and also used for other multiple use services such as irrigation, livestock rearing, small businesses, etc. With growing urbanisation that induces unhealthy land-use practices, deforestation, and increased tourism in the region has led to the construction of successive dug-wells. This has resulted in over extraction of groundwater, which, added with encroachments of tea plantations into wetlands have endangered the existing spring system in the region.

The natural ecosystem is under threat with the disappearance of forests and wetlands where the springs originate. This has led to the shift in the management of water resources from local communities and indigenous groups to the state (Nilgiris Water Portal). Keystone Foundation felt the intense pressure in the water issue and began to work with the community in the Nilgiris district from the year 2002 till the date. The work mainly pertains in engaging with the indigenous and other local people for the protection and management of water resources.

The study attempts to frame a user-friendly methodology that helps to compute costs for different water supply systems like natural springs and open wells. This could later be used by other service providers and NGOs who are working on providing new or improving the existing water supply systems to the rural people in remote regions of the country.

Objective of the study

To compute the range of costs incurred for different types of water supply infrastructure systems and to see if Natural Springs are cost effective over other sources.

The framework to estimate costs can be used as an advocacy tool with the government for hilly areas where springs are a good source of water. It can also be used to highlight the actual total cost of water supply to all stakeholders to emphasis the need to maintain natural sources, additional financial burden required to maintain the existing infrastructure systems, etc. Protecting a spring equals conserving an entire ecosystem around it.

The report is organised as follows. It has five sections including this introduction. Section Two gives an account of review of literature. Section Three outlines the methodology and the selection of the study areas. Section Four examines the costs of providing water services with different water supply infrastructure systems: gravity fed springs, open wells and combination of both. Section Five concludes the report.

REVIEW OF LITERATURE

The study initially began with reviewing the existing relevant literature, useful insights have been drawn from a few selected studies that have attempted to frame a cost analysis of Water Supply and Sanitation using empirical findings.

The Contingent Valuation method is used to evaluate the level of service provision of water supply in Ten Indian States along with analysing the performance of different rural water supply schemes by **World Bank (2008)**. The efficient institutional cost is taken as 10 percent of the total cost with water supplied at 70 liters per capita per day (lpcd). The cost of electricity is computed based on its requirements which are derived from the population to be served, design lpcd level and pumping head. The annual expenditure for maintenance and repair for the design performance of schemes is taken as 2.5 percent of the capital cost (inflation adjusted). The study revealed that nearly 23 percent of the households in Tamil Nadu were able to meet only less than half of their water requirement in summer from the main water supply scheme accessed by them. The average coping cost defined as the cost of storage, expenditure on repair and maintenance of own water sources and public water sources, and opportunity cost of time spent on water collection per household is Rs 81. It ranges from Rs 32 to Rs 287 per month across different categories of schemes. The costs borne by households are relatively higher in Tamil Nadu, Karnataka and Kerala. Over-provisioning of water supply services would reduce the opportunity cost of time incurred by households, but, results in higher per capita cost as in the case of Tamil Nadu. For the 17 percent of sources in Tamil Nadu, the overall cost of service tend to raise because of defunct system before its useful lifetime, but, the present study revealed that the water supply infrastructure systems from the sample villages in the hilly regions of the Nilgiris district is maintained regularly with nearly 50 percent of total funds allocated for operations and minor maintenance and seem to be functioning till date. The report also points out the resource wastages in the states of Karnataka and Tamil Nadu which as a result of multiple schemes in the same region i.e. a poor functioning scheme is supplemented by a new scheme. The per-capita expenditure at 2005-06 prices for Tamil Nadu was Rs 201 with the highest in Maharashtra with Rs 258 and lowest in Orissa with Rs 33. A more empirical study by **Carlevaro F. et al. (2010)** uses Least Cost Analyses method to derive the best economic alternative from the "appropriate" improved Water Supply technologies. The authors have designed an Economic Pricing Input Data Sheet to value and discount the quantified invested resources in water supply using information like currency, reference date, real annual discount rate, shadow factors, Consumer Price Index. The costing summary sheet of the water supply project is given. Unit Cost Approach adopted by **Jagals P. et al. (2011)** categorise costs into 'Capital costs' which includes investment in planning, preparing, construction, purchase of hardware and 'Recurrent cost' which includes operation, maintenance and monitoring at every stages of water supply i.e. source, treatment, pumping, storage and distribution respectively.

In India, a decade ago there was no economic value assigned to water resources (Planning Commission, GoI, 2002). The main body of work in estimating the cost of water supply systems was mainly initiated by IRC International Water and Sanitation Centre in 2008. WASHCost was a five-year action research project that investigates the costs of providing water, sanitation and hygiene in a sustainable manner to rural and peri-urban communities in Ghana, Burkina-Faso, Mozambique and India. Hence, the major literature references for the present study are from Water Sanitation and Hygiene Cost (WASHCost) project.

Reddy R. and Bachelor C. (2009) uses basic Life Cycle Cost Model (LCC) which is function of all the costs that are cumulated over the years except Operation and Maintenance cost. The authors' emphasis on estimating the present value of the investment for comparison purposes of old and new investments. Accounting for the risk and uncertainty factors using probabilistic phenomena and/or using Bayesian Networks to the LCC model is termed as Risk-Based Life Cycle Cost Analysis. The cost analysis is further distinguished into Cash accounting approach- helps govt. to budget for future cash requirements, Regulatory approach- fixed asset accounting and asset mgt. that gives the cost per person of delivering clean water and sanitation and Economic approach- Life Cycle cost assessments and present value analysis that helps to plan for future investment in **Fronseca C. et al. (2011)**. It highlights on certain terminologies such as cost not price, defines unit costs, distinguishes real vs. estimated costs, compares costs over time using GDP deflator/market inflation rate, compares country to country using market US\$/ PPP US\$, separates financial (nominal/real current costs) and economic (present costs) costs. The paper further highlights unit costs as estimates rather than actual expenditure, Non-networked unit-costs are rarely known due to lack of metered distribution, while, networked unit-cost use per cubic meter that reflects total cost (normative population used than population served), a note to account for inflation. The concept of service levels and describes the ways to identify them is given in **Moriarity P. et al. (2011)**. Quantity, Accessibility, Quality and Reliability/ Dependability are the overall water-service level parameters where each parameter corresponds to various service levels like high, intermediate, basic, limited, no service. The scope of the paper relies on investigating the difference between 'designed for' and 'received' quality of service both at the community and household levels. As it helps to identify the 'slippage' at individual level, which later used to show per community in terms of percentages of individuals receiving different levels of services.

The WASHCost (India) Project is discussed in detail by **Reddy R. and et al. (2013)** which includes Life-Cycle Cost Assessment (LCCA), sustainability, equity and cost-efficiency. To make the study robust, the state of Andhra Pradesh is divided into 9 Agro-climatic zones which minimises the differences with respect to rainfall, water quality, water scarcity, water source, type of scheme, village type, management & coverage of sanitation, hygiene levels, etc. Villages are selected using Stratified Sampling Design with village (habitation) as the sampling unit. Depending upon WASH services, each village is classified into 3 strata, namely: Fully Covered, Partially Covered and Not Safe Source. Household and secondary data are collected from nine agro-climatic zones. Regression analysis is used in identifying the factors that affect *cost* and *service* levels within & across villages (with varying socio-economic attribute like income, social groups, gender and spatial/location). Advanced mapping techniques are used to capture the variations in WASH services within & between villages which helps to identify the gap in the policy as well as institutional requirement.

It further highlights the following points:

- Differences between various regions in a state are due to labour costs- averaged to arrive at norms.
- Most villages use more than one source to meet their water requirements.
- Only financial costs are included in the analysis.
- Only investments in infrastructure that is still functional are considered.
- Operating Expenditure (OpEx) - average of the values for the years for which data is available after converting them to current-year values.

- Capital Expenditure (CapEx) and Capital Maintenance Expenditure (CapManEx) are annualised according to both normative and observed life spans of the systems.
- Total cost of provision is estimated in terms of per capita cost per year after converting the past capital investments (CapEx) to their current value and then annualising them.
- Lifespan of a system can be improved by making investments or allocations towards capital maintenance.
- To include equity aspect, the 2010 guidelines emphasise the shift away from normative service levels measured in liters per capita per day (lpcd) towards water security at the household level.
- Reasons for gaps between standard unit costs and actual unit costs.
- Resource allocation - Source protection 20%; Water quality 20%; O&M 10%; Mitigation 5% and Capital Expenditure on Hardware and Software - 45%. But these are not followed in reality. CapEx can be as high as 85%.
- CapManEx is not part of official norms. Only mentioned under O&M. It could be the reason why the budget allocations do not have provision for depreciation.
- Vacancies at state level may also indicate poor support services.
- CapManEx is ad hoc. New infrastructure is preferred.
- Adopting uniform unit costs and blanket allocation of funds may not be effective in achieving sustainable service delivery.
- Household investment may not simply reflect investment to supplement below normative service levels; they may be made to achieve higher service levels.
- Access levels - time spent by households fetching water was converted to monetary terms by multiplying it with the wage rate - opportunity cost.
- In underserved areas, household costs are more than the annualised capital costs and more than ten times the recurring costs.
- Service ladder - quantity, quality, accessibility and reliability.
- Comparing villages served by a single technology could help identify the least-cost options for policy purposes.
- Per capita costs are higher in the case of villages being served by multiple schemes.
- Observed life span of systems is lower because of frequent break downs, lack of maintenance or hydrogeology of the region.
- Observed unit cost is greater than the normative unit cost.
- Recurring costs are also annualised on per capita basis.
- Each technology has its cost advantages as well as disadvantages.
- No clear relations between unit costs and service levels between zones and technologies.
- Unit costs would go up in case of low accessibility when opportunity costs of time are taken into account.
- Actual use of water is estimated from household sample survey. Actual service received is the net wastage from the water pumped. This is estimated to be about 50% of pumped water (WASHCost 2010).
- Ratio between the annualised cost and the annual water use of the habitation provides the cost per unit of water.
- Cost composition as well as cost shares vary across locations. Cost composition is presently focused on infrastructure to the neglect of other important components such as source protection, capital maintenance, quality etc.
- Single Village Scheme (SVS) - Panchayat in full control. Multiple Village Scheme (MVS) - Additional player in the form of contractor. Problems of source sustainability, water quality etc.

METHODOLOGY

Main purpose for adopting LCCA in India is to arrive at the disaggregated unit costs & identify the gaps in terms of different cost components. The WASHCost (India) Project covered 187 villages in Andhra Pradesh and investigated the costs for a period of five years. Given the short span of time, we in the present study have adopted certain components from the WASHCost project toolkit that is relevant to the hilly regions for which data could be collected from various sources within the limited time-frame.

Fully developed life-cycle cost model includes: Capital Expenditure on Hardware (**CapExHrd**), Capital Expenditure on Software (**CapExSft**), Capital Maintenance Expenditure (**CapManEx**), Cost of Capital (**CoC**), Operation & Maintenance Expenditure (**OpEx**), Direct Expenses (**ExDS**) and Indirect Expenses (**ExIDS**). Apart from public investments, the households also invest to complement the service levels whose cost is evaluated in terms of “*Opportunity Cost of time*” i.e. village wage rates. Thereby,

Financial analysis involves only public investments

Economic analysis involves both public & household investments

The LCCA cost components adopted from the WASHCost project are as follows,

FIXED COSTS:

CapExHrd: Govt. expenditure on infrastructure like water sources, pumps, storage tanks, filters, distribution system.

HHCapExHrd: Household expenditure on water storage toilets, wells, pumps.

CapExSft: Govt. expenditure on planning & design cost of the scheme.

Note: The costs are accumulated over years and estimated in terms of Per capita cost per year. We need to convert them into current value using National GDP deflator for specific years. To get ‘UNIT COST’ per year, all capital costs are annualised using the actual life-spans of the systems.

RECURRING COSTS:

CapManEx: Renewal & Rehabilitation of sources, water supply systems.

CoC: Interest paid on borrowed investment in WASH sector.

ExDS: Staff salary, post-implementation activities Information, Education & Communication (IEC), demand management, training of machines.

ExIDS: Cost of policy planning at macro-level both at centre and state level.

OpEx: Regular Operations & Maintenance of the water supply systems with respect to energy cost, minor repairs, filtering costs, salaries of water supply system operators.

HHOpEx: Household expenditure on Operations & Maintenance of the water supply system and sanitation facilities.

Calculation of Per Unit cost of water

The cost per unit of water estimates the quantity of water to be supplied as per TWAD norms (designed for) and the actual use of water at household level (received quantity) respectively.

$$\text{Cost per unit of water} = \frac{\text{Average Annualised cost (Rs.)}}{\text{Total Quantity of water used (lpcd)}}$$

The unit cost of water per liters is calculated using financial and economic analysis respectively. The model costing summary sheet is given in Appendix A-I. The difference between the two costs gives us the cost borne by the community to fill the service level gap (if any) pertaining to the inadequacy in supply of water to the community by the Panchayat.

If the pattern/ log of the quantity of water pumped in storage tanks are known from the pump operators, it would help in estimating the unit cost of water per liter with the quantity of water supplied in each village from different sources during monsoon and summer months. This will help us triangulate the household data, but it is beyond the scope of the current study.

Service Ladder

WASHCost analyses the LCC against water service levels within a service delivery ladder which ranges from No service, Sub-standard service, Basic service, Intermediate service and High service. The progress made from one level to another depicts the improvement in supply of water to the community and households. The indicators for service delivery adopted from WASHCost are:

Quantity: Measured in terms of liters per capita per day (lpcd).

Quality: It refers to both the microbial and chemical quality of water based on regular testing, but the current study considers the household's assessment on water quality with respect to colour, content (clear/muddy), etc.

Accessibility: It refers to the time taken to fetch water from its delivery point to the houses per day. This is measured in minutes per capita per day (mpcd).

Reliability: It refers to the regularity in receiving water by the community in different seasons.

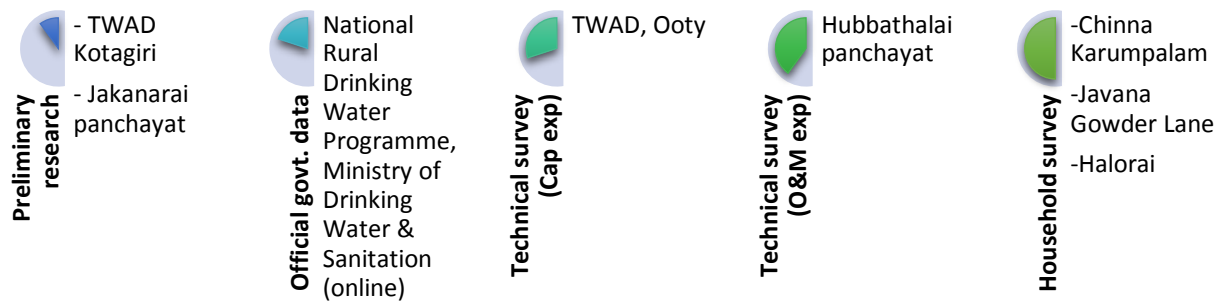
Table-1: Service levels of Water Supply System and its indicators

Service level	Quantity (liters per capita per day)	Quality	Accessibility (min/capita/day)	Reliability	Status
High	≥60	Good	≤10	Very reliable	Improved
Intermediate	≥40	Acceptable	≤30	Reliable/Secure	Improved
Basic	≥20	Acceptable	≤30	Reliable/Secure	Improved
Sub-standard	≥5	Problematic	≤60	Problematic	Unimproved
No service	≤5	Unacceptable	≥60	Unreliable/Insecure	Unimproved

Source: WASHCost proposed service levels and indicators

DATA COLLECTION

Process involved in Data Collection (Secondary & Primary sources)



After gathering various cost details involved in establishing and running a water supply system from various literature, we initially tried to merge the Life-Cycle Cost components adopted from the WASHCost project with the different *stages of water supply* i.e. *source, treatment, pumping, storage and distribution*. An excel spread sheet with detailed cost break-up along with sources of data to be collected was framed (with our knowledge). To identify the accessible secondary sources of information, a preliminary research was conducted by visiting a sub-divisional TWAD office and a village panchayat to know what kind of disaggregated cost data they would share with us for our study.

Preliminary Research:

It involves conducting a few key informant interviews with government officials, local well contractors, and other local bodies. During such interviews, we got access to view a sample water supply project report with cost information and additional guidance/support in identifying other sources of cost data.

TWAD, Kotagiri: They briefed us about the role of Tamil Nadu Water and Drainage Board (TWAD) in provision of water to villages. It involves initial planning where assessment of water demand at different regions in a community/ locality happens, followed by their role in different stages of setting up a water supply system, namely: storage, treatment, distribution- common; household and public source points. We got access to view their project document of the most recent Multi-Village Scheme for the district with all parameters of initial capital hardware costs. A copy of the most recent Schedule of Rates (SSR) which gives the standard rates to estimate a project issued by Tamil Nadu Water Supply and Drainage Board for respective years was shared with us.

Jekanarai Panchayat, Kotagiri: Once a water supply system is constructed, it is transferred in the name of the respective panchayat head. Then, it is the local bodies' responsibility to maintain the water supply infrastructure and it is they who incur the operations & maintenance expenditure on such infrastructure. The capital maintenance expenditure is also the responsibility of the panchayats. TWAD, Kotagiri referred us to this village panchayat to get costs incurred by a panchayat. We got a copy of Village Panchayat Form No.30 from the Vice-president. The form gives the monthly statement of classified Receipts & Expenditure for all sub-accounts that to be sent for audit to the inspector.

Sampling Design

Keystone as a part of Springs Initiative programme have been working on identifying the natural spring sources in the Nilgiris region and working on the measures to protect them by closely working with the community. The significant changes have been made in the upper catchments of the Coonoor town, the conservation of which might ensure successive benefits to the people residing in the downstream. The five villages under Keystone Water team's ongoing monitoring study are Hubbathalai, Yedapalli, Berhatty, Bandishola and Barliyar. A baseline survey of water resources and sanitation has been conducted for 90 habitations which draw drinking water from different sources like springs, wells, wetlands and streams.

Considering that the present study is a pilot survey and also to be ensured about the access to the existing necessary data from the local body i.e. Village Panchayat; from the experiences of earlier studies **Hubbathalai panchayat** is chosen for their good response at both higher and lower institutional levels (Panchayat office and household level). Also, Keystone has constructed a Spring-box in 2015 in Pazhathottam village that comes under Hubbathalai panchayat, the cost details of which can be used when needed.

Official government data

The National Rural Drinking Water Programme under Ministry of Drinking Water and Sanitation (MDWS), Govt. of India, manages data and information on drinking water status in rural habitations of India. It gives details on reported water sources, assessable delivery points and villages with individual house connections. It also gives a detailed scheme profile, with information on:

- Name of the scheme
- Scheme type and category
- Commencement and tentative completion dates
- Estimated cost, revised cost (if any)
- GOI share, State/other share, community share (cash+kind+labour)
- Total expenditure (till date)
- Service level (LPCD)
- Population (proposed to be covered)
- Implementing agency
- Programme that funded the scheme
- Status on contamination
- Agency responsible for O&M expenditure
- Sustainability measure taken
- Use of Non-Conventional energy
- Status on Waste Water Management

After extracting data on water supply systems from the basic habitation information of 33 villages under Hubbathalai panchayat, we framed a time-line for each village to depict the total No. of bore-wells, dug-wells and gravity fed spring system. We selected 3 sample villages with different sources of water supply. They are:

Chinna Karumpalam: Gravity fed spring only source

Javana Gowder Lane: Dug well only source

Halorai: Presence of gravity fed spring & dug well as sources of water-supply

Technical Survey (Capital Exp.):

Tamil Nadu Water, Sanitation and Drainage (TWAD) board, Ooty is the main government agency to assess demand and provide water supply infrastructure system to the Nilgiris district. With the data extracted from the online portal of Ministry of Drinking Water and Sanitation (MDWS), we had identified the schemes that were established in the sample villages in the respective years as early as 1981-82 till 2013-14. We requested for the detailed cost estimate of these schemes for our comprehensive study. They helped us get access to the cost estimates of schemes established from 1995-96 onwards, as the earlier estimates were very difficult to search from the old records. The then current TWAD Board Schedule of Rates has been adopted to prepare the estimates. Excise duties for pipes and machineries have also been included in the estimate.

Table-2: List of Water Supply Schemes in sample villages

Habitation	Scheme ID	Scheme Name	Sanction Year	Source type
Chinna Karumpalam	135425	Gravity Scheme- Filter points (1985)	1984-85	Filter points
	209530	Gravity Scheme- Filter points (1985)	1995-96	Filter points
	266904	Gravity Scheme- Filter points (2006)	2004-05	Filter points
	4694555	WSS to Chinna Karumpalam	2012-13	Open well*
Javana Gowder Lane	2534843	WSS to Javana Gowder Lane	2010-11	Open well
Halorai	NA	Gravity Scheme- Filter points (1982)	1981-82	Filter points
	135409	Gravity Scheme- Filter points (1997)	1996-97	Filter points
	32812	Halorai	2007-08	Open well
	4696674	WSS to Halorai	2012-13	Open well

Note: (*) the scheme's cost estimate was prepared but not executed due to unavailability of land

Source: indiawater.gov.in

Technical Survey (Operations & Maintenance Exp.):

Visit to AD Panchayat - After getting a rough idea about the kind of information to expect from Village panchayat offices, we approached the AD Panchayat whose role mainly relies on allocating various funds like funds from Planning Commission, HADP, etc. to different activities like water supply, laying roads, construction of buildings, etc. It also periodically monitors the usage of such funds by the village panchayats at block level. The Block Development Officer referred us to get the cost details on water supply systems incurred by the panchayat from the Secretary at the block level (Hubbathalai Panchayat) for the sample 3 villages.

The Village Panchayat officials were generous enough to let us extract data from their annual accounts ledgers for a period of 23 years (1993-94 till 2015-16). We have disaggregated cost data with respect to:

- Village specific expenditures on water supply
- Common expenditures for all villages pertaining to water supply
- Direct expenditure on water supply across villages
- Indirect expenditures like administrative staff salaries, travel expenses, stationary expenses, computer maintenance charges, gram-sabha, etc.

Household Survey:

To capture the households' investment in water supply system, we framed a questionnaire that includes the information to be gathered on service levels from the community. The major components are quantity of water supplied, quality of water, accessibility where time taken to fetch water from the common tap to the house is used as a proxy variable, reliability of the source and other expenditures incurred by the households in getting water for domestic consumption like laying and maintenance of pipelines, water storage tanks, etc.

We collected primary information from 10 households in each of the three sample villages that were earlier covered under the base-line study conducted by Keystone in 2015. The information is collected with respect to monsoon and summer pertaining to each accessed sources. The valuation of household expenses is used in estimating the economic cost borne by the community which helps to identify service gap and also to determine the service level in the three villages respectively.

All costs related to water supply are obtained with respect to every individual water supply projects in each of the three sample villages that are considered for the study from the year of its establishment till the financial year 2015-16. The costs are categorised under the various life-cycle cost heads. The average of the expenses incurred under each head is taken for the final calculations after converting the historical costs to their present values and then annualising them as per their normative lifespan of 30 years (TWAD, Kotagiri).

ANALYSIS

Case Study I: Chinna Karumpalam (Spring only source)

Chinna Karumpalam is a habitation in Hubbathalai Village Panchayat of Coonoor town. It is situated at a distance of 8kms from Coonoor. Most of the villagers are engaged in agriculture works and the area is generally dry land with low facilities.

Current total population : 482

No. of households : 142

Role of TWAD and Panchayat

Existing Water supply arrangements: A protected water supply scheme was formulated by the TWAD Board for the habitation in 1984-85. Under the scope of this scheme, a check dam cum filter chamber was constructed near by the Jungle stream. The water supply is effected from the check dam by gravity and collected in a newly constructed GLSR with the capacity of 30,000 liters from where water is distributed to the community through a distribution network. The scheme was functioning until the then existing check dam and filter chamber was fully silted and the main pipeline parts were broken by heavy floods in mid 1990's. A new collection chamber and replacement of broken pipes with new 32mm GI pipe from gravity main was executed in 1996-97. By 2004-05 there were few replacements and laying of 50mm GI pipes and the regular maintenance of check dam by the village panchayat. The existing main could carry the total requirement of the hamlet with a distribution network of 1100m, TWAD further provided a distribution system of 500m for the lower zone of the hamlet from the existing GLSR. Later, in 2012-13 it was proposed to dug a well to meet water requirements during summer seasons, the estimate was prepared but the scheme was not undertaken due to unavailability of land i.e. estate owners refused to give land for digging a common well. Hence, this village purely gets water only from the natural spring. Throughout the year it is the responsibility of the village panchayat to ensure uninterrupted supply of water to the community by regular maintenance of the water supply systems, along with providing individual house connections for water.

Role of Pump operators

He is employed by the panchayat for a monthly salary of Rs 2400/month, is in charge of ensuring uninterrupted water supply from the sources to the village. There are two GLR tanks that stores water from the spring and a main tank in the jungle. Water is supplied twice a day for almost six hours a day. The gate valve is closed with at least 2 feet for the tank to fill water in the remaining hours. During very dry seasons, the water is supplied once a day. There are 28 common public taps along with 48 individual house connections where the water is supplied in the same timing.

Tank cleaning:

- Notification about tank-cleaning is done via writing on the common village black-board.
- The GLR tank is cleaned (chlorination) once in a month for which Rs.250/tank is paid as wage.

Note: As the tanks are really huge, it takes 4-5 extra labours to do the cleaning of three tanks in a day, they are paid separately by the village pump-operator Mr. Kumar from his pocket (his earnings from working in a needle factory), Rs. 400/day per person. He does this because he is the village panchayat personnel with monthly wage of Rs.2400.

- Cost of cleaning- Main tank needs 1kg of chlorine, Tank-1 and Tank-2 requires ½ kg of chlorine respectively, which is obtained from the village panchayat office.
- Extra supply hours are provided to compensate for a day's non-supply due to cleaning works.
- Pump operator needs to get signature from at least 10 households along with pictures to show as proof to get payment for cleaning from the panchayat.

Repair works:

- The minor repair works are done by the pump-operator while in case of major repair works the panchayat sends an expertise along with the needed spare parts. The repair work is done within a day or two at maximum (meanwhile people fetch water from other lines which are functioning).
- When there is some repair works happening in a line, water is supplied in other pump lines for few extra hours for the people (from broken pipe-line) to access it.

Community's contribution

The village gets water from natural spring, the water received is muddy but when filtered it is clear. Thus, the Self Help Groups (SHGs) have initiated a two month loan where they can buy a filter system costing Rs.3000 and the payment can be made in two instalments. There are nearly 12 such SHGs in the village with young women as the active participants. Hence, cost incurred for filtration is significant in the village.

Cost per unit of water

The cost data for all the existing and functional public water supply infrastructure pertaining to the village are collected from the TWAD Board, the respective operation and maintenance expenditures from the village panchayat, and household expenses incurred for collection and storage of water from sample households added with the expenses incurred by pump operators (if any) are all taken in for the detailed unit-cost estimation. The various costs from all the stakeholders are disaggregated under different heads as per WASHCost LCC method. After following the said methodology, we have arrived at an approximate unit cost of water per 1000 liters. (Appendix A-II)

	Financial analysis	Economic analysis
As per TWAD norms (40lpcd)	Rs 12.74/1000 liters	Rs 23.74/1000 liters
As per HH survey (52.5lpcd)	Rs 9.71/1000 liters	Rs 18.09/1000 liters

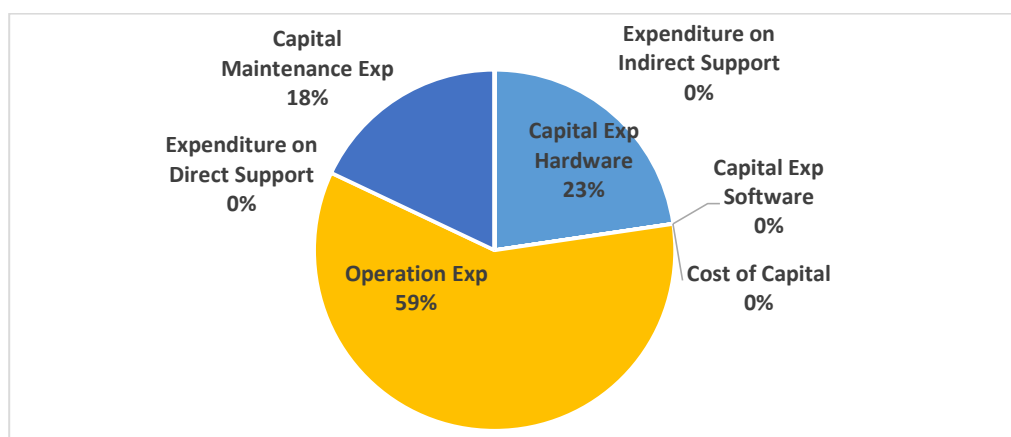


Fig-1: Cost composition of Chinna Karumpalam village

The economic cost is the additional money shelled out by the individual households to bridge the unfilled service gap with the public investment in water supply system. Here, the community spends their time and energy to fetch water from the main tank many a times than from the nearest common tap due to the breakage of pipes by gaur's activities. Also, since the spring water is muddy either due to bad weather or due to disturbance at water source caused by wild animals, people tend to mandatorily spend on installation of water filtration system at their houses. The situation is unavoidable, but the time taken to mend such repair works could be minimised with an additional pump operator. The operational expenditure is relatively high than the expenditure incurred on capital hardware and its maintenance. This signifies the cost effectiveness of the natural springs where the capital expenditure is very minimal.

Service Level of water supply system in Chinna Karumpalam

Quantity : Greater than 40 liters per capita per day

Quality : Good

Accessibility : Less than 30 minutes per capita per day

Reliability : Regular supply at least once in a day, reliable

Therefore, we conclude that the village on the whole has an 'Improved' water supply system.

Case Study II: Halorai (Spring & Well combined sources)

Halorai is a habitation in Hubbathalai Village Panchayat of Coonoor town. It is situated at a distance of 8kms from Coonoor. Most of the villagers are engaged in agriculture works and the area is generally dry land with low facilities.

Current total population : 400
No. of households : 100

Role of TWAD and Panchayat

Existing Water supply arrangements: A protected water supply system was executed by TWAD Board during the year 1981-82 with check dam, GLSR with capacity of 15000lt, laying and joining of GI conveying main and distribution system. Due to heavy rain the existing check dam and GI pipes were silted and fully damaged by 1996-97, except for the GLR. A new proposal was executed in 1996-67 by construction of a collection chamber in the upstream side of the existing check dam and replacement of old damaged GI pipes with new 32mm GI pipes for a distance of 1000m for the conveying main. In 2006-07, Water Board recognised the lesser yield from the source which turns dry during summer with supply of just 15lpcd. Hence, a 10000lt capacity GLR was constructed to store the pumped water from the existing panchayat well, which was be supplied to the people through an additional distribution network to the existing one. A new pump room was also constructed. By 2012-13, the uncovered population was about 123 and for the remaining population, water could be supplied only once a week during summer season. So a new well was constructed to provide a protected water supply to the uncovered population in addition to the main habitation; the scheme included digging a new well, pump-set, control room to handle the control panel board and piping main. This new scheme had lump-sum provision for: power-supply connection charges, disinfection arrangement, road cutting and restoration charges. The funding for the recent scheme was equally shared by both the Govt. of Tamil Nadu and GoI (NRDWP).

Role of Pump operators

He is employed by the panchayat for a monthly salary of Rs 2,300, who is in charge of ensuring the uninterrupted water supply from the sources to the village. There are three GLR tanks that stores water from the spring and well respectively. Every day the motors run for two and half hours and an hour a day respectively in the evenings which is stored for the next day's supply, irrespective of the seasons (summer or monsoon). The water supply during its scarcity is adjusted by reducing the hours of supply by 30 minutes. The water pumped from wells is supplied on alternative days to 100 houses with individual house-connections for half an hour a day from 7am to 7.30am. The water from the spring source is supplied at 5 common public taps installed in the village from 6am till 9am on a daily basis.

Tank cleaning:

- The GLR tank is cleaned (chlorination) once a month for and the wage is Rs.250/tank. He further collects Rs.20/month from each household as panchayat does not pay anything for the maintenance of the spring source.
- Cost of cleaning- 1000lt needs 10g of chlorine powder, therefore a GLR tank with capacity of 30000lt needs 300g of chlorine powder, which is obtained at the village panchayat office.
- No alternative supply timings are provided during power-cuts or on tank cleaning days.

Community's contribution

Halorai initially constituted many small habitations with total population of nearly 900 individuals during 1996-97 (TWAD reports). Till 2009-10, it was supplying water to these small habitations including Javana Gowder Lane.

People of Halorai use the spring water (common tap) for cooking and drinking purposes while the well water supplied via house connection is used for other domestic purposes. During severe drought season, people have bought water for Rs.750 per sintex tank. The alternative source of water for the habitation is the nearby village Chinna Hubbathalai (locally referred as Hatty) where the main source of water is from a very old spring situated in Sengaranai Thotam. The water is supplied throughout the day. So, people from Halorai village need to fetch water from this village's common tap. People claim that it takes nearly half an hour to fetch a pot of water, so it consumes more time to get enough water to their respective houses.

Cost per unit of water

The cost data for all the existing and functional public water supply infrastructure pertaining to the village are collected from the TWAD, the respective operation and maintenance expenditures from the village panchayat, and household expenses incurred for collection and storage of water from sample households added with the expenses incurred by pump operators (if any) are all taken in for the detailed unit-cost estimation. The various costs from all the stakeholders are disaggregated under different heads as per WASHCost LCC method. After following the said methodology, we have arrived at an approximate unit cost of water per 1000 liters. (Appendix A-III)

	Financial analysis	Economic analysis
As per TWAD norms (40lpcd)	Rs 18.04/1000 liters	Rs 31.63/1000 liters
As per HH survey (58.3lpcd)	Rs 12.38/1000 liters	Rs 21.70/1000 liters

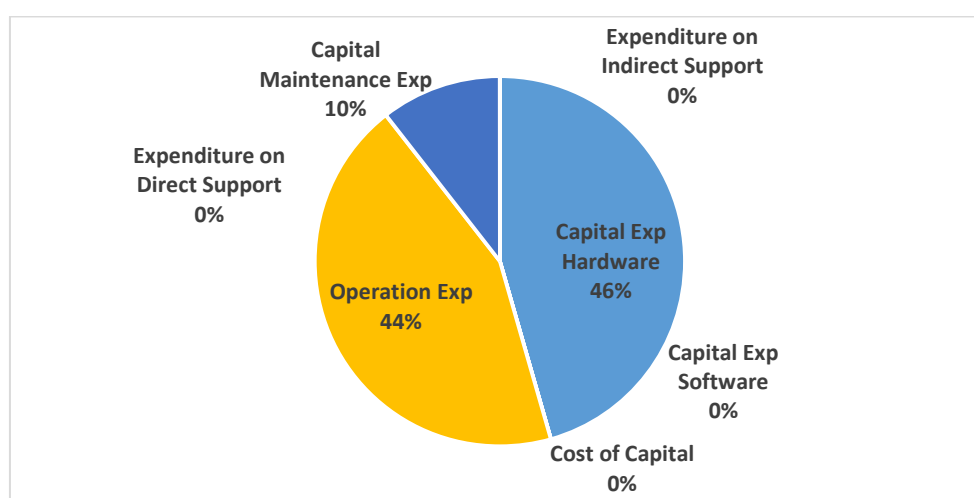


Fig-2: Cost composition of Halorai village

The proportion of economic cost to financial cost is slightly higher compared to a spring only source village, because, people need to initially spend some money in getting individual house connections which supplies well water. This includes extension of pipelines from the public road connections to the individual houses, taps, etc., and its regular maintenance. Here, the capital expenditure is higher

compared to operational expenditure due to the construction of common well, additional GLR, expansion of pipelines, etc. The operation expenditure that includes regular tank cleanings and salary of pump operators comprises nearly 50 percent of the total expenditure incurred for provision of water supply to the village. This village along with Chinna Hubbathalai acts as hosts to other nearby small villages in times of water scarcity.

Service Level of water supply system in Halorai

SOURCE: Spring

Quantity : Greater than 5 liters per capita per day

Quality : Good

Accessibility : Less than 10 minutes per capita per day

Reliability : Regular supply at least once in a day, reliable

SOURCE: Wells

Quantity : Greater than 20 liters per capita per day

Quality : Acceptable

Accessibility : Less than 30 minutes per capita per day

Reliability : Regular supply during alternative days, reliable

Note: Quantity of water used per person from the combined source is greater than or equal to 20lpcd.

Therefore, we conclude that the village on the whole has an 'Improved' water supply system.

Case Study III: Javana Gowder Lane (Well only source)

Javana Gowder Lane is a habitation in Hubbathalai Village Panchayat of Coonoor town. It is situated at a distance of 8kms from Coonoor. Most of the villagers are engaged in agriculture and are agricultural labourers. It's a complete wet land region.

Current total population : 175
No. of households : 65

Role of TWAD and Panchayat

Existing Water supply arrangements: The habitation was getting water from the nearby Halorai habitation through EPL with 20 lpcd as the level of service. There was no separate Water Supply Scheme for the habitation prior to 2010. Only in 2010-11, the need for a separate water supply system was recognised, thus, a new scheme was proposed and executed whereby a new well came up along with recharge structure. The other components include pump-room; GLR; Supply, delivery and erection of Pump-set; Laying and joining of Pumping main and Distribution system. The funding for the recent scheme was equally met by both the Govt. of Tamil Nadu and Gol (NRDWP).

Role of Pump operators

He is employed by the panchayat for a monthly salary of Rs 2300, is in charge of ensuring the uninterrupted water supply from the sources to the village. There is only one GLR tank that stores water from the well. Water is supplied once in two days for an hour in the evenings. The motor is operated from 5.30pm till 6.30pm when the tank is filled with water. There are almost 7-9 motors operated in the nearby localities, if all motors are operated in the same timing it would result in tripping. So, few villages mutually agree to operate during evening hours. During very dry seasons, the water is supplied once/twice a week (according to the availability of water in the well). When the water in tank is less than 1/4th its full volume, then motor is not operated. This is to prevent the motor from getting damaged; also the pump operators are responsible for its functioning. There are 6 common public taps (main lines) where the water is supplied in the same timing. Individual house connections are available from 2016, but the water supply is not given yet.

Tank cleaning:

- It is done monthly once. Extra labour is needed and he is paid Rs.300-400/person by the pump-operator from his pocket. Panchayat pays Rs.250/tank for cleaning.
- Note: 1kg chlorine powder provided by the panchayat can be used for 20 days according to its use.

Water quality test:

- The water quality test is done once in six months where the samples are taken by the pump-operator to the panchayat office, which is later taken to TWAD lab, Ooty.

Community's contribution

During the 2004 drought, people of Javana Gowder Lane had sleepless nights spent in fetching water from the nearby Chinna Hubbathalia (commonly referred as Hatty). It is when the community people started to demand for a separate water source for their habitation. But, since there was no move from the panchayat side due to the unavailability of land, the community people decided to pool in cash to purchase a land for the digging a common well. There were 43 households where each household contributed Rs 1300 and the total cash was summed to Rs 55900. The village got its

individual own source of water from a dug well only by 2010-11. By then, many households have dug their own individual well. So, there are very few houses which currently depend on the common well for its water supply.

Cost per unit of water

The cost data for all the existing and functional public water supply infrastructure pertaining to the village are collected from the TWAD, the respective operation and maintenance expenditures from the village panchayat, and households expenses incurred for collection and storage of water from sample households added with the expenses incurred by pump operators (if any) are all taken in for the detailed unit-cost estimation. The various costs from all the stakeholders are disaggregated under different heads as per WASHCost LCC method. After following the said methodology, we have arrived at an approximate unit cost of water per 1000 liters. (Appendix A-IV)

	Financial analysis	Economic analysis
As per TWAD norms (40lpcd)	Rs 36.05/1000 liters	Rs 108.51/1000 liters
As per HH survey (12.125lpcd)	Rs 118.94/1000 liters	Rs 357.98/1000 liters

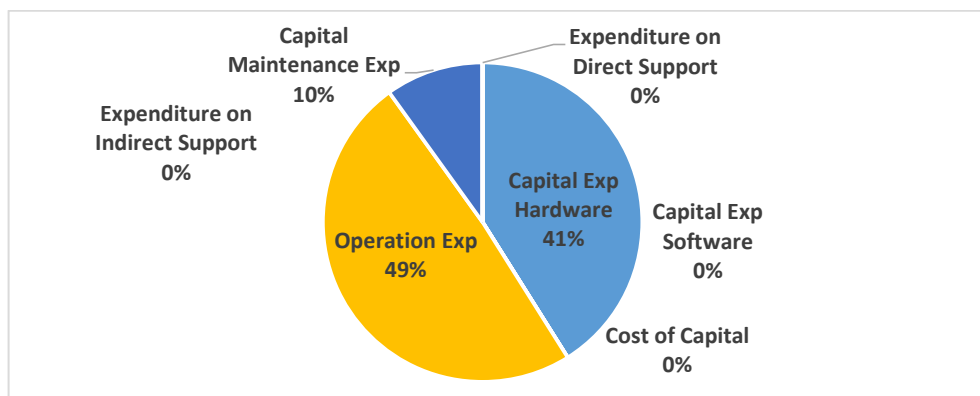


Fig-3: Cost composition of Jevana Gowder Lane village

The high economic cost is due to household investments in private wells which are due to the poor quality of water supplied by the panchayat. The high financial cost is due to many of the households not using the panchayat water supply, thereby, skewing the average. The operational and maintenance expenditure exceeds the capital hardware expenditure for the recently constructed open well and GLR tank. If adequate capital hardware were invested to provide the required service, the village need not seek alternative sources of water like private wells.

Service Level of water supply system

SOURCE: Common well

Quantity : Greater than 5 liters per capita per day

Quality : Problematic

Accessibility : Less than 30 minutes per capita per day

Reliability : Problematic

Therefore, we conclude that the village on the whole has an 'Unimproved' water supply system.

Conclusion

This study focused on framing a methodology that helps to estimate the unit cost of water from different sources like springs and open wells. The various costs have been identified from existing relevant literature and disaggregated into CapExHrd, CapExSft, CapManEx, CoC, OpEx, ExDS and ExIDS as defined by WASHCost Project. After finding the present values of all costs and annualising capital costs using the life-span of the respective systems which tend to be longer compared to plains (inferring from WASHCost, Andhra Pradesh). We get the unit cost of water by dividing the average annualised cost by total quantity of water used by a village in a year.

To adapt this framework to the local context and to ensure the practical feasibility of the methodology, we selected three villages from a panchayat with different water supply sources in the Nilgiris district. The case-specific findings are as follows:

Case-study I: Chinna Karumpalam

The spring only source village receives nearly 52lpcd of water at the rate of Rs.9.71 per 1000liters while the households additionally spend Rs.8 per 1000litres to bridge the service level gap that is not met by the public investments in the water supply system to the village. Households mainly spend for installation of filtration system to remove the muddy particles from the spring water which is later used for all other domestic purposes. But, overall the village has an improved water supply system.

Case-study II: Halorai

The village gets nearly 58lpcd of water from both the natural spring and from a public well at the rate of Rs.12 per 1000liters while the households additionally spend Rs.9 per 1000liters to avail the said quantity of water in uninterrupted basis. Households are much satisfied with the quality and quantity of spring water that is readily used for direct domestic consumption, while a certain amount needed to be spent to get individual house connections that supplies the well water on alternative days. The village has an improved water supply system.

Case-study III: Jevana Gowder Lane

In spite of being a wet-land, the village suffers from water scarcity the most. The village gets only 12.125lpcd of water from its public well. The irregular and poor water supply to the village has resulted in growing individual dug wells in the locality which shows the shifting of burden on the community. The cost of per 1000liters of water to the village is Rs.118 and households additionally spend Rs.240 per 1000liters to meet the service level gaps. They spend for digging individual private wells which starts from Rs. 30,000 to Rs.60,000 depending on the number of rings and the depth of the wells along with recurring maintenance costs. This well only source village thus has an unimproved water supply system.

From the case studies, it is seen that the methodology adapted from the WASHCost Project to the local context seems to be robust across different water supply sources. It is observed that the water supply systems in the hilly region have longer life compared to the ones in the plains where the WASHCost, India study was conducted. This could be due to the large share of expenditure incurred for operations and capital maintenance rather than investing only on new Capital Hardware. More accurate cost analysis could be estimated with the maintenance of regular pumping logs or

automated water level monitors at source to accurately measure the quantity of water supplied by the system. Also, it is seen that the village with well as its only source relatively spends more money in getting water compared to other villages which either depend completely on natural springs or having combined sources. Thus, this study throws light on the stability and reliability of natural springs which is under the threat of disappearance due to land encroachments for commercial and other purposes. Protection of wet-lands is of much necessity to ensure sustainable access to water supply in the hilly regions of the country.

References

- Carlevaro, F. and Gonzalez, C. 2009. "Costing Improved Water Supply Systems for Low-Income Communities, A Practical Manual", University of Geneva/ World Health Organization.
- Fronseca, C. et al. 2011. "Life-cycle costs approach: costing sustainable services, (WASHCost Briefing Note 1), IRC International Water and Sanitation Centre, The Hague.
- McIntyre P. et al. 2014. "Priceless! Uncovering the real costs of water and sanitation", IRC International Water and Sanitation Centre, The Hague.
- Moriarty P. et al. 2011. "Ladders for assessing and costing water service delivery", WASHCost Second Edition, IRC International Water and Sanitation Centre, The Hague.
- Nyarko K. B., et al. 2010. "Cost of delivering water services in rural areas and small towns in Ghana", IRC Symposium.
- Reddy, R. and Bachelor, C. 2009. "Costs of Providing Sustainable Water, Sanitation and Hygiene Services in Rural and Peri-Urban India", WASHCost (India) Inception report, Centre for Economic and Social Studies.
- Reddy R. and et al. 2013. "Sustainable Water and Sanitation Services: The Life-Cycle Cost Approach to Planning and Management". First edition. 1-81. New York: Routledge.
- Rietveld, L. and Jagals, P. 2011. "Valuing water, valuing livelihoods: Guidance on social cost-benefit analysis of drinking-water interventions, with special reference to small community water supplies". 149-166. United Kingdom: IWA Publishing.
- Thompson, G. 2009. "Statistical Literacy Guide - How to adjust for Inflation". House of Commons Library.
- World Bank 2008. "Review of Effectiveness of Rural Water Supply Schemes in India". Report: 44789, 12-31, New Delhi: World Bank, June 2008.

Appendix

A-I: MODEL COSTING SUMMARY SHEET

Table-1: Dis-aggregated cost sheet

S.No	Head	1993-94	1994-95	1995-96	1996-97	etc	2015-16	Total
1	Capital Exp Hardware	xx	xx	xx	xx		xx	xxx
2	Capital Exp Software	xx	xx	xx	xx		xx	xxx
3	Cost of Capital	xx	xx	xx	xx		xx	xxx
4	Operation Exp	xx	xx	xx	xx		xx	xxx
5	Capital Maintenance Exp	xx	xx	xx	xx		xx	xxx
6	Expenditure on Direct Support	xx	xx	xx	xx		xx	xxx
7	Expenditure on Indirect Support	xx	xx	xx	xx		xx	xxx

Steps:

1. All disaggregated costs are collected from 1993-94 till 2015-16.
2. The costs are categorised under different heads and the table above gives the sum of the costs for each year. The present study mainly has Capital Expenditure Hardware, Capital Maintenance Expenditure and Operations and Maintenance Expenditure. There is no Cost of Capital as there is all expenditures are met from state funds.

Table-2: Converting to Present value (2015-16) using GDP deflator

S.No	Head	1993-94	1994-95	1995-96	1996-97	etc	2015-16	Total
	GDP Deflator (Respective yrs)	zz	zz	zz	zz		zz	
	Consumer Price Index (2014-15)	tt	tt	tt	tt		tt	
1	Capital Exp Hardware	yy	yy	yy	yy		yy	yyy
2	Capital Exp Software	yy	yy	yy	yy		yy	yyy
3	Cost of Capital	yy	yy	yy	yy		yy	yyy
4	Operation Exp	yy	yy	yy	yy		yy	yyy
5	Capital Maintenance Exp	yy	yy	yy	yy		yy	yyy
6	Expenditure on Direct Support	yy	yy	yy	yy		yy	yyy
7	Expenditure on Indirect Support	yy	yy	yy	yy		yy	yyy

Steps:

1. Calculation of GDP deflator:
 - The GDP values (both current and constant) are used from the Economic Survey 2015-16.
 - All the GDP values are converted to the same base year 2004-05, rather than converting to 2011-12 to restrict errors (Appendix A-V).
 - Calculation of the GDP Deflator:

$$\text{GDP Deflator} = [\text{Current price of GDP} / \text{Constant price of GDP}] * 100$$
2. The procedure for adjusting past cost information (year Y) to present cost information (year X) is:
 - Step 1: To remove the effect of inflation (to get real value of the asset)

$$[\text{Year Y value} / \text{GDP deflator of year Y}]$$
 - Step 2: To get the present cost

$$[\text{Year Y value} / \text{GDP deflator of year Y}] * \text{Price of year X}$$

Note: For price data, Consumer Price Index is used. It is a measure that examines the weighted average of prices of a basket of consumer goods and services. It is calculated by taking price changes for each item in the predetermined basket of goods and averaging them. Annual average CPI rural prices are use as the present study computes costs for the off-grid habitations of the Nilgiris district (Source: Economic Survey, 2015-16).

Table-3: Total Financial costs including annualised capital

S.No	Head	1993-94	1994-95	1995-96	1996-97	etc	2015-16	Average	Common	EB	Total
1	CapExHrd	ww	ww	ww	ww		ww	aa	rr		qqq
2	CapExSft	ww	ww	ww	ww		ww	aa	rr		qqq
3	CoC	ww	ww	ww	ww		ww	aa	rr		qqq
4	OpEx	ww	ww	ww	ww		ww	aa	rr	ee	qqq
5	CapManEx	ww	ww	ww	ww		ww	aa	rr		qqq
6	ExDS	ww	ww	ww	ww		ww	aa	rr		qqq
7	ExIDS	ww	ww	ww	ww		ww	aa	rr		qqq

Steps:

1. After converting the past values to their current values, we annualise the capital expenditures and capital maintenance expenditures according to either their normative or observed life-span.

- Normative life-span: Expected life-span of a specific component provided by TWAD, Ooty.
- Observed life-span: Actual no. years the system lasts.

Since, all the components in the water supply infrastructure systems have been functioning till date, we have annualised costs according to the normative life-span of the system which is 30 years as per TWAD norms.

2. Annualising capital costs:

Example: Annualising the capital exp. hardware cost incurred in 1996-97.

$$= \text{CapManEx}_{1996-97} / \text{Years} = \text{yy} / 30 = \text{ww}$$

This amount will be added to the following years from 1996-97 till 2025-26 (i.e. 30 years).

3. The average value of 2013-14 and 2014-15 is taken as EB value for evaluation purpose.

Table-4: Financial analysis (Public investments only)

Head	As per Norms				Actual HH survey			
	Avg. cost per year (2015-16 prices)	Qty. of water supplied (lpcd)	Pop ^{ln}	Unit cost (lpcd)	Avg. cost per year (2015-16 prices)	Qty. of water supplied (lpcd)	Pop ^{ln}	Unit cost (lpcd)
CapExHrd	pp	40	hh	u	pp	vv	hh	u
CapExSft	pp	40	hh	u	pp	vv	hh	u
CoC	pp	40	hh	u	pp	vv	hh	u
OpEx	pp	40	hh	u	pp	vv	hh	u
CapManEx	pp	40	hh	u	pp	vv	hh	u
ExDS	pp	40	hh	u	pp	vv	hh	u
ExIDS	pp	40	hh	u	pp	vv	hh	u
Total	ppp			uu	ppp			uu

Steps:

1. The financial costs includes only the public investments in water supply infrastructure and its maintenance.
2. The unit costs are estimated with respect to the quantity used as per TWAD norms and Household survey respectively.
3. As per TWAD norms the quantity supplied per person is 40 liters per day while HH survey gives a quantity of vv liters per person per day. Quantity of water by households are weighted average of monsoon and summer water use.
4. Estimation of unit-cost of water per liter is:

$$\text{Cost per unit of water} = \text{Rs} [\text{Annualised cost} / \text{Quantity of water used}]$$

Table-5: Economic analysis (Public and Private investments)

Head	As per Norms				Actual HH survey			
	Avg. cost per year (2015-16 prices)	Qty. of water supplied (lpcd)	Pop ^{ln}	Unit cost (lpcd)	Avg. cost per year (2015-16 prices)	Qty. of water supplied (lpcd)	Pop ^{ln}	Unit cost (lpcd)
CapExHrd	pp	40	hh	u	pp	vv	hh	u
HH CapExHrd	pp	40	hh	u	pp	vv	hh	u
CapExSft	pp	40	hh	u	pp	vv	hh	u
CoC	pp	40	hh	u	pp	vv	hh	u
OpEx	pp	40	hh	u	pp	vv	hh	u
HHOpEx	pp	40	hh	u	pp	vv	hh	u
CapManEx	pp	40	hh	u	pp	vv	hh	u
ExDS	pp	40	hh	u	pp	vv	hh	u
ExIDS	pp	40	hh	u	pp	vv	hh	u
Opp. cost	g	40	hh	gy	g	vv	hh	gy
Total	ppp			uu	ppp			uu

Steps:

1. The economic costs include both the public investments and household investments in water supply infrastructure and its maintenance.
2. The unit costs are estimated with respect to the quantity used as per TWAD norms and Household survey respectively.
3. Household Capital Expenditure includes costs incurred in pipelines, taps, things used to store water at home like tanks, pots, etc. and filtration cost (if any). HH Capital expenditure is annualised for 30 years in case of pipelines and 10 years in case of storage tanks/drums.
4. Household Maintenance Expenditure includes the costs related to maintenance of pipelines/ taps.
Note: HHOpEx includes recurring expenditure paid to pump operators and pump operators' expenses. Pump operators spend some amount from their pocket mainly for cleaning tanks which is not reimbursed by the panchayat, while in some villages the pump operators collect Rs.20/month per household to meet the expenses. These expenses are also included in the Household maintenance exp.
5. Opportunity cost of time used to fetch water from the public water tap to the house is calculated in minutes per person per day. Time taken to fetch by households are weighted average of monsoon and summer water use. (Monsoon: 9 months; Summer: 3 months).
6. Deriving the monetary value for the opportunity cost of time using the MGNREGA programme's wage rate (value of minimum wage-rate). The MGNREGA wage rate in 2016 is Rs.203/person for 8hrs of work/day. Therefore, [Rs203/8 hrs/60min] Rs. 0.42 is the minimum wage rate per person per day per minute.
Example: Opportunity cost of time for Chinna Karumpalam is **g** min/capita/day
= **g***0.42 = Rs **gy**

7. Estimation of unit-cost of water per liter is:

$$\text{Cost per unit of water} = \text{Rs } [\text{Annualised cost}/\text{Quantity of water used}]$$

A-II: CHINNA KARUMPALAM

Financial analysis (Public investments only)

Head	As per Norms				Actual Household survey			
	Avg. cost per year (2015-16 prices)	Qty. of water supplied (lpcd)	Pop ^{ln}	Unit cost (lpcd)	Avg. cost per year (2015-16 prices)	Qty. of water supplied (lpcd)	Pop ^{ln}	Unit cost (lpcd)
CapExHrd	20174	40	482	0.0029	20174	52.5	482	0.0022
CapExSft	0	40	482	0.0000	0	52.5	482	0.0000
CoC	0	40	482	0.0000	0	52.5	482	0.0000
OpEx	53267	40	482	0.0076	53267	52.5	482	0.0058
CapManEx	16266	40	482	0.0023	16266	52.5	482	0.0018
ExDS	0	40	482	0.0000	0	52.5	482	0.0000
ExIDS	0	40	482	0.0000	0	52.5	482	0.0000
Total	89707			0.0127	89707			0.0097

Economic analysis (Public and Private investments)

Head	As per Norms				Actual Household survey			
	Avg. cost per year (2015-16 prices)	Qty. of water supplied (lpcd)	Pop ^{ln}	Unit cost (lpcd)	Avg. cost per year (2015-16 prices)	Qty. of water supplied (lpcd)	Pop ^{ln}	Unit cost (lpcd)
CapExHrd	20174	40	482	0.0029	20174	52.5	482	0.0022
HH CapExHrd	125	40	482	0.0085	125	52.5	482	0.0065
CapExSft	0	40	482	0.0000	0	52.5	482	0.0000
CoC	0	40	482	0.0000	0	52.5	482	0.0000
OpEx	53267	40	482	0.0076	53267	52.5	482	0.0058
HHOpEx	31	40	482	0.0021	31	52.5	482	0.0016
CapManEx	16266	40	482	0.0023	16266	52.5	482	0.0018
ExDS	0	40	482	0.0000	0	52.5	482	0.0000
ExIDS	0	40	482	0.0000	0	52.5	482	0.0000
Opp. cost	4.12	40	482	0.00028	4.12	52.5	482	0.0002
Total	89868			0.0237	89868			0.0181

Service levels and indicators

Service level	Quantity (lppd)	Quality	Accessibility (min/capita/day)	Reliability	Status
High	≥60	Good	≤10	Very reliable	Improved
Intermediate	≥40	Acceptable	≤30	Reliable/Secure	Improved
Basic	≥20	Acceptable	≤30	Reliable/Secure	Improved
Sub-standard	≥5	Problematic	≤60	Problematic	Unimproved
No service	≤5	Unacceptable	≥60	Unreliable/Insecure	Unimproved

Note: The village gets water only from natural spring. The households' responses on the service levels are highlighted under each indicator to determine the overall status of the water supply system in the village.

A-III: HALORAI

Financial analysis (Public investments only)

Head	As per Norms				Actual Household survey			
	Avg. cost per year (2015-16 prices)	Qty. of water supplied (lpcd)	Pop ^{ln}	Unit cost (lpcd)	Avg. cost per year (2015-16 prices)	Qty. of water supplied (lpcd)	Pop ^{ln}	Unit cost (lpcd)
CapExHrd	47849	40	400	0.0082	47849	58.3	400	0.0056
CapExSft	0	40	400	0.0000	0	58.3	400	0.0000
CoC	0	40	400	0.0000	0	58.3	400	0.0000
OpEx	46340	40	400	0.0079	46340	58.3	400	0.0054
CapManEx	11209	40	400	0.0019	11209	58.3	400	0.0013
ExDS	0	40	400	0.0000	0	58.3	400	0.0000
ExIDS	0	40	400	0.0000	0	58.3	400	0.0000
Total	105398			0.0180	105398			0.0124

Economic analysis (Public and Private investments)

Head	As per Norms				Actual Household survey			
	Avg. cost per year (2015-16 prices)	Qty. of water supplied (lpcd)	Pop ^{ln}	Unit cost (lpcd)	Avg. cost per year (2015-16 prices)	Qty. of water supplied (lpcd)	Pop ^{ln}	Unit cost (lpcd)
CapExHrd	47849	40	400	0.0082	47849	58.3	400	0.0056
HH CapExHrd	121	40	400	0.0083	121	58.3	400	0.0057
CapExSft	0	40	400	0.0000	0	58.3	400	0.0000
CoC	0	40	400	0.0000	0	58.3	400	0.0000
OpEx	46340	40	400	0.0079	46340	58.3	400	0.0054
HHOpEx	75	40	400	0.0051	75	58.3	400	0.0035
CapManEx	11209	40	400	0.0019	11209	58.3	400	0.0013
ExDS	0	40	400	0.0000	0	58.3	400	0.0000
ExIDS	0	40	400	0.0000	0	58.3	400	0.0000
Opp. cost	2.71	40	400	0.0002	2.71	58.3	400	0.0001
Total	105596			0.0316	105596			0.0217

Service levels and indicators

Service level	Quantity (lppd)	Quality	Accessibility (min/capita/day)	Reliability	Status
High	≥60	Good	≤10	Very reliable	Improved
Intermediate	≥40	Acceptable	≤30	Reliable/Secure	Improved
Basic	≥20	Acceptable	≤30	Reliable/Secure	Improved
Sub-standard	≥5	Problematic	≤60	Problematic	Unimproved
No service	≤5	Unacceptable	≥60	Unreliable/Insecure	Unimproved

Note: The village gets water from spring and open well. The least response on the service levels from both sources is highlighted under each indicator to determine the overall status of the water supply system in the village.

A- IV: JAVANA GOWDER LANE

Financial analysis (Public investments only)

Head	As per Norms				Actual Household survey			
	Avg. cost per year (2015-16 prices)	Qty. of water supplied (lpcd)	Pop ^{ln}	Unit cost (lpcd)	Avg. cost per year (2015-16 prices)	Qty. of water supplied (lpcd)	Pop ^{ln}	Unit cost (lpcd)
CapExHrd	37837	40	175	0.0148	37837	12.125	175	0.0488
CapExSft	0	40	175	0.0000	0	12.125	175	0.0000
CoC	0	40	175	0.0000	0	12.125	175	0.0000
OpEx	45137	40	175	0.0176	45137	12.125	175	0.0582
CapManEx	9148	40	175	0.0035	9148	12.125	175	0.0118
ExDS	0	40	175	0.0000	0	12.125	175	0.0000
ExIDS	0	40	175	0.0000	0	12.125	175	0.0000
Total	56695			0.0361	56695			0.1189

Economic analysis (Public and Private investments)

Head	As per Norms				Actual Household survey			
	Avg. cost per year (2015-16 prices)	Qty. of water supplied (lpcd)	Pop ^{ln}	Unit cost (lpcd)	Avg. cost per year (2015-16 prices)	Qty. of water supplied (lpcd)	Pop ^{ln}	Unit cost (lpcd)
CapExHrd	37837	40	175	0.0148	37837	12.125	175	0.0029
HH CapExHrd	742	40	175	0.0508	742	12.125	175	0.1676
CapExSft	0	40	175	0.0000	0	12.125	175	0.0000
CoC	0	40	175	0.0000	0	12.125	175	0.0000
OpEx	45137	40	175	0.0177	45137	12.125	175	0.0583
HHOpEx	313	40	175	0.0214	313	12.125	175	0.0708
CapManEx	9148	40	175	0.0036	9148	12.125	175	0.0118
ExDS	0	40	175	0.0000	0	12.125	175	0.0000
ExIDS	0	40	175	0.0000	0	12.125	175	0.0000
Opp. cost	2.51	40	175	0.0001	2.51	12.125	175	0.0006
Total	57753			0.1085	57753			0.3580

Service levels and indicators

Service level	Quantity (lpcd)	Quality	Accessibility (min/capita/day)	Reliability	Status
High	≥60	Good	≤10	Very reliable	Improved
Intermediate	≥40	Acceptable	≤30	Reliable/Secure	Improved
Basic	≥20	Acceptable	≤30	Reliable/Secure	Improved
Sub-standard	≥5	Problematic	≤60	Problematic	Unimproved
No service	≤5	Unacceptable	≥60	Unreliable/Insecure	Unimproved

Note: The village households have their own individual open wells to meet their daily water needs. The responses on the service levels of only those households which consume water from public common well are highlighted under each indicator to determine the overall status of the water supply system in the village.

A-V: Calculation of GDP Deflator

GDP Deflator is a more reliable Index of Inflation.

$$\text{GDP Deflator} = [\text{Current price of GDP} / \text{Constant price of GDP}] * 100$$

YEAR	GDP (Current Prices)	GDP (Constant Prices)	GDP Deflator
1990-91	586212	1487615	39.406
1991-92	673875	1503337	44.825
1992-93	774545	1585756	48.844
1993-94	891355	1661092	53.661
1994-95	1045590	1771702	59.016
1995-96	1226725	1905900	64.365
1996-97	1419277	2049786	69.240
1997-98	1572394	2132799	73.724
1998-99	1803378	2264700	79.630
1999-2000	2023130	2465029	82.073
2000-01	2177413	2559711	85.065
2001-02	2355845	2683190	87.800
2002-03	2536327	2785258	91.063
2003-04	2841503	3004190	94.585
2004-05	3242209	3242209	100.000
2005-06	3693369	3543244	104.237
2006-07	4294706	3871489	110.932
2007-08	4987090	4250947	117.317
2008-09	5630063	4416350	127.482
2009-10	6477827	4790847	135.213
2010-11	7784115	5282386	147.360
2011-12	9009722	5633050	159.944
2012-13	10263100	5949547	172.502
2013-14	11625918	6344526	183.243
2014-15	12879436	6804091	189.290
2015-16	13992226	7319169	191.172

Source: Economic Survey 2015-16

Note: All the values in the series from 1990-91 to 2015-16 are converted to base-year 2004-05.