

## Who pays what? Communicating financial data of rural water supply in India: Community Water *plus* Research Output for DFAT, Australian Aid



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managed by Cranfield University on behalf of the Department of Foreign Affairs and Trade (DFAT) of the Australian Government

## About Community Water Plus

Community management is the common model for rural water supply, but it has limitations, particularly when it comes to the ability to sustain services over the long-term. In an effort to identify what works and what doesn't when it comes to community management, the Community Water Plus project is investigating successful community-managed rural water supply programmes and approaches across India.

The project is funded by DFAT, Australian Aid and has been implemented by a consortium of partners, including: the Administrative Staff College of India (ASCI), the Centre of Excellence for Change (CEC), Malaviya National Institute of Technology (MNIT), the Xavier Institute of Social Service (XISS) and IRC, The Netherlands with overall project coordination provided by Cranfield University. It has also been working closely with national and State government agencies as well as civil society partners.

This research output, undertaken by Cranfield University Masters students, finalised the cross-case study financial costs summary reports of the 20 case studies, to deliver consistent indicative costs incurred by external support organisations relative to varying technical modes of supply and then designed and tested a 'Financial Flow Diagram' that visually conveys the message of the 'plus', while being easily reproducible in order to encourage understanding of financial implications of Community Water plus across the WASH sector.

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Cite this publication as follows:

Guinaldo, T., Leitner, C., Justus, N., Thomas, V., Zeilinger, J. and Franceys, R. 2016. "Who pays what? Communicating financial data of rural water supply in India: Community Water plus Research Output for DFAT, Australian Aid"

*The research has been funded by the Australian Government through the Australian Development Awards Research Scheme under an award titled Community Management of Rural Water Supply Systems in India. The views expressed in this report are those of the project and not necessarily those of the Australian Government. The Australian Government accepts no responsibility for any loss, damage or injury, resulting from reliance on any of the information or views contained in this report.*

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Centre of Excellence for Change, Chennai, Tamil Nadu



Malaviya National Institute of Technology, Jaipur, Rajasthan



Xavier Institute of Social Service, Ranchi, Jharkhand



IRC, The Hague, The Netherlands



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### Acknowledgements

The research is funded by the Department of Foreign Affairs and Trade through the Australian Development Awards Scheme under an award titled 'Community management of rural water supply systems, India'.

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## **LIST OF ABBREVIATIONS**

CapEx	Capital Expenditure
CapManEx	Capital Maintenance Expenditure
CPI	Consumer Price Index
CW+	Community Water Plus
CWS	Community Water and Sanitation MSc programme
ESE	Enabling Support Environment
INR	Indian Rupee
OpEx	Operating Expenditure
PHED	Public Health Engineering Department
PPP	Purchasing Power Parity
SFD	Shit Flow Diagram
USD	United States Dollar
WASH	Water, Sanitation and Hygiene



# 1 INTRODUCTION

Over the past three years, a consortium led by Cranfield University has been implementing the Community Water Plus (CW+) project. The objective is to gain insights into the modalities and costs of service provision in what are considered successful community-managed rural water supply programmes. The project is founded on the premise that the long advocated and dominant community management model for rural water supplies has reached a limit in many low- and middle-income countries.

It is argued that in order for community managed systems to ensure long-term quality water supply services, there is a need for continued support (labelled as 'plus') from the government and other entities outside of the local community. It is often difficult to obtain reliable data on the costs of sustainable water and sanitation. Yet such data is critical to improve the planning and budgeting for WASH (Water, Sanitation and Hygiene) projects and policies. It helps to inform economic analysis of technologies and business models, thus improving the efficiency, effectiveness, and sustainability of WASH services. Ultimately, data is central to supporting developing countries to reach the Millennium Development Goals, and as such, is of great interest to donors and aid agencies. The CW+ project has been accounting this 'plus' factor, focusing on 20 purposefully sampled successful cases of community-managed water supply systems in India. Each case study consists of three best practice villages with similar water supply setups, and one control village using a different model. The cases cover a wide range of socio-economic, political and geographic conditions, and of applied water supply technologies.

This project has contributed directly to the CW+ project. The team was primarily expected to develop financial flow visuals that would support communication on indicative costs of the external 'plus' support necessary to enable communities to deliver good water services to every household.

To this end, the project had two specific objectives:

1. To prepare a reliable database of financial data by analysing and consolidating existing data from reports and research protocols. The database, which was required to design Financial Flow Diagrams for the 20 case studies, was to include indicative costs incurred by external support organisations relative to varying technical modes of supply.
2. To design and test a Financial Flow Diagram that visually conveys the message of the 'plus', while being easily reproducible in order to encourage use across the WASH sector.

The following section of this report describes how the team built a consolidated database reflecting the capital and recurrent expenditure associated with the construction, operation and maintenance of the rural water supply systems in all 20 case studies.

In sections 3, we describe the context in which the client had developed the initial draft Financial Flow Diagram. This diagram was the starting point of the project, and determined its frame of reference for the visualisation of financial data.

In section 4, we describe the design parameters considered when preparing the Financial Flow Diagram. These include the choice of a diagram type to display resource flows, associated tools and software, arguments about the strengths and limitations of fixed versus interactive visuals, and aspects such as readability, colour, and visual grouping.

In section 5, we juxtapose the diagrams that we submitted for testing to a panel of key informants, including some closely related to the CW+ project. We summarise the feedback we received, and present our final Financial Flow Diagram.

In the last section of this report, we provide a critical analysis of both the strengths and the limitations of using Financial Flow Diagrams as a means to visualise the funding structure in rural water supply.

The conclusion sums-up the key lessons learned from this project, the value of the outputs, and the extent to which they may be used as part of communication and advocacy programmes.

## 2 SUMMARY COST TABLE

This project started by analysing the financial data of the 20 case studies, which eight researchers of Indian partner institutions had previously collected. Figure 1 and Table 1 give an overview of these case studies.

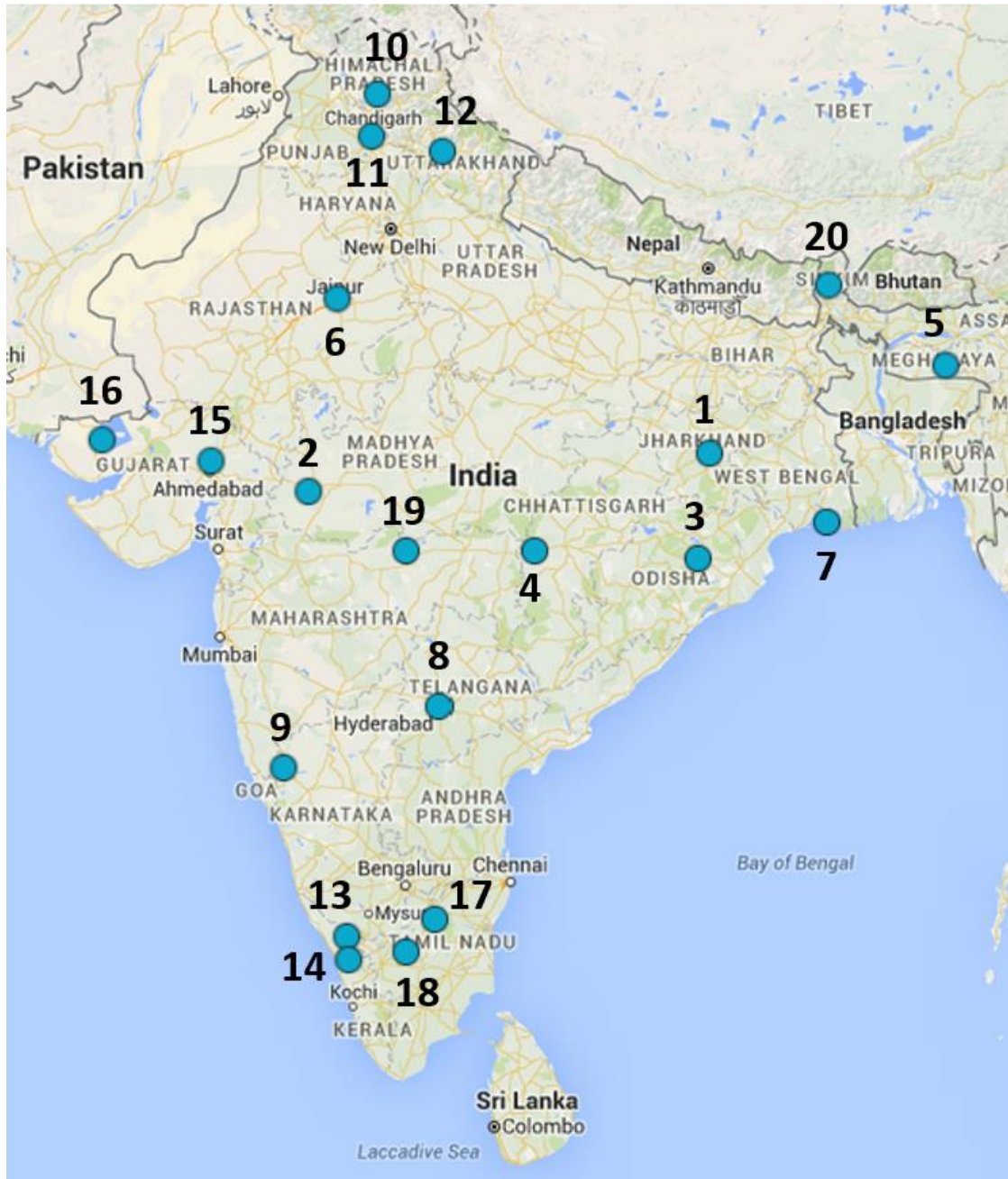


Figure 1: Map of India with the 20 CW+ case studies

**Table 1: Overview of the 20 CW+ case studies in India**

#	Indian State	#	Indian State
1	Jharkhand	11	Punjab
2	Madhya Pradesh	12	Uttarakhand
3	Odisha	13	Kerala (Kodur)
4	Chhattisgarh	14	Kerala (Nenmeni)
5	Meghalaya	15	Gujarat (Ghandinagar)
6	Rajasthan	16	Gujarat (Kutch)
7	West Bengal	17	Tamil Nadu (Morappur)
8	Telangana	18	Tamil Nadu (Kathirampatti)
9	Karnataka	19	Maharashtra
10	Himachal Pradesh	20	Sikkim

The financial data were summarised in Summary Cost Tables. The initial version of one case study table is shown in Table 2. The table contains average data of the three best practice villages of each case study. In a few cases, some of the best practice villages were not taken into account due to significant data gaps. In the case studies of West Bengal, Telangana, and Tamil Nadu (Kathirampatti), data was available for only one best practice village and the corresponding control village. In the Tamil Nadu (Morappur) case study, data was available for two best practice villages and the control village.

The dataset initially suffered from two major shortcomings: some expenditure records were missing, while for some other contradicting information was available in reports and costing databases. The responsible researchers of the CW+ project had analysed and processed the data to varying degrees, making different assumptions. It was not yet possible to visualise the financial data at this stage.

We therefore systematically traced back and validated missing or conflicting data. Most detailed data were available in draft case study reports and in corresponding Excel sheets. Where necessary, we discussed data with the researchers. Some additional adjustments, such as adding overhead costs to reflect higher-level staff expenses, were necessary across a majority of cases.

**Table 2: Initial Summary Cost Table for case study 4 Chhatthisgarh in 2014 United States Dollars (USD) in Purchasing Power Parity (PPP)**

Source of Funds	Use of Funds Implementation			Use of Funds Annual Recurrent									
	Capex Hardware	Capex Software	CAPEX TOTAL	Opex Labour	Opex Power	Opex Chemicals	Opex Minor Spares	Opex Office	Bulk Water	Opex ESE Support	CapManEx Hardware	CapManEx Software	RECURRENT TOTAL
Community/Consumer	\$ -	\$ -	\$ -	\$ 0,38	\$ 1,87	\$ 0,01	\$ 0,18	\$ -	\$ -	\$ -	\$ 0,15	\$ -	\$ 2,59
Gram Panchayat (PRI)	\$ -	\$ -	\$ -	\$ 0,09	\$ 0,36	\$ 0,00	\$ 0,03	\$ -	\$ -	\$ -	\$ 0,04	\$ -	\$ 0,52
	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
State Government entity (incl elec. Subs	\$ -	\$ -	\$ -	\$ 0,13	\$ 0,60	\$ 0,00	\$ 0,04	\$ -	\$ -	\$ -	\$ 0,13	\$ -	\$ 0,91
PHED or equivalent	\$ 110,19	\$ 2,04	\$ 112,24	\$ 0,09	\$ 0,25	\$ 0,00	\$ 0,02	\$ -	\$ -	\$ 0,25	\$ 0,04	\$ -	\$ 0,64
WSSO/BRC or equivalent	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Gol Programme	\$ -	\$ -	\$ -	\$ 0,13	\$ 0,60	\$ 0,00	\$ 0,04	\$ -	\$ -	\$ -	\$ 0,13	\$ -	\$ 0,91
NGO Donor National/International	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
World Bank/International Donor	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
TOTALS	\$ 110,19	\$ 2,04	\$ 112,24	\$ 0,82	\$ 3,68	\$ 0,01	\$ 0,31	\$ -	\$ -	\$ 0,25	\$ 0,50	\$ -	\$ 5,57
'Plus' %age	100%	100,00%	100%	52,97%	49,09%	30,11%	43,44%	#DIV/0!	#DIV/0!	100,00%	69,79%	#DIV/0!	53,4%

Notes: Assuming a 50/50 split of the funding for OpEx support to the CSP by the PHED between the Gol and the GoC (State Finance Commission)

As we improved our understanding of the available financial data and the message we aim to communicate, we simplified the Summary Cost Table. It initially presented recurrent expenditure in nine categories. Moving away from this very high level of detail, we subsumed recurrent expenditure into the following five subgroups:

- OpEx (operating expenditure) labour & materials,
- OpEx power,
- OpEx bulk water,
- OpEx enabling support and
- CapManEx.

We refined and standardised the row and column headings to avoid misunderstandings. We chose general terminology over entity names that are specific to India and the CW+ project in order to allow comparison both across case studies and to future datasets in other regions. For example, we changed Public Health Engineering Department (PHED) to State water supply agency, and Gram Panchayat to Local self-government. Where necessary, we added notes to explain underlying assumptions that could not be reflected within the table itself. Table 3 shows an example of the Summary Cost Table's final iteration.

To allow comparison, medians of recurrent and capital expenditure across all 20 case studies were added to the Summary Cost Table. We decided to use the median as opposed to the mean because it is more resistant to the widely scattered values on the top end of our dataset's distribution of values. These large differences in expenditure result both from the varying degrees, to which communities' water needs have already been addressed, as well as from the varying capital intensity of used technologies, including handpumps and multi-village piped network schemes.

**Table 3: Final Summary Cost Table for case study 4 Chhatthisgarh in 2014 USD in PPP**

Source of funds	Use of funds - implementation			Use of funds - annual recurrent					RECURRENT EXPENDITURE TOTAL
	CapEx hardware	CapEx software	CAPEX TOTAL	OpEx labour & materials	OpEx power	OpEx bulk water	OpEx enabling support	CapManEx	
Community/consumers	-	-	-	\$ 0,57	\$ 1,87	-	-	\$ 0,15	\$ 2,59
Local self-government	-	-	-	\$ 0,12	\$ 0,36	-	-	\$ 0,04	\$ 0,52
State government entity	-	-	-	\$ 0,17	\$ 0,60	-	-	\$ 0,13	\$ 0,91
State water supply agency	\$ 110,19	\$ 2,04	\$ 112,24	\$ 0,11	\$ 0,25	-	\$ 0,25	\$ 0,04	\$ 0,64
Government of India	-	-	-	\$ 0,17	\$ 0,60	-	-	\$ 0,13	\$ 0,91
NGO national & international	-	-	-	-	-	-	-	-	-
International donor	-	-	-	-	-	-	-	-	-
TOTALS	\$ 110,19	\$ 2,04	\$ 112,24	\$ 1,14	\$ 3,68	-	\$ 0,25	\$ 0,50	\$ 5,57
Median of 20 case studies			\$ 184,16						\$ 11,78
'Plus' %age	100%	100%	100%	50%	49%	-	100%	70%	53%
Median of 20 case studies			95%						57%

Notes: Assuming a 50/50 split of the funding for OpEx support to the community by the State water supply agency between the Government of India and the State

All financial data had been collected in Indian Rupees (INR). For most types of recurrent expenditure it was available for 2014. Capital expenditure (CapEx) and capital maintenance expenditure (CapManEx), however, had been recorded in INR of the year in which they had been incurred. In order to allow comparison between case studies, we converted CapEx and CapManEx data to 2014 INR. Following a previously developed CW+ methodology, we employed two indices for this conversion: the Indian Consumer Price Index (CPI) for software expenditure, and a separate index based on the Construction Industry Development Council Indices for hardware costs because the CPI overstates their inflation rate. We converted all data from INR to USD in Purchasing Power Parity (PPP) using the 2014 mid-year conversion rate and the World Bank PPP Index. This is necessary to account for different price levels across the globe. Converting expenditure in local currency to international dollars allows comparison between different countries (Eurostat 2014).

Another database called 'Master spreadsheet table' was created for subsequent statistical analysis. This database contains disaggregated information for each best practice village and for the control village of each case study. It will be used in a PhD project to analyse the links between expenditure and achieved service levels.



The complete set of financial data for all 20 case studies was due by the end of March 2016. Before the handover, we reviewed the financial data with the client to verify all changes. We then shifted our focus to data visualisation. The two following sections discuss how our visualisation ideas progressed over the course of the project, and present the final Financial Flow Diagram.

### 3 INITIAL VISUALISATION IDEAS

The Financial Flow Diagram is an advocacy and communication tool. It aims at visualising the ‘plus’ percentage necessary for sustainable community-managed rural water supply services. The Financial Flow Diagram follows a visualisation approach that was popularised in the WASH sector by Shit Flow Diagrams (SFDs).

#### 3.1 Earlier flow diagrams

Both the SFD and the Financial Flow Diagram are rooted in the idea of tracking the flow of a key variable across a system. The infographics by Charles Joseph Minard shown in Figure 2 and Figure 3 are early and very powerful iterations of this concept.

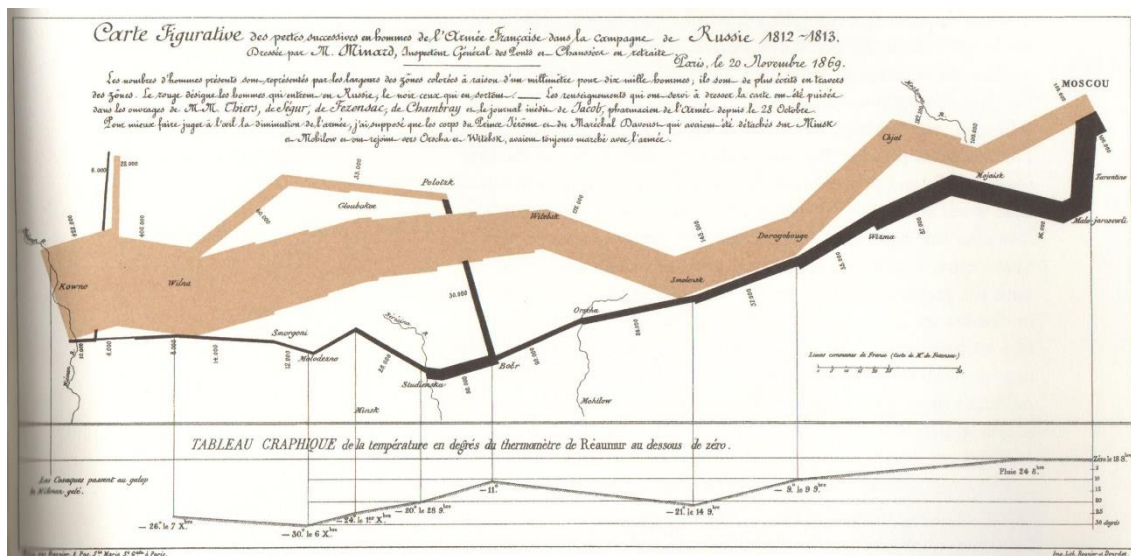
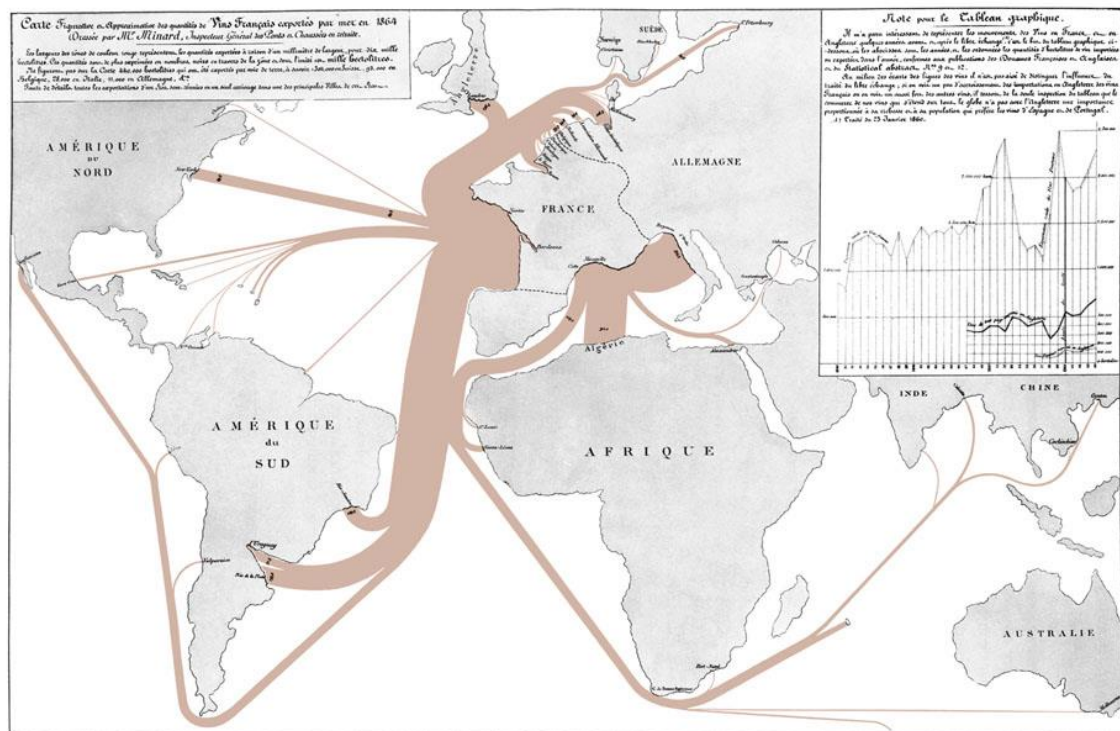


Figure 2: Carte figurative des pertes successives en hommes de l'Armée Française dans la campagne de Russie 1812-1813 (Minard 1861) as shown in Tufte (1983)

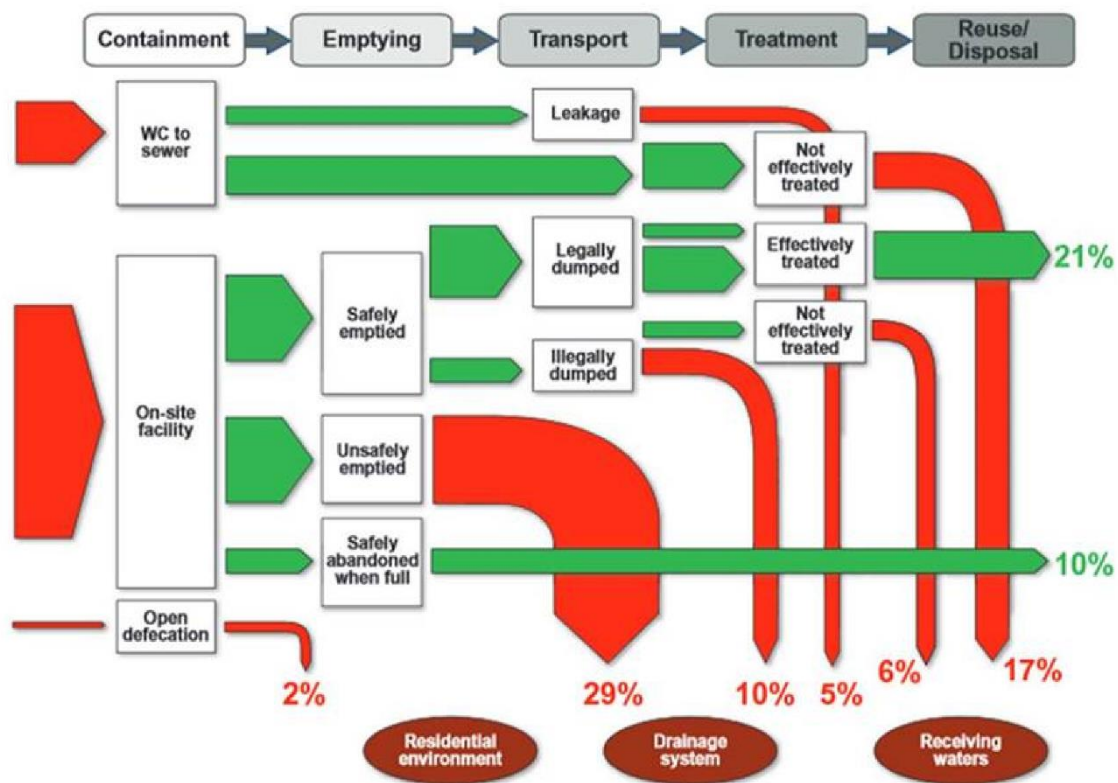


Charles Joseph Minard, *Tableaux Graphiques et Cartes Figuratives de M. Minard, 1845-1869*, a portfolio of his work held by the Bibliothèque de l'École Nationale des Ponts et Chaussées, Paris.

**Figure 3: Carte figurative et approximative des quantités de Vins Français exportés par mer en 1864 (Minard unknown) as shown in Tufte (1983)**

### 3.2 Shit Flow Diagram

Building on earlier flow diagrams, SFDs (see Figure 4) display physical flow of excreta within a defined area as it moves from source to containment, emptying, transport, treatment and reuse or disposal (SFD Promotion Initiative 2015). They do not show data along a temporal dimension. SFDs provide a snapshot of an area's sanitation system at the time when the diagram is created.



**Figure 4: SFD for Dakar, Senegal (Blackett et al. 2014)**

The World Bank Water and Sanitation Program developed the SFD approach in 2012-2013 (SFD Promotion Initiative 2015). The diagrams are used for advocacy and decision-making support in urban sanitation. They are published together with an accompanying report and the complete dataset used to produce both the diagram and the report. SFDs target stakeholders with and without technical backgrounds (SFD Promotion Initiative 2015).

In the CW+ project, this methodology, which is now used widely in urban sanitation, was transferred to rural water supply. The Financial Flow Diagram, as envisaged by the client and refined in this project, builds on the SFD approach in many ways. However, instead of excreta moving along the sanitation value chain, it displays flows of funds from source to use. In contrast to SFDs, the Financial Flow Diagram, shows data relating to two different reference periods – recurrent expenditure in \$/person/year and one-off CapEx in \$/person.

### 3.3 Initial versions of the Financial Flow Diagram

Following the visualisation approach taken by flow diagrams, and more specifically by SFDs, the client had created the generic initial Financial Flow Diagram as shown in Figure 5. This visual sparked considerable interest when presented to other stakeholders in the Indian rural water supply sector, but required further explanation in order to convey its message. The initial diagram combines the visual language of material flow diagrams with symbolic messages such as a water reservoir being 'topped up' by CapManEx. It splits OpEx into several components including labour, power and minor spares.

In this generic initial diagram, only few entities contribute to capital and recurrent expenditure. It could get considerably harder to read when more entities contribute to both types of expenditure, requiring more arrows to display these flows.

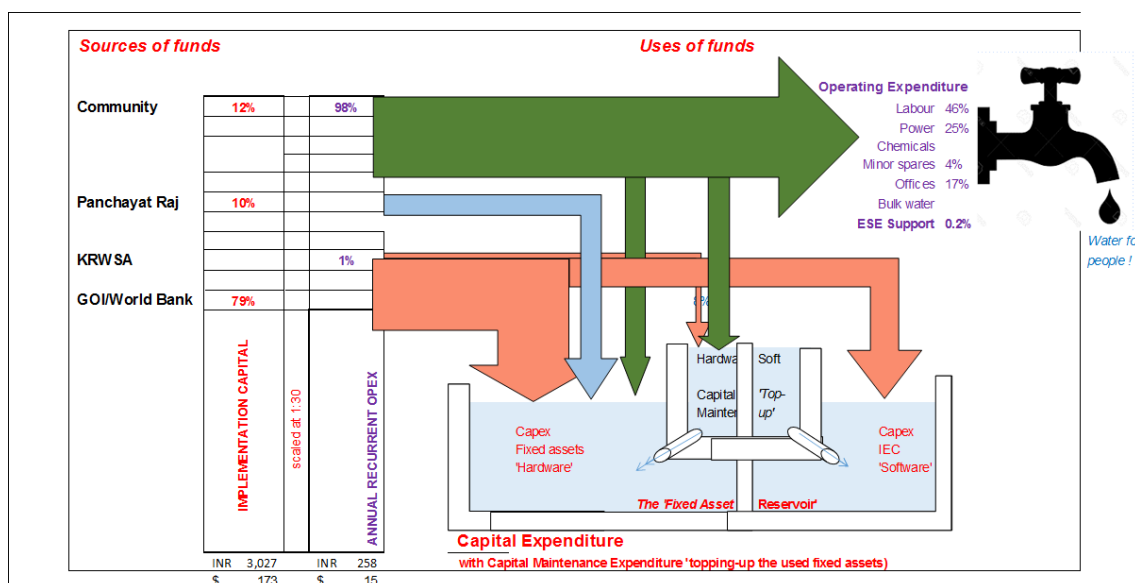


Figure 5: Generic initial Financial Flow Diagram (Franceys, 2015)

We took this diagram as a starting point and reviewed literature on flow diagrams, as well as on data visualisation in general. Our sources of inspiration for the visual representation of (quantitative) data include Aisch (2013), Cleveland and McGill (1984), EIA (2016), Fung (2016), GLAAS (2015), IEA (2016), Knezovich (2015), Lima (2016), LLNL (2016), McCandless (2014), Morelli (2016), Phineas (2016), Rebecca (2016), Tufte (1983, 1990), and Vande Moere (2016).

At the beginning of this phase of the project, we drafted interactive Financial Flow Diagrams for webpages and presentations, as well as static ones for printed reports. Interactive visuals might make it possible to display more information than static ones distracting or confusing the reader.

The interactive diagrams shown in Figure 6 to Figure 9, however, allow readers to explore the data according to their interests by using a point-and-click approach. Readers can click buttons to change the colour of the flow arrows, as well as to see further explanations of the entities and types of expenditure (compare between Figure 6 and Figure 7, and between Figure 8 and Figure 9). This allows showing more information in one diagram than is possible in static visuals, and allows the reader to choose the order in which he works through it. This might help readers understand who contributes how much to what.

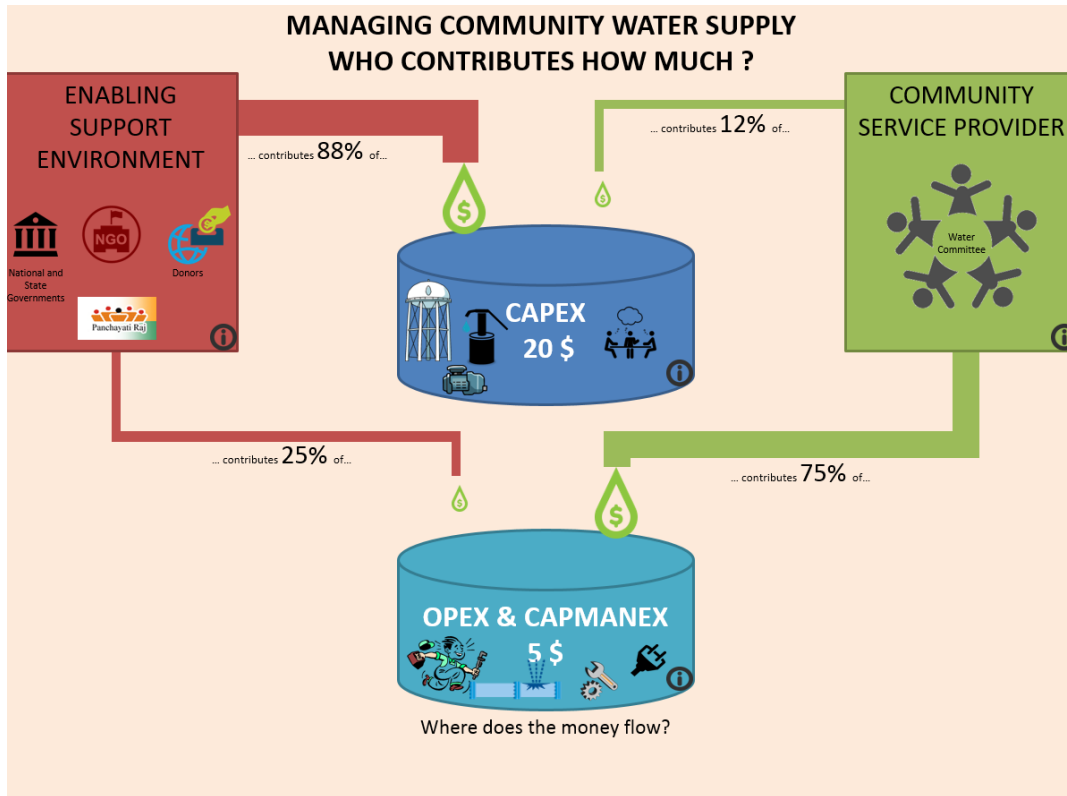


Figure 6: Interactive trial version 1 – little information shown

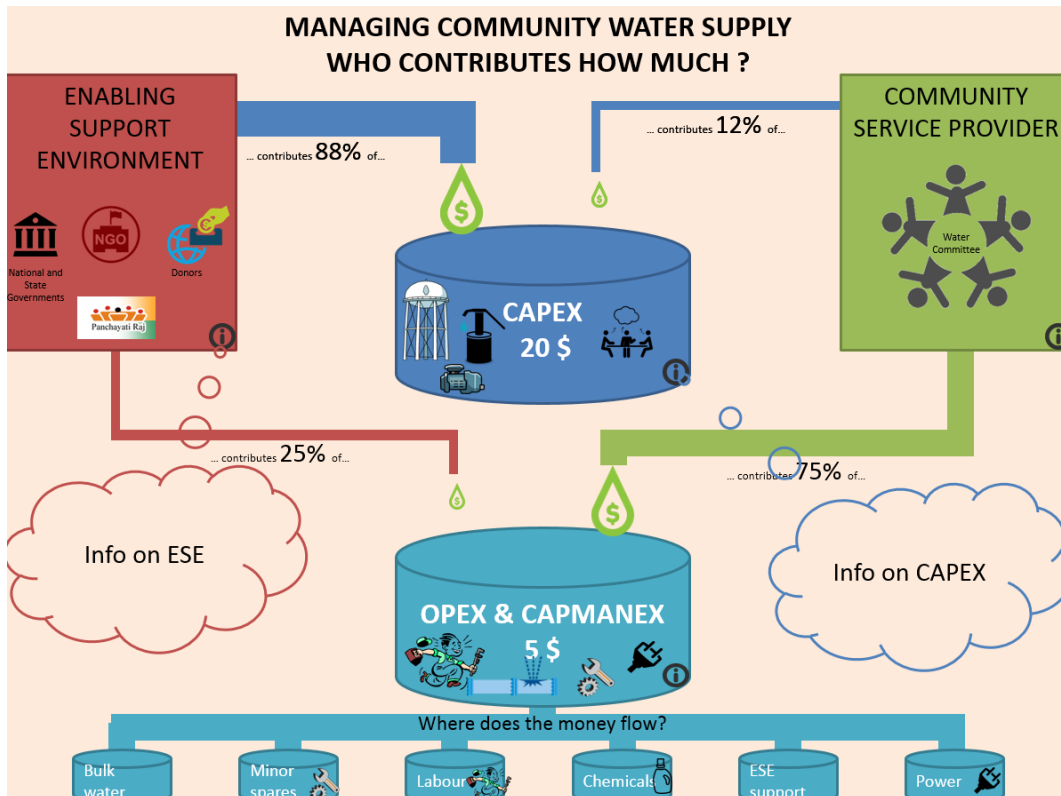


Figure 7: Interactive trial version 1 – more information shown

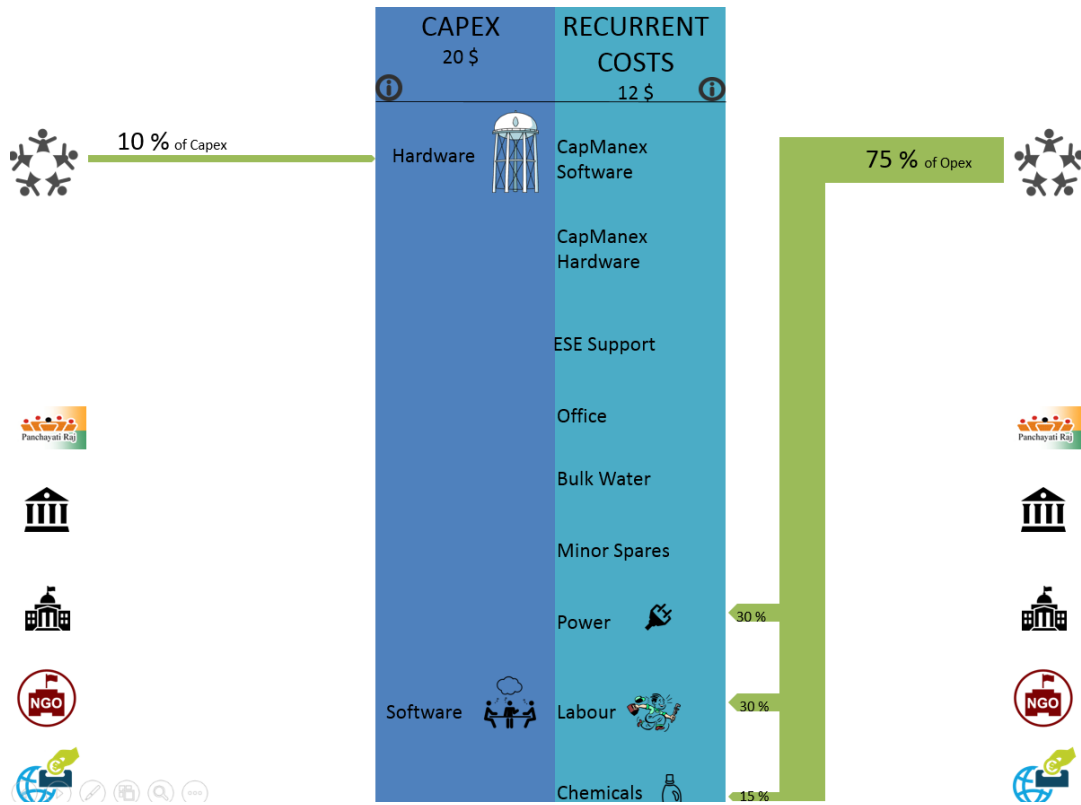


Figure 8: Interactive trial version 2 – little information shown

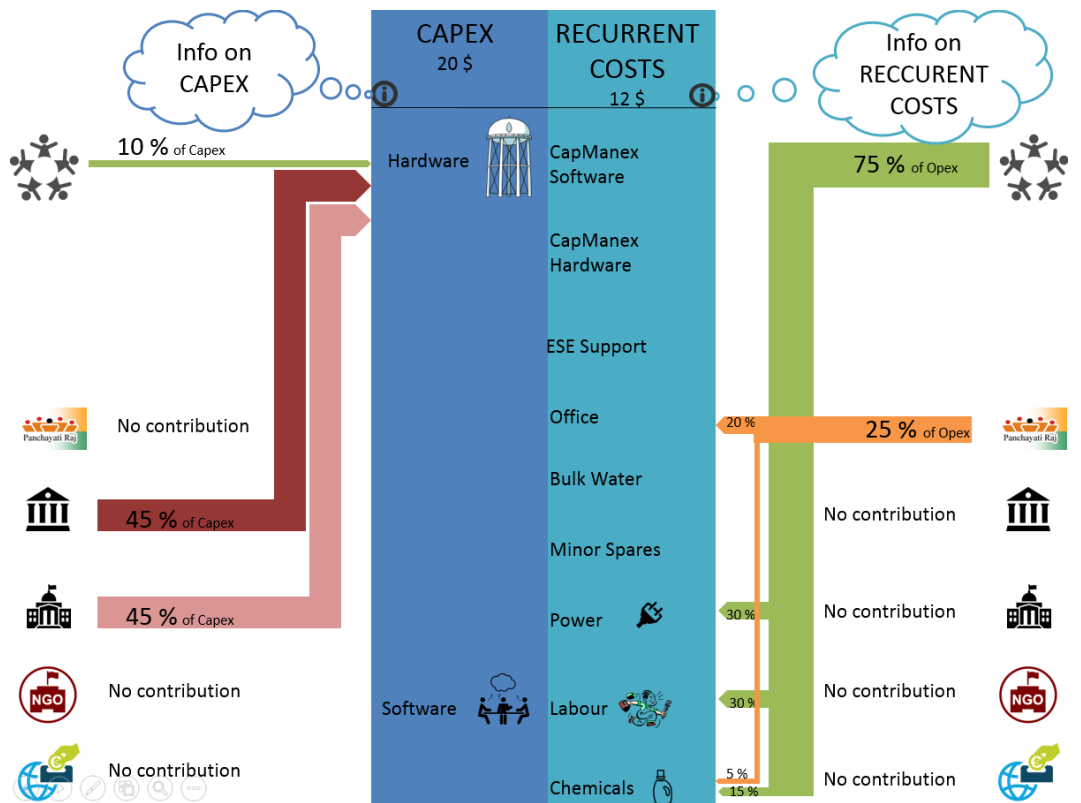


Figure 9: Interactive trial version 2 – more information shown



Figure 7 and Figure 7 give equal visual weight to the Enabling Support Environment (ESE) and the community. In doing so, it does not reflect the relative size of financial contributions. The diagram does not differentiate between payments by the various ESE entities.

The main problem of Figure 8 and Figure 9 lies in the use of rectangular angles for flow arrows. In order to remain consistent about the visual code of using arrow width to represent the size of financial contributions, these arrows should not overlap. As the space available on both sides of the diagram is limited, it would be difficult to stay true to the principals of the diagram in case studies where several entities contribute to a number of expenditure types. PowerPoint and similar software packages are ill suited for creating flow arrows. Creating them by hand would have required professional graphic design skills, and would therefore have been outside of the project's scope. It would also have missed the aim of developing an easily reproducible graphic display of financial data.

Following the client's preference, we subsequently focused on static Financial Flow Diagrams. Static visuals are required for printed reports, and will be used on the CW+ project webpage. Based on our literature review, we consider diagrams based on Sankey diagrams as the most appropriate method to visualise key financial data of rural water supply services.

## 4 SANKEY DIAGRAMS

The Sankey diagram is a type of flow chart, which provides the conceptual basis for the design of the Financial Flow Diagram. This section gives an overview of the origins and fields of applications for Sankey diagrams. It describes how we created the Financial Flow Diagrams for the CW+ project with the online tool SankeyMATIC.

### 4.1 Origins and fields of application for Sankey diagrams

In 1898, Riall Sankey casually published a diagram illustrating the efficiency of a steam engine by showing its thermal flows. This form of data representation would later be named after him. In very simple terms, the Sankey diagrams consists of nodes and flows. Flows interlink nodes, which represent sources or sinks or process steps for those flows. Nodes are balanced, which means the input flows and the output flows are equally big. Flow width is usually a direct representation of the related quantity, which facilitates an intuitive understanding of the proportions and magnitudes of different flows in a diagram (Schmidt 2008a, 2008b).

Even in its early days, the Sankey diagram was mainly considered a communication tool for explaining and illustrating complex relations or processes in science and engineering, rather than having its main purpose in technical use. It was difficult to create accurate diagrams manually.

Sankey-like flow diagrams were used throughout the early twentieth century. They were sometimes called

*'cosmographs, [...] the trade name for a type of flow chart presenting numerical information or percentages by means of black and white stripes of paper, showing source contrasted with destination.'* (Brinton 1939, p.73)

After the First World War, Sankey diagrams were used in technical analyses of German industry to identify inefficiencies and soon became standard practice (Schmidt 2008a).

Particularly from the 1960s onwards, this concept of arrows with changing widths representing changes in flow of a variable was developed further and. It became the popular visual interface of what is now often called material flow analysis (Fischer-Kowalski 1998; Fischer-Kowalski and Hüttler 1998). Starting in the 1990s, Sankey diagrams were widely used in life cycle assessments (Schmidt 2008a). WU Vienna (2016) provides a global overview of material flow data and visualisation tools. In the field of industrial metabolism, heat balance diagrams and energy flow charts are prominent examples for the application of Sankey diagrams.

The diagrams are also useful to illustrate the flow of goods from one place to another, to visualise voter migration analyses, and to show where money comes from and where it goes, i.e. financial flows (Bogart 2016). Therefore, the Sankey diagram was chosen as a practicable way of displaying the financial data of the CW+ project.

## **4.2 SankeyMATIC**

The Financial Flow Diagram is considered as a tool to communicate and raise awareness for the 'plus' percentage of the 20 case studies in the CW+ project. Thus, we describe the process of creating the Financial Flow Diagrams in detail to facilitate easy reproduction, including beyond the scope of the CW+ project.

As a starting point, we reviewed available Sankey diagram programmes, tools and applications to evaluate ease of use and suitability for the Financial Flow Diagrams. Eventually, the browser-based tool SankeyMATIC, was chosen for creating the Financial Flow Diagrams for the CW+ project. It is available at [www.sankeymatic.com](http://www.sankeymatic.com) (see Bogart 2016).

SankeyMATIC meets the following key criteria, which mirror the outreach strategy for SFDs:

- SankeyMATIC is easy to use.
- It is a free online tool.
- There is no need for programming skills to use SankeyMATIC.
- It allows customising of the diagrams.

Bogart (2016) offers a brief but comprehensible manual for SankeyMATIC, describing the general features and advanced options. It takes three steps to create a Sankey diagram: entering the data, customising the diagram and downloading the finished product.

Figure 10 shows the default settings of SankeyMATIC as they are presented when accessing the homepage. Data is entered in a standardised format into the input section. For customising, different setting menus can be chosen and adapted to the project's needs. The box on the right shows a preview of the diagram. An automatised error check highlights the overall diagram consistency.

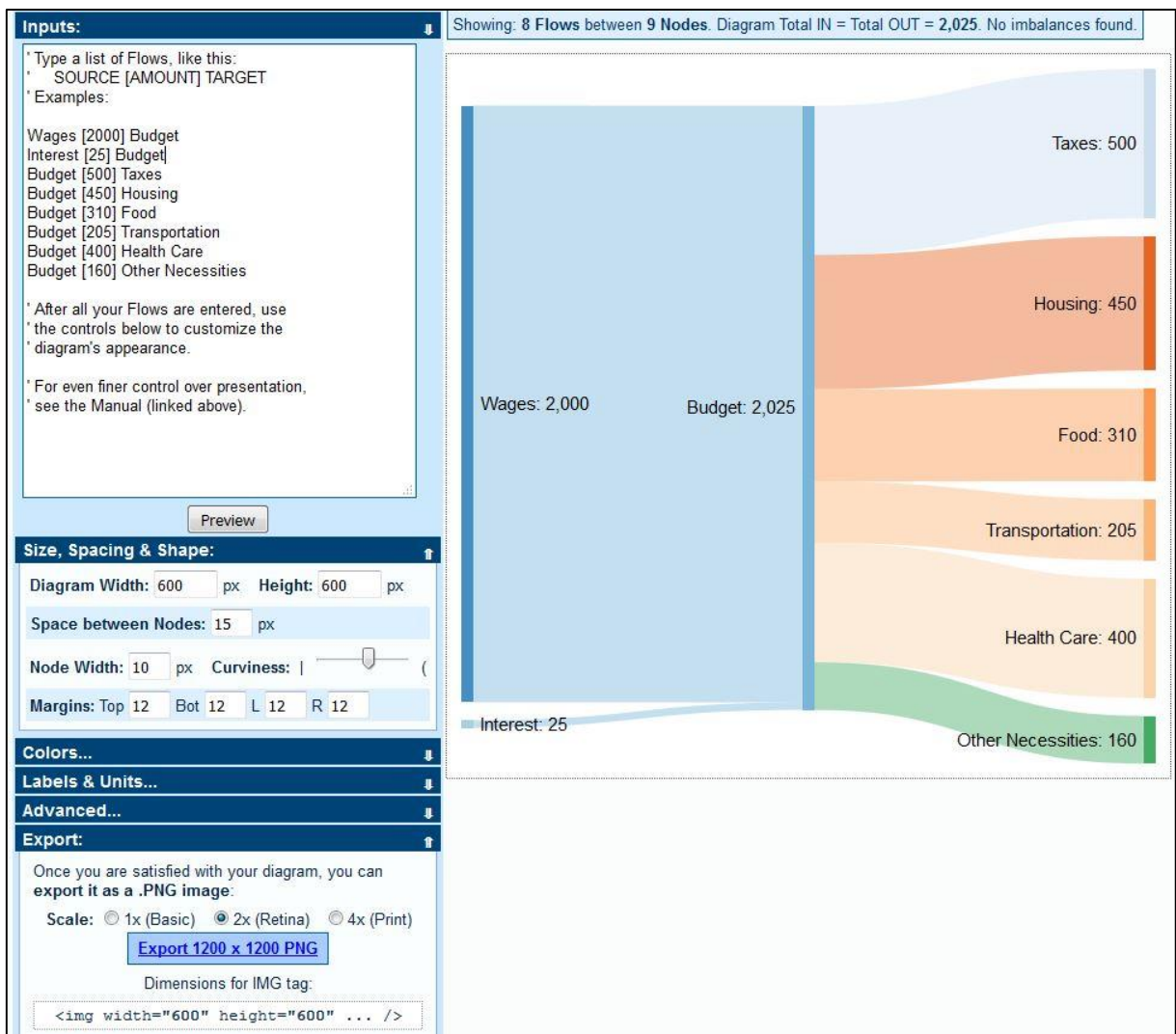


Figure 10: Default settings of SankeyMATIC

### 4.2.1 Entering the data

SankeyMATIC is only able to process data provided in a distinct format:

*Source [Number] Target*

SankeyMATIC will then create flows by connecting all source and target nodes with proportional thickness. In order to simplify the process of editing data into the SankeyMATIC format, Bogart (2016) suggests creating a simple spreadsheet document, using the columns “from”, “to” and “amount” as given in Table 4.

**Table 4: Example table as used for SankeyMATIC**

	A	B	C
1	From	To	Amount
2	Income	Budget	100
3	Budget	Expenses	60.75
4	Budget	Savings	39.25

The following formula has to be applied to all relevant rows:

*=CONCATENATE (A2, " [" ,C2, "]" ",B2) ,*

This step transfers the input into formatted datasets that can be processed by SankeyMATIC. The datasets can easily copied into the SankeyMATIC input section.

Therefore, as a first step to create the Financial Flow Diagrams, we transferred all the collated data of the Summary Cost Tables into SankeyMATIC code and created a raw version for each case study. This raw version was subsequently customised.

### 4.2.2 Customising the diagrams

SankeyMATIC offers a variety of options to customise the diagrams. In order to explore the SankeyMATIC options and possibilities in detail, a test trial was undertaken with the averaged data of all case studies (see Figure 11). Because the case studies are so specific and different, comparison of different case studies is not the focal point of the visualisation and thus, the average case study

was not meant to be presented as part of the project outcomes. Nevertheless, it served its purpose in exploring the possibilities and limitations of SankeyMATIC because it included all peculiarities that would later appear in the individual case studies. By means of using this average case study, we determined all general design considerations.

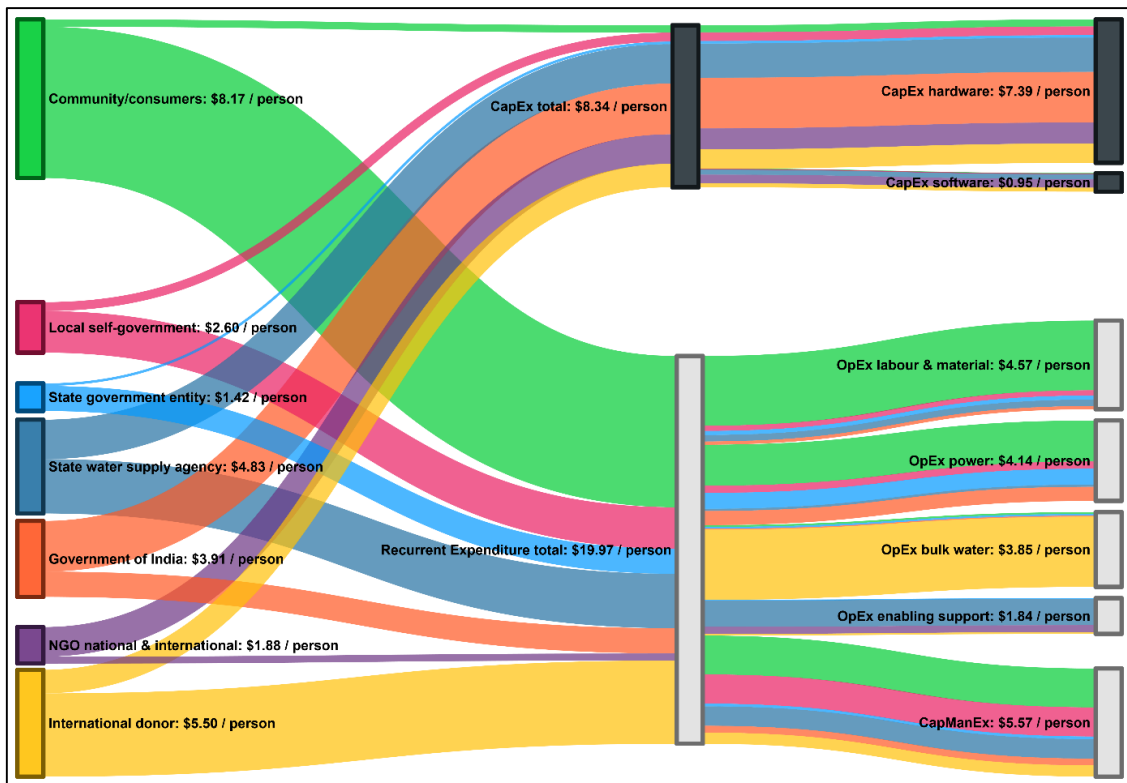


Figure 11: Sankey diagram with average data of 20 case studies

#### 4.2.2.1 Flow Colours

We defined two requirements for colour selection: clarity and appropriateness. Visual clarity is key to help the viewer understand the key message of the diagram. Thus, the colours should help the viewer to follow the flows. Therefore, the colours have to be easily identifiable and in good contrast, so that they can even be discerned when the flows are overlapping. With regard to appropriateness, we tried to take into account that colours might evoke different associations, perceptions and emotions in different cultures. Therefore, literature was consulted in order to examine the meaning of colours in India and to avoid

offensive colour coding in the Financial Flow Diagram (Akçay et al. 2011, McCandless 2012).

On a trial and error basis, different colour combinations were tested to come up with a pleasant colour mix. We decided to use grey as a “non-colour” for CapEx and recurrent expenditure in order to have a clear distinction from the entities. SankeyMATIC allows defining flow colours by using Hex colour codes, which were taken from the website [www.htmlcolorcodes.com](http://www.htmlcolorcodes.com) (see Dixon & Moe 2016). An additional line has to be added to the code:

*Node-name#Color>><<*

Table 5 summarises the considerations and settings on the flow colours.

**Table 5: Design considerations and SankeyMATIC settings**

Entity	Colour	Meaning in India	Hex colour code
<b>Community/Consumer</b>	Green	Nature, health, money	#00cc33
<b>Local self-government</b>	Pink	Feminine, happy, hopeful, associated with Ganesh	#e91e63
<b>State government entity</b>	Light blue	Calm, cleanliness, trust	#0099ff
<b>State water supply agency</b>	Dark blue		#2471a3
<b>National government (formerly: Government of India)</b>	Orange	Warmth, balance, courage	#ff5722
<b>NGO national &amp; international</b>	Purple	Royalty, mystery, spirituality	#6c3483
<b>International donor</b>	Yellow	Hope, happiness, optimism	#ffc107
<b>Capital Expenditure</b>	Dark grey	Modesty, intellect, sadness	#263238
<b>Recurrent Expenditure</b>	Light grey		#e0e0e0

The default settings for the flow opacity were perceived as too pale, thus the opacity settings were increased.

#### **4.2.2.2 Grouping of entities**

The position of the entities in the Sankey diagram aligns with their position in the Summary Cost Table in order to achieve consistency:

- Community/Consumers
- Local self-government
- State government entity
- State water supply agency
- National government
- NGO national & international
- International donor

In the initial average case study Sankey diagram (see Figure 11), CapEx was sitting on top of recurrent expenditure, which we changed in later phases of the project, as it reduces the flow overlaps and thus contributes to more clarity in the diagram. It was also considered more intuitive, as CapEx can be perceived as the foundation of the system and thus should sit at the bottom of the diagram.

Another aspect we considered in early stages of conceptualisation is the breakdown of CapEx and recurrent expenditure into more detailed categories, such as OpEx labour & materials, OpEx power, etc. as seen in Figure 11. There were two major issues why this idea was later abandoned and is not part of the final diagram. Firstly, there were technical limitations in SankeyMATIC itself, which could not be overcome. After the intermediate node for CapEx or recurrent expenditure, the colours did not align with their original source, resulting in a somewhat confusing mix-up of colours in the right half of the diagram. Secondly, testing showed that the level of detail was perceived as too high and thus distracting from the actual key message of the diagram. Ultimately, the idea of showing this level of detail in the Financial Flow Diagrams was discarded under the assumption that an interested viewer could still look up further details in the case study reports and in the Summary Cost Tables.



Finally, a clear optical division of the Community/consumers and all the other entities is key to the diagram, as it represents the 'plus' in this CW+ project and therefore is the key message of the diagram.

#### **4.2.2.3 Final SankeyMATIC settings**

Figure 12 displays the general settings used for the final Sankey diagrams. Width and height of the diagram are oriented towards the golden ratio, a geometric proportion that is widely considered aesthetically pleasing (McVeigh 2009). For all case studies, a fixed size was used for the diagram. The spacing settings were accustomed to the characteristics of each case study. In order to avoid the visual appearing bloated, the space between nodes was increased depending on the number of entities involved. This resulted in a sleeker and more appealing appearance than when using fixed node distances. However, as the height of one \$ differs therefore in each case study, direct visual comparison between case studies is problematic. We prioritised the aesthetical aspects because there is a great variation in the context of the case studies. This variation in socio-economic, political and geographic conditions, as well as in used water supply technologies means that direct comparisons between case studies are of limited value.

In order to visualise both CapEx and recurrent expenditure in one diagram without the recurrent expenditure being dwarfed by the capital expenditure, some modification of the input data was necessary. This resulted in a fundamental debate whether the CapEx should be displayed as a ratio or as a scale.

In the ratio approach, CapEx would have been divided by 30 in order to be understood as an equivalent annualized CapEx. The ratio of 30 was chosen as a rough approximation of average lifetime for the fixed infrastructure. In this approach, the equivalent annualised CapEx value would be directly comparable to the annual recurrent expenditures.

In the scale approach, the main reason to divide by 30 is only to allow visual comparison between CapEx and recurrent expenditure in one diagram. The visual display of CapEx is scaled by 1 to 30, whereas the displayed value is not scaled. The client decided in favour of scaling by 1:30.

However, by this decision the underlying concept and logic of Sankey diagrams was breached, as the different flows are now not any more proportional with the widths of the arrows. This endangers the intuitive understanding of the orders of magnitude of flows. Schmidt (2008b) gives an example where a similar approach has been applied. In that case, it would have been impossible without the data formatting to identify all significant quantity flows. Thus, data can sometimes be presented in a more abstracted way.

The labelling of the Financial Flow Diagrams was done in a manually, and changed various times in the testing process. Eventually, we incorporated Tufte's (1983) recommendation of having clear, detailed and thorough labels that counteract graphical distortions and ambiguities.

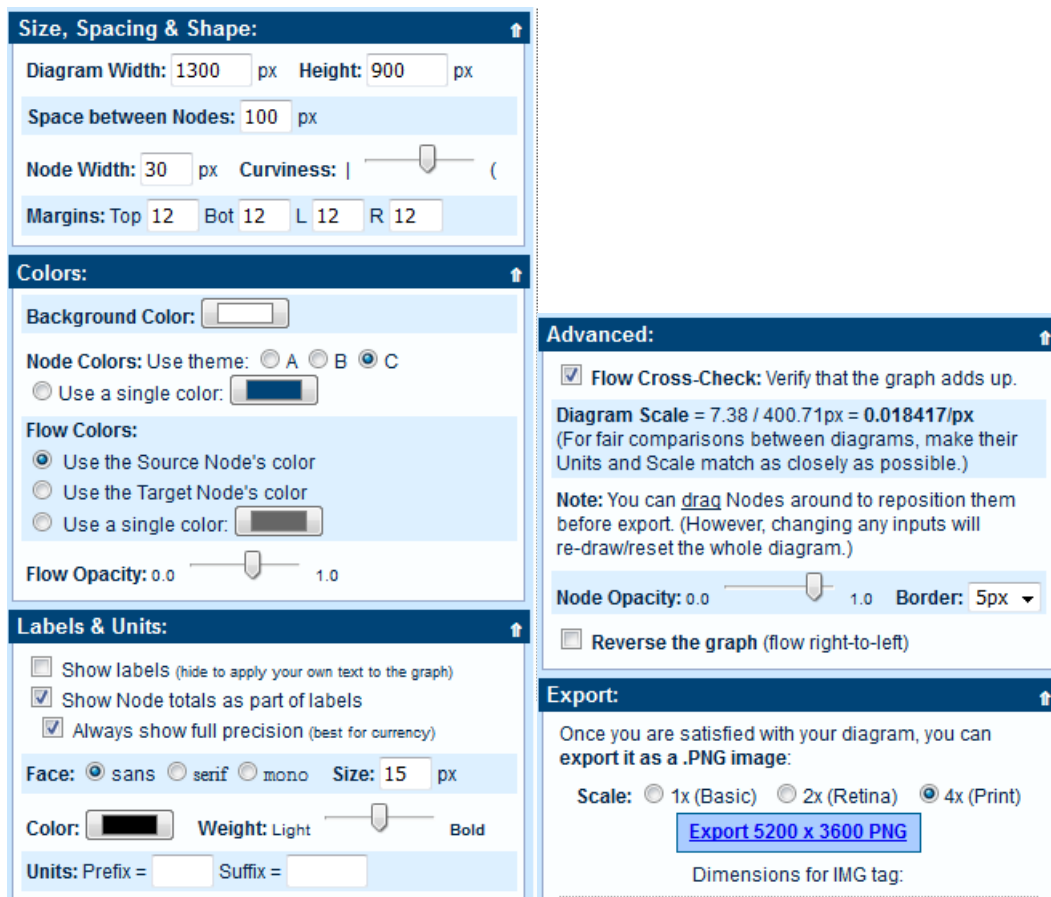











Figure 12: Final SankeyMATIC settings

### 4.2.3 Finalising the Sankey diagrams

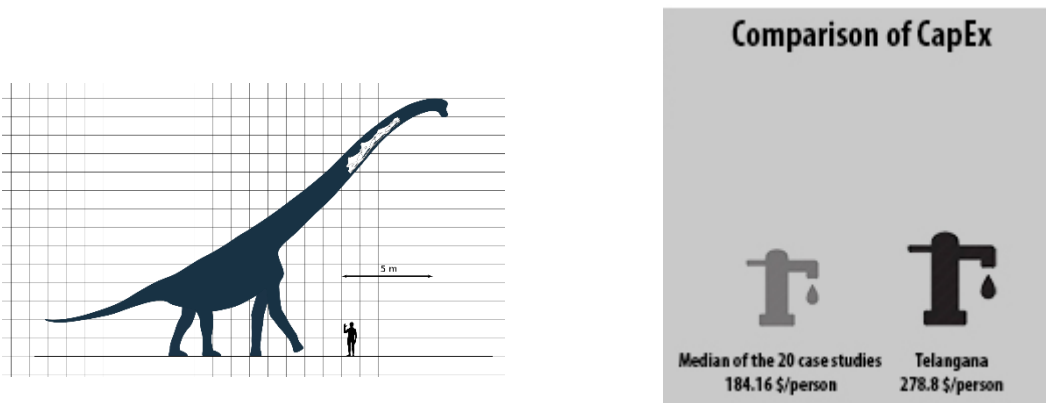
Once finished with customisation in SankeyMATIC, the diagrams were exported on the highest possible resolution as a PNG document to be finalised in Adobe Photoshop. Icons for each entity were chosen from the online database [www.iconfinder.com](http://www.iconfinder.com) (see Iconfinder 2015) with the aim to increase visual attractiveness and comprehensibility of the diagram. Labels, title and context information were added. In an iterative process, different icons were tested in order to identify a clear and unambiguous option. Table 6 shows the final selection of used icons.

**Table 6: Icons used for the Financial Flow Diagram**

Entity	Icon	Entity	Icon
Community/Consumer		NGO national & international	
Local self-government		International donor	
State government entity		Capital Expenditure	
State water supply agency		Recurrent Expenditure	
National government			

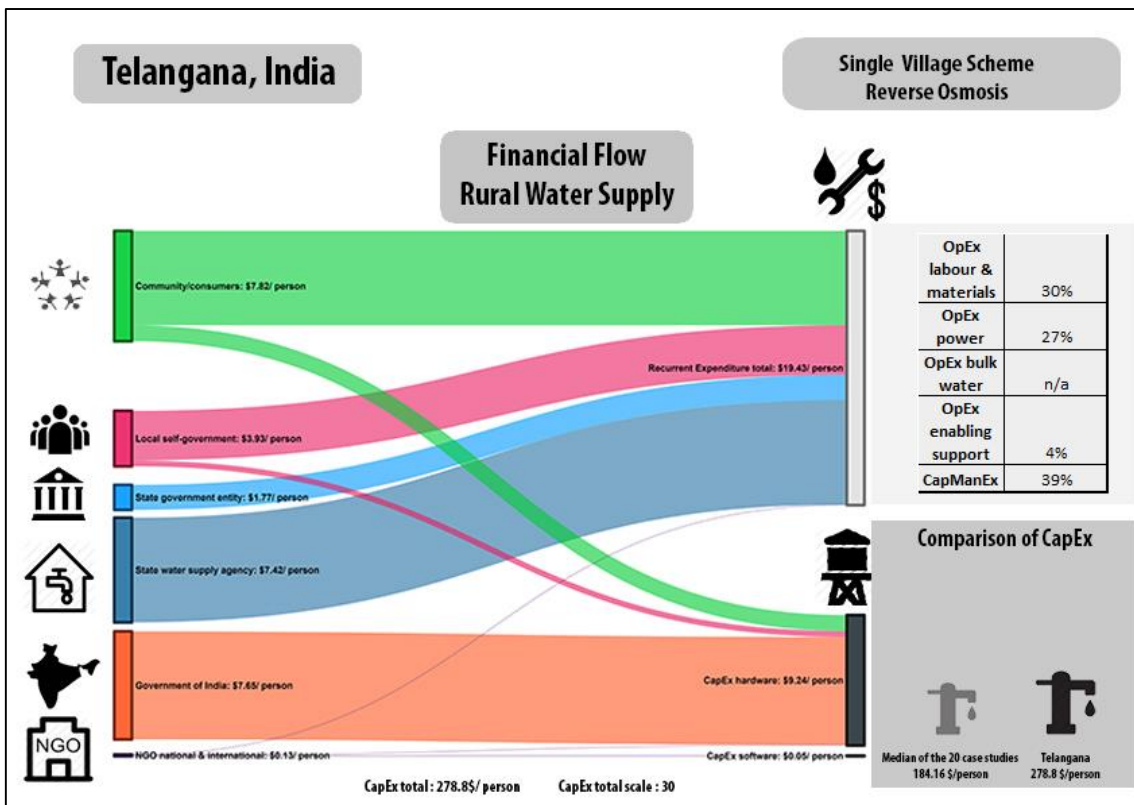
Considerations on ways of displaying an individual case study in the broader picture of the 20 case study sample lead to the idea of an icon-based visual comparison, similar to a 'human to animal comparison' as seen in Figure 13.

The icon of choice was a water tap, and a reference tap representing the median of the case studies was displayed for a comparison to the area of the specific case study. An example is given in Figure 13. This idea was later abandoned to satisfy the comments and impressions received from key informants during testing.



**Figure 13: Example of size comparison and trial of CapEx comparison by size**

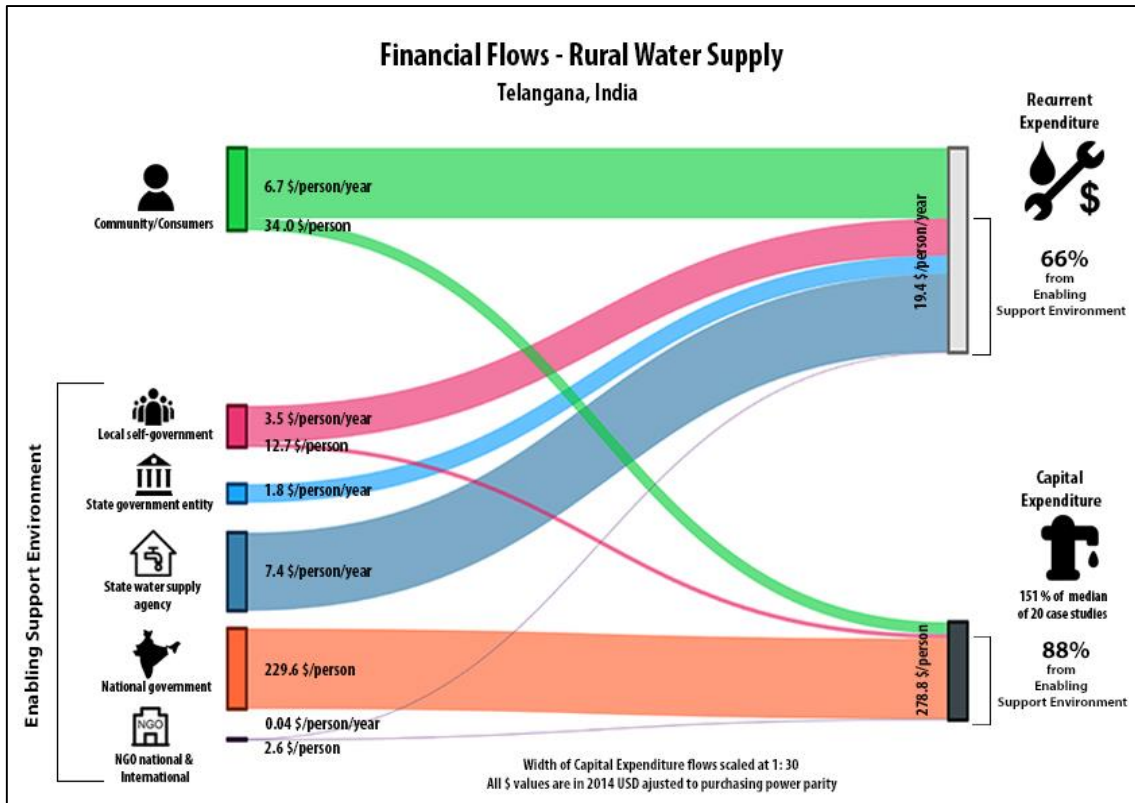
The informants emphasised the importance of showing less ancillary information in order to focus on the key message of the diagram, which is to visualise the proportion of the ‘plus’. In the final diagram, there is only a small text putting the case study into context by comparing its CapEx with the median of all 20 case studies. Eventually, the complex interim diagram of case study data shown in Figure 14 was compiled. We subsequently used this diagram for the testing explained in the following section.



**Figure 14: Complex interim diagram for case study 8 Telangana**

## 5 TESTING AND RESULTS

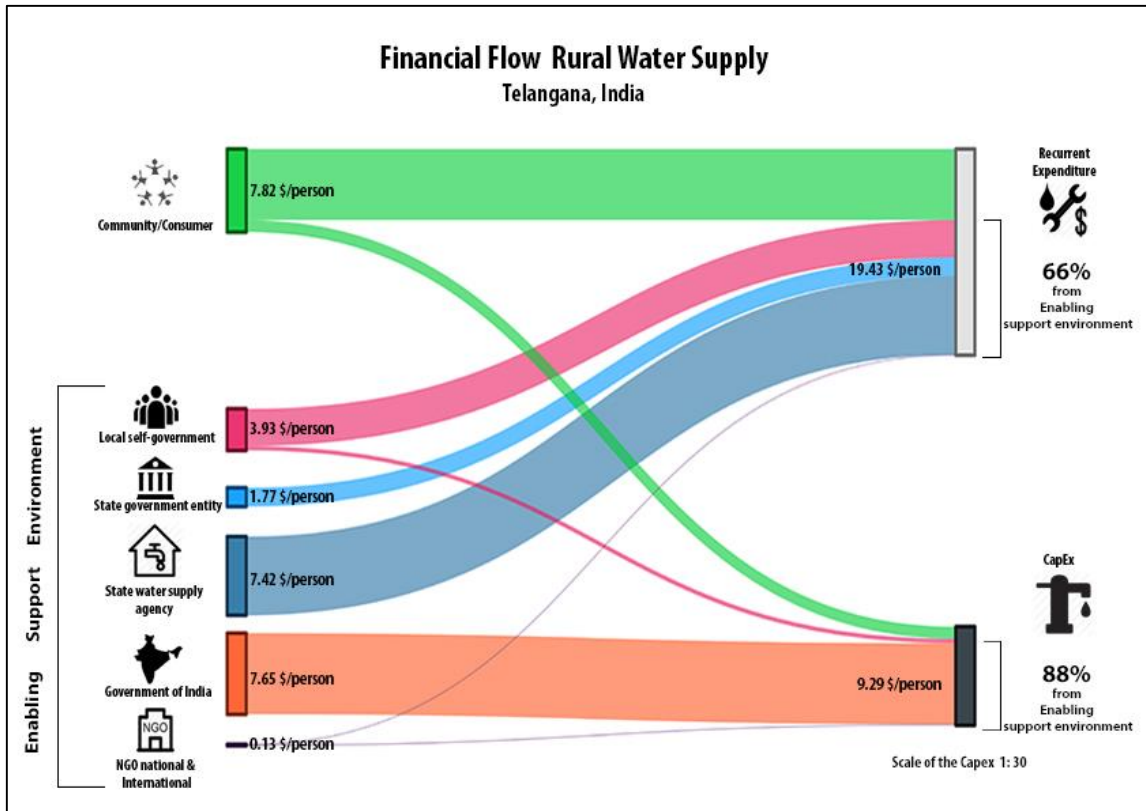
The final development step of the Financial Flow Diagram is shown in Figure 15. This diagram satisfies the client's requirements and incorporates feedback received from a number of key informants.



**Figure 15: Final diagram for case study 8 Telangana**

Figure 15 is the result of the internal iterative design process described in the previous section. This process was followed by an informal discussion with the 2015-2016 Cranfield Community Water and Sanitation (CWS) cohort and by a test with key informants.

The aim of the discussion was to get an initial insight of how readers perceive and understand the diagram. In a participatory setting, we followed a semi-structured interview guide to receive a large range of opinions. We used these in to design the simplified interim Financial Flow Diagram, as shown in Figure 16.



**Figure 16: Simplified interim diagram for case study 8 Telangana**

The test run was done as a survey with open-ended questions, in which we juxtaposed the complex and simplified interim diagrams (see Figure 14 and Figure 16).

This complex interim diagram provides additional information on the split of recurrent expenditure into the same categories as the final Summary Cost Table (see Table 3): OpEx labour & materials, OpEx power, OpEx bulk water, OpEx enabling support, and CapManEx. It visually compares capital expenditure of the respective case study with the median of all 20 case studies using two proportionally sized tapstand icons (see and).

In the test run (see Appendix A for the full questionnaire), we asked the key informants to explain their understanding of both diagrams with regard to six aspects:

- key messages of the diagrams,
- ease of understanding of various elements,
- suitability for illustrating the external 'plus' for CapEx and recurrent expenditure,
- two opposing concepts of bringing CapEx into the same diagram as recurrent expenditure, namely by
  - annualising CapEx over the asset's estimated average lifetime, resulting in flow width and values expressed as \$/person/year, or by
  - scaling the width of CapEx flows with a factor equal to estimated average lifetime, while still showing the actual values as \$/person,
- general suggestions for improvements and
- choice of their preferred diagram.

We received responses from five persons both inside and outside of the WASH sector. Several common points of criticism emerged from their feedback. They can be split in two groups:

Concept of the diagram:

- The complex diagram in Figure 14 tries to communicate too much information (e.g. visual and numerical comparison of CapEx to other cases, split of recurrent expenditure into different categories), thereby failing to convey the key message of the 'plus' percentage.
- Showing CapEx and recurrent expenditure in one graph can mislead readers, as they might not notice and/or understand that different time scales and, hence, different units are used.
- The split of CapEx into software and hardware might be regarded as interesting additional information.

Design details:

- Acronyms and project-specific vocabulary might confuse readers.
- Font size in Figure 14 was too small.
- Icons in Figure 14 were not sufficiently self-explanatory to function without explanations.
- Entity names either should consistently be of a general nature, or should be specific to the Indian context and the individual case study. Generic names such as 'State water supply agency' allow easier comparison between case studies, but provide less detail than actual names such as Maharashtra Water Supply and Sewerage Board.

- Values on the right side of both diagrams do not refer to total recurrent expenditure and CapEx with sufficient clarity. Some readers thought the values refer to the contribution of just one entity.

We revised the diagram based on this feedback, as well as on a second informal discussion with the 2015-2016 Cranfield CWS cohort, and on final feedback from our client. We reduced the amount of information shown to the minimum required in order to convey the key messages, and adapted the layout and design details, resulting in the final Financial Flow diagram (see Figure 15) For the full set of diagrams for all 20 case studies, see Appendix B.



## **6 DISCUSSION**

In the following chapter, we discuss the main strengths and limitations of the Financial Flow Diagram, and suggest some alternatives to the approach followed in this project.

### **6.1 Strengths of the Financial Flow Diagram**

The use of financial flows in the context of WASH sector financing is an innovative idea. A core strength of the diagram is that all the financial flows of a case study are shown in one compact picture.

The Financial Flow Diagram provides a visual clue of how contributions to both capital and recurrent expenditure by different entities compare to each other. All entities of the Enabling Support Environment are grouped together, framed with a bracket, and therefore clearly separated from the community. Brackets also indicate the 'plus' percentage in recurrent and capital expenditure. These visual aids help communicating the diagram's key message of the 'plus' percentage.

The diagram provides an overview of the entities financing the construction and operation of rural water supply systems. Icons with text facilitate quick identification of the different entities involved in a case study.

Comparison of CapEx between all 20 cases is possible by presenting case study CapEx as a percentage of median CapEx. This helps readers put a specific case study in context of the 20 case studies of the CW+ project, without encouraging direct comparison of absolute values.

The main part of the Financial Flow Diagram was built using a free online tool. All utilised icons are either available at low cost or under a Creative Commons license. Any publishing application, graphics editor or presentation program can be used to bring together the Sankey diagram and the additional information, including logos, brackets and text. Hence, reproducing and adapting the Financial Flow Diagram for future case studies is easy and affordable.

## 6.2 Limitations of the Financial Flow Diagram

The Financial Flow Diagram combines both capital and recurrent expenditure in one visual, and challenges the norm whereby CapEx and recurrent expenditures are separated. Consequently, the final diagram tries to combine statements about the one-off expenditures (in '\$/person') with periodically incurred expenditures (in '\$/person/year'). In order to fit both the capital-intensive CapEx and the more modest yearly recurrent expenditure in one diagram, the CapEx values had to be scaled down to be visually comparable to recurrent expenditure. Displaying figures and corresponding visuals that are so fundamentally different invite irrelevant and misleading comparison. Our testing has shown that readers of the diagram had severe difficulties to notice that CapEx and recurrent expenditure are not displayed at the same scale. Indeed, Sankey diagrams are poorly adapted to situations where different scales are used for different resource flows. For instance, the nodes of entities that contribute to both capital and recurrent expenditure combine widths in two scales in one visual statement: the arrow width of the recurrent expenditure is directly proportional to its value, whereas the CapEx arrow is scaled. Subsequently, while it would be intuitive (as our tests show) to visually compare both flows by their size, the conclusion drawn from such comparison generates an inaccurate message (e.g. recurrent expenditure might seem higher than CapEx while the opposite may actually be the case). In attempt to mitigate, the final diagram shows the un-scaled numeric value for each flow on top of the scaled arrow. This direct mismatch between what the numbers indicate and what the visual intuitively suggests therefore remains. Thus, there is still a risk that readers utterly misinterpret the displayed information. Visuals should be self-explanatory. The additional values should only confirm what the visual already indicates. They should not convey a message that requires re-interpretation of the message suggested initially by the visual.

The Financial Flow Diagram does not allow intuitively reliable visual comparison between the different case studies. Using a fixed total diagram size means that the height of \$1 varies between the case studies. While SankeyMATIC theoretically allows bringing all 20 diagrams to one \$:cm scale, this would entail big differences in total diagram size due to the large range of recurrent and capital

expenditures. Furthermore, the CW+ project does not encourage direct comparison between cases. Socio-economic, political, geographic and technical variations are too big to allow meaningful direct comparison, which would possibly lead readers to draw meaningless conclusions.

In its current form, the Financial Flow Diagram does not link capital and recurrent expenditure and their 'plus' percentages to achieved service levels. This information deliberately has not been included, as this analysis is part of an ongoing PhD project.

## 7 CONCLUSION

This project has contributed to the development of a visual display of financial flows as part of the CW+ project on rural water supply in India. A key request was to communicate the extent to which communities receive external financial support in order to deliver good water services in a sustainable manner. Another requirement was to bring together both capital and recurrent expenditures in a single flow diagram.

The proposed visual builds on Sankey diagrams. In order to better highlight the key messages of the CW+ project, the number of entities, the type of expenditures to be displayed and the amount of information to be communicated had to be trimmed down (as compared to the Summary Cost Tables) through several iterations and testing.

While the final visual attempts to provide the key messages of the CW+ project in a clear manner, it is not without fundamental limitations. In fact, its key flaw lies in trying to display flows for both recurrent expenditure and capital expenditure in one diagram. This leads to a comparison of elements that are essentially different in units and scale. Our testing with key informants indicates that therefore there is a high risk for readers to be misled in their reading of the key messages emerging from the visual.

Thus, while the display of financial data through a flow diagram seems to be a valuable idea at first, it may not be the most suitable type of visual display for the CW+ project. We also recommend considering less original yet perhaps less misleading displays such as stacked histograms, which separate capital and recurrent expenditure. Although the flow element may be lost visually, the information on the 'plus' might be communicated better.

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# **APPENDIX A – Testing survey**

## **CRITICAL REVIEW OF FINANCIAL FLOW VISUALS**

### **FOR THE COMMUNITY WATER <sup>PLUS</sup> PROJECT**

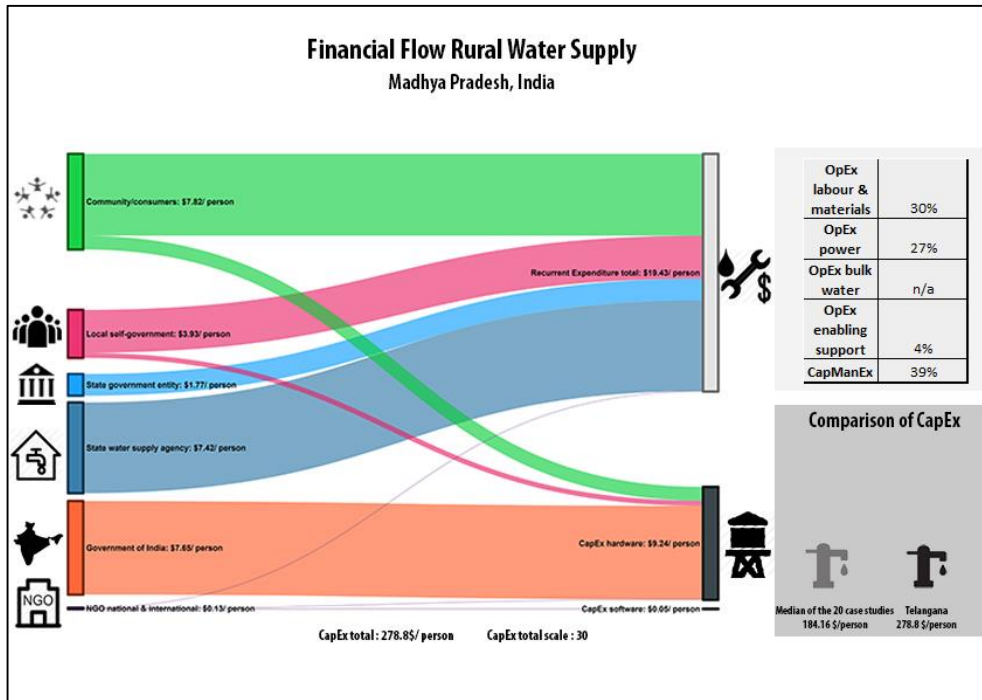
#### **Introduction:**

The following diagrams are part of the Community Water <sup>plus</sup> project, which investigates 20 successful community-managed rural water supply systems across India. The diagrams show the source (community and external support) and the allocation (capital and recurrent expenditure) of funds used to provide water.

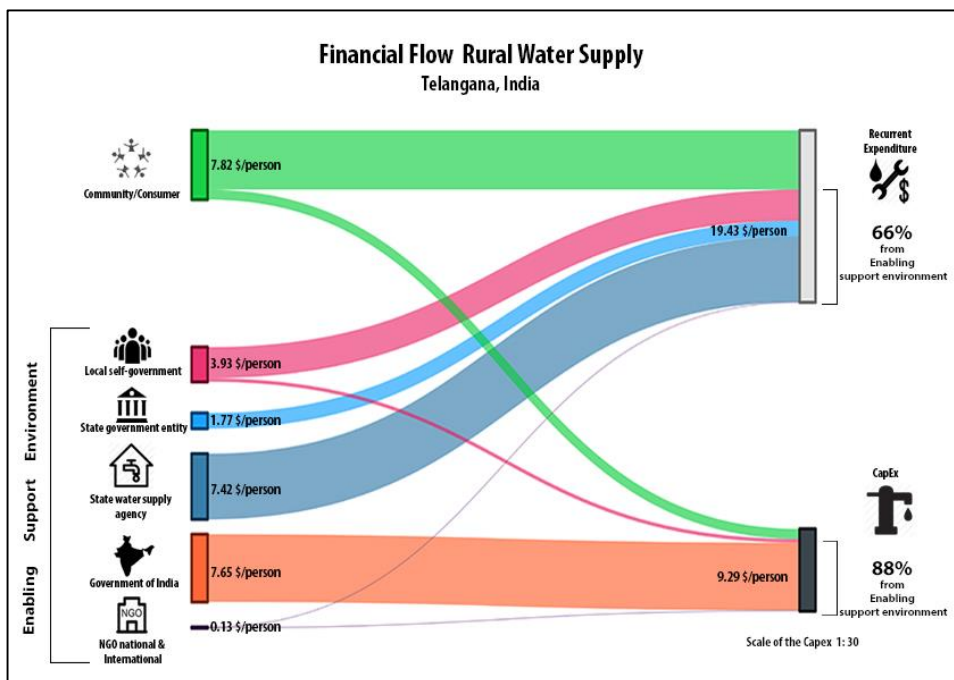
We would like get your critical views and feedback on these diagrams. To this end, after presenting the two visuals, we have developed a few questions (see below).



## VISUAL 1:



## VISUAL 2



1. Write in one (or few) sentence(s) the key message(s) that you think these two visuals are illustrating:

2. Do you think the different elements of the visuals are easy or difficult to understand?

**VISUAL 1:**

- Flow of information (i.e. funds)?
  
- Different scales between CapEx and Recurrent Expenditure
  
- Table of OpEx & CapManEx?
  
- Comparison of CapEx across cases?
  
- Icons (suitability and size)?

**VISUAL 2:**

- Flow of information (i.e. funds)?
  
- Different scales between CapEx total and Recurrent Expenditure?
  
- Icons (suitability, location and size)?

3. How well would you say the visuals illustrate the 'Plus' (i.e. Support to community from the enabling support environment) for CapEx and for Recurrent Expenditures?

**VISUAL 1:**

**VISUAL 2:**

4. Capex total is currently displayed at one thirtieth of the total amount. There are two suggested approaches (see below) to justify this choice. Please choose which approach you find more appropriate.

- The first approach is to divide Capex total by 30 and consider the value as an equivalent annualized CapEx. The value of '30' was chosen as an estimate of average lifetime for the fixed infrastructure. With that approach, this equivalent annualized CapEx would be directly comparable to the annual recurrent expenditures.

- The second approach is to divide by 30 only to allow visual comparison between CapEx and recurrent expenditure in one diagram. In other words, the visual display of CapEx is scaled by 1 to 30 and explicitly not as an annual breakdown of CapEx (as for the first approach).

5. Do you have any suggestions to improve the diagrams?

**VISUAL 1:**

**VISUAL 2:**

6. In the end, which visual would you recommend to be displayed in reports/presentations?

# APPENDIX B – Summary Cost Tables and final Financial Flow Diagrams in 2014 USD in PPP

Table 7: Summary Cost Table for case study 1 Jharkhand

Source of funds	Use of funds - implementation			Use of funds - annual recurrent					RECURRENT EXPENDITURE TOTAL
	CapEx hardware	CapEx software	CAPEX TOTAL	OpEx labour & materials	OpEx power	OpEx bulk water	OpEx enabling support	CapManEx	
Community/consumers	-	-	-	\$ 1,21	-	-	-	\$ 0,41	\$ 1,62
Local self-government	-	-	-	-	-	-	-	-	-
State government entity	-	-	-	-	-	-	-	-	-
State water supply agency	\$ 103,43	\$ 0,47	\$ 103,90	\$ 1,90	\$ 1,98	-	\$ 0,03	-	\$ 3,92
Government of India	\$ 103,43	-	\$ 103,43	-	-	-	-	-	-
NGO national & international	-	-	-	-	-	-	-	-	-
International donor	-	-	-	-	-	-	-	-	-
TOTALS	\$ 206,87	\$ 0,47	\$ 207,34	\$ 3,11	\$ 1,98	\$ -	\$ 0,03	\$ 0,41	\$ 5,54
Median of 20 case studies			\$ 184,16						\$ 11,78
'Plus' %age	100%	100%	100%	61%	100%	-	100%	0%	71%
Median of 20 case studies			95%						57%

Notes: CapManEx is only for the village Bero, as no data could be obtained for the other best practice villages

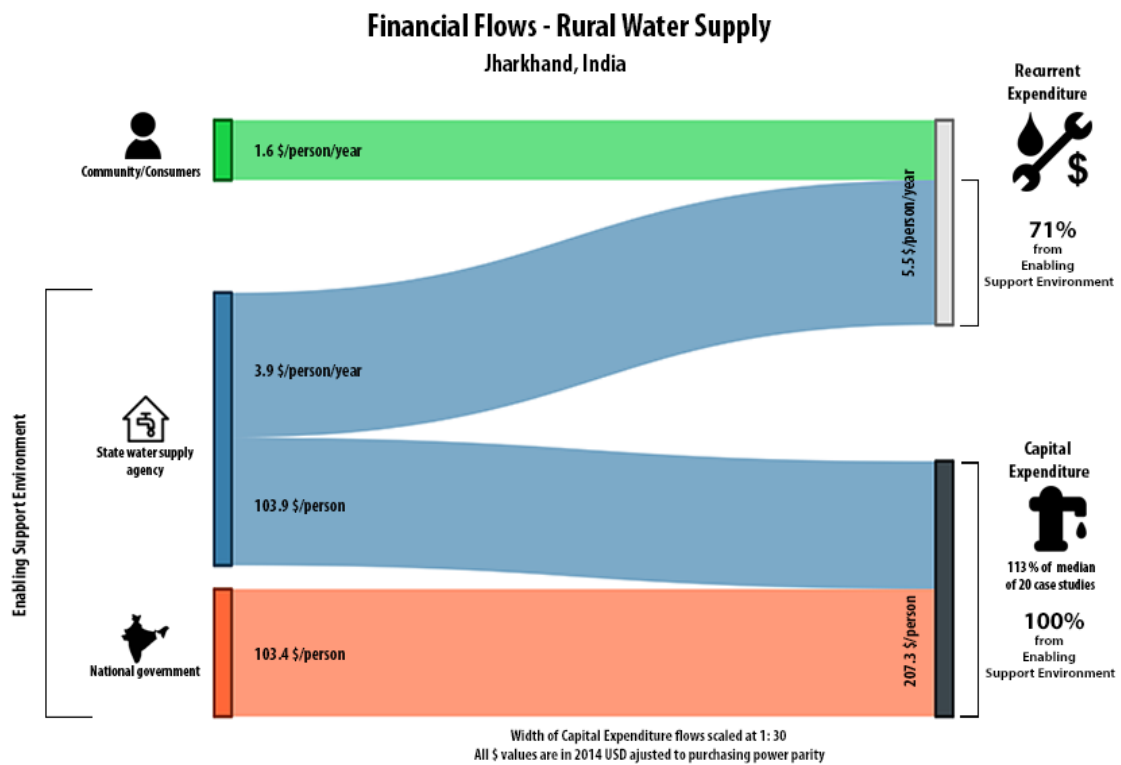
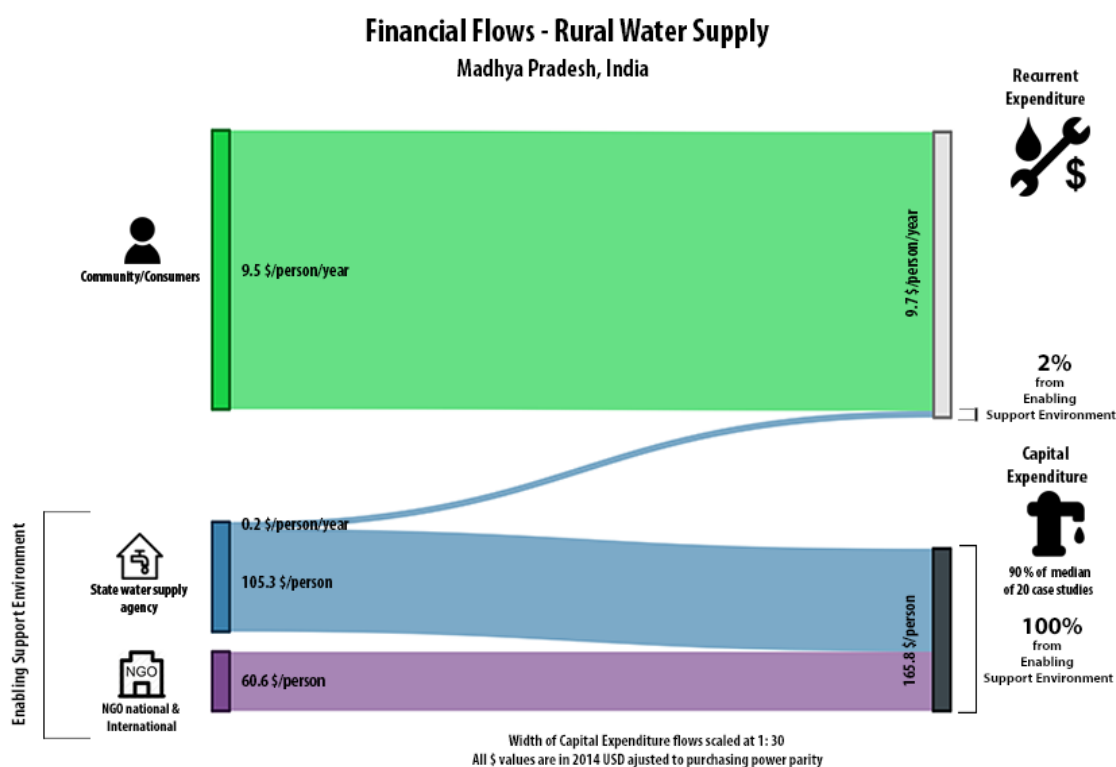


Figure 17: Financial Flow Diagram for case study 1 Jharkhand

**Table 8: Summary Cost Table for case study 2 Madhya Pradesh**

Source of funds	Use of funds - implementation			Use of funds - annual recurrent					RECURRENT EXPENDITURE TOTAL
	CapEx hardware	CapEx software	CAPEX TOTAL	OpEx labour & materials	OpEx power	OpEx bulk water	OpEx enabling support	CapManEx	
Community/consumers	-	-	-	\$ 2.93	\$ 0.72	-	-	\$ 5.85	\$ 9.51
Local self-government	-	-	-	-	-	-	-	-	-
State government entity	-	-	-	-	-	-	-	-	-
State water supply agency	\$ 105.01	\$ 0.25	\$ 105.26	-	-	-	\$ 0.23	-	\$ 0.23
National Government	-	-	-	-	-	-	-	-	-
NGO national & international	\$ 59.22	\$ 1.36	\$ 60.58	-	-	-	-	-	-
International donor	-	-	-	-	-	-	-	-	-
TOTALS	\$ 164.23	\$ 1.61	\$ 165.84	\$ 2.93	\$ 0.72	-	\$ 0.23	\$ 5.85	\$ 9.73
Median of 20 case studies			\$ 184.16						\$ 11.78
'Plus' %age	100%	100%	100%	0%	0%	-	100%	0%	2%
Median of 20 case studies			95%						57%

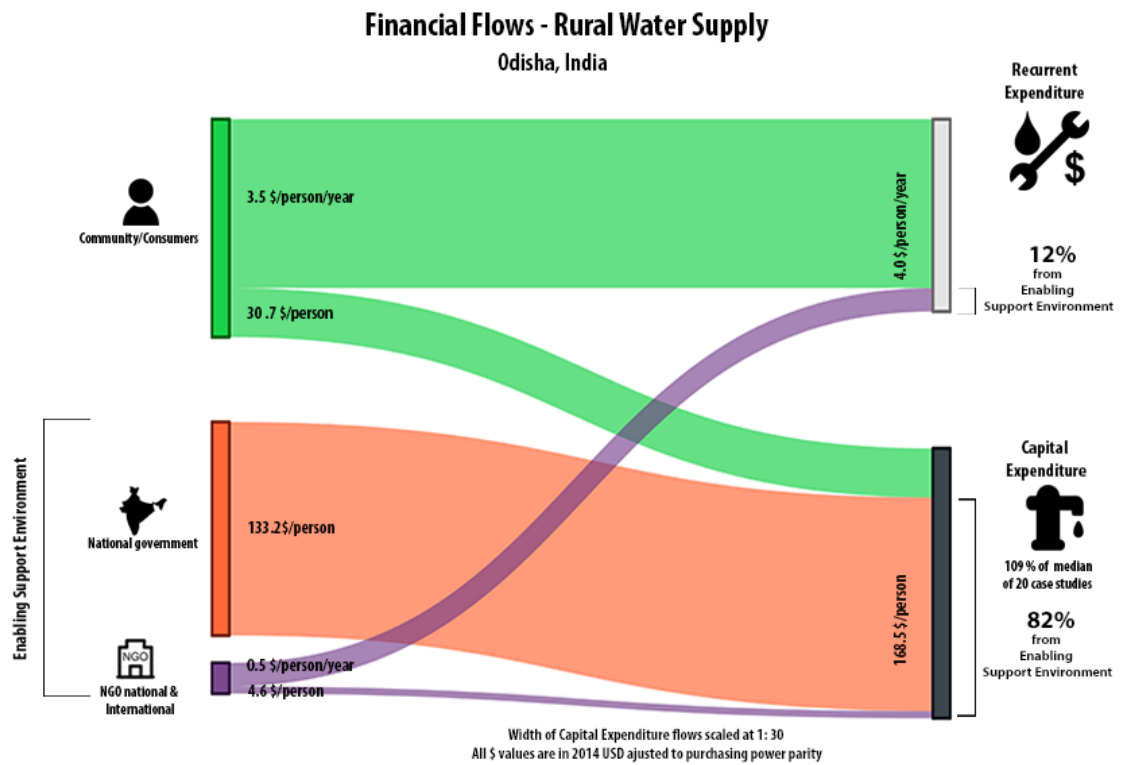
Notes: No CapManEx because schemes are new; State water supply agency committed to pay for CapManEx



**Figure 18: Financial Flow Diagram for case study 2 Madhya Pradesh**

**Table 9: Summary Cost Table for case study 3 Odisha**

Source of funds	Use of funds - implementation			Use of funds - annual recurrent					RECURRENT EXPENDITURE TOTAL
	CapEx hardware	CapEx software	CAPEX TOTAL	OpEx labour & materials	OpEx power	OpEx bulk water	OpEx enabling support	CapManEx	
Community/consumers	\$ 30,72	-	\$ 30,72	\$ 1,85	\$ 1,66	-	-	-	\$ 3,51
Local self-government	-	-	-	-	-	-	-	-	-
State government entity	-	-	-	-	-	-	-	-	-
State water supply agency	-	-	-	-	-	-	-	-	-
Government of India	\$ 133,19	-	\$ 133,19	-	-	-	-	-	-
NGO national & international	-	\$ 4,62	\$ 4,62	-	-	-	\$ 0,49	-	\$ 0,49
International donor	-	-	-	-	-	-	-	-	-
TOTALS	\$ 163,90	\$ 4,62	\$ 168,52	\$ 1,85	\$ 1,66	-	\$ 0,49	-	\$ 4,00
Median of 20 case studies			\$ 184,16						\$ 11,78
'Plus' %age	81%	100%	82%	0%	0%	-	100%	-	12%
Median of 20 case studies			95%						57%



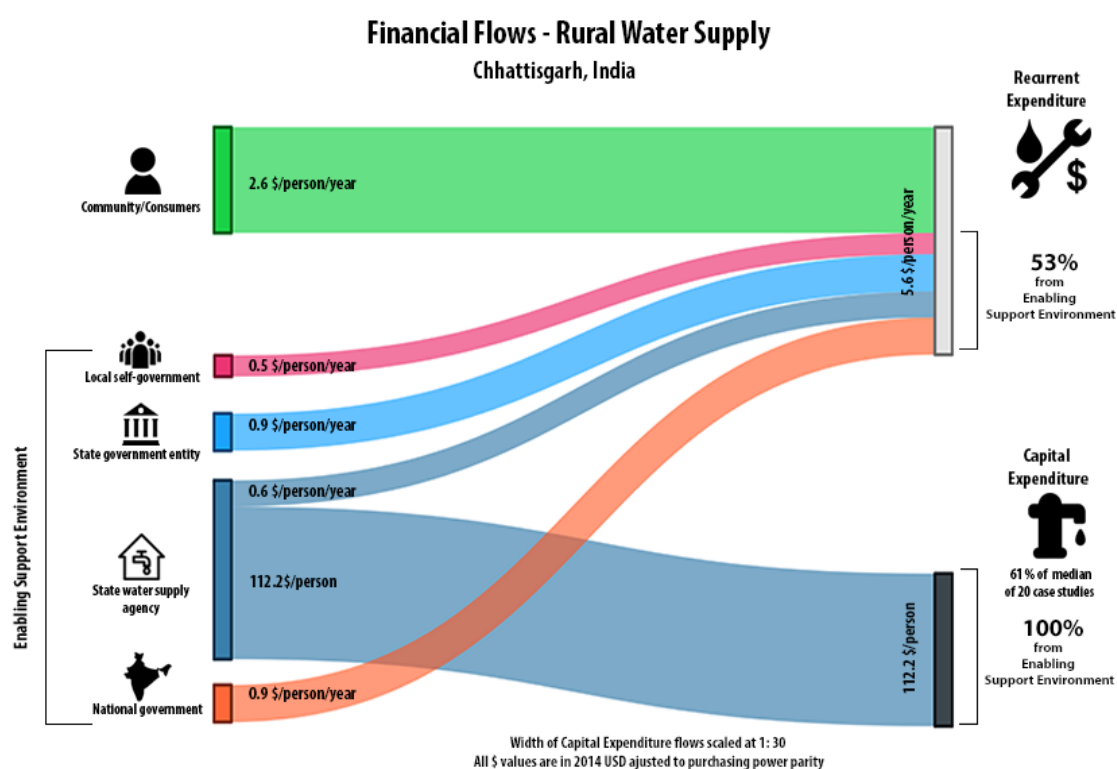
**Figure 19: Financial Flow Diagram for case study 3 Odisha**



**Table 10: Summary Cost Table for case study 4 Chhattisgarh**

Source of funds	Use of funds - implementation			Use of funds - annual recurrent					RECURRENT EXPENDITURE TOTAL
	CapEx hardware	CapEx software	CAPEX TOTAL	OpEx labour & materials	OpEx power	OpEx bulk water	OpEx enabling support	CapManEx	
Community/consumers	-	-	-	\$ 0,57	\$ 1,87	-	-	\$ 0,15	\$ 2,59
Local self-government	-	-	-	\$ 0,12	\$ 0,36	-	-	\$ 0,04	\$ 0,52
State government entity	-	-	-	\$ 0,17	\$ 0,60	-	-	\$ 0,13	\$ 0,91
State water supply agency	\$ 110,19	\$ 2,04	\$ 112,24	\$ 0,11	\$ 0,25	-	\$ 0,25	\$ 0,04	\$ 0,64
Government of India	-	-	-	\$ 0,17	\$ 0,60	-	-	\$ 0,13	\$ 0,91
NGO national & international	-	-	-	-	-	-	-	-	-
International donor	-	-	-	-	-	-	-	-	-
TOTALS	\$ 110,19	\$ 2,04	\$ 112,24	\$ 1,14	\$ 3,68	-	\$ 0,25	\$ 0,50	\$ 5,57
Median of 20 case studies			\$ 184,16						\$ 11,78
'Plus' %age	100%	100%	100%	50%	49%	-	100%	70%	53%
Median of 20 case studies			95%						57%

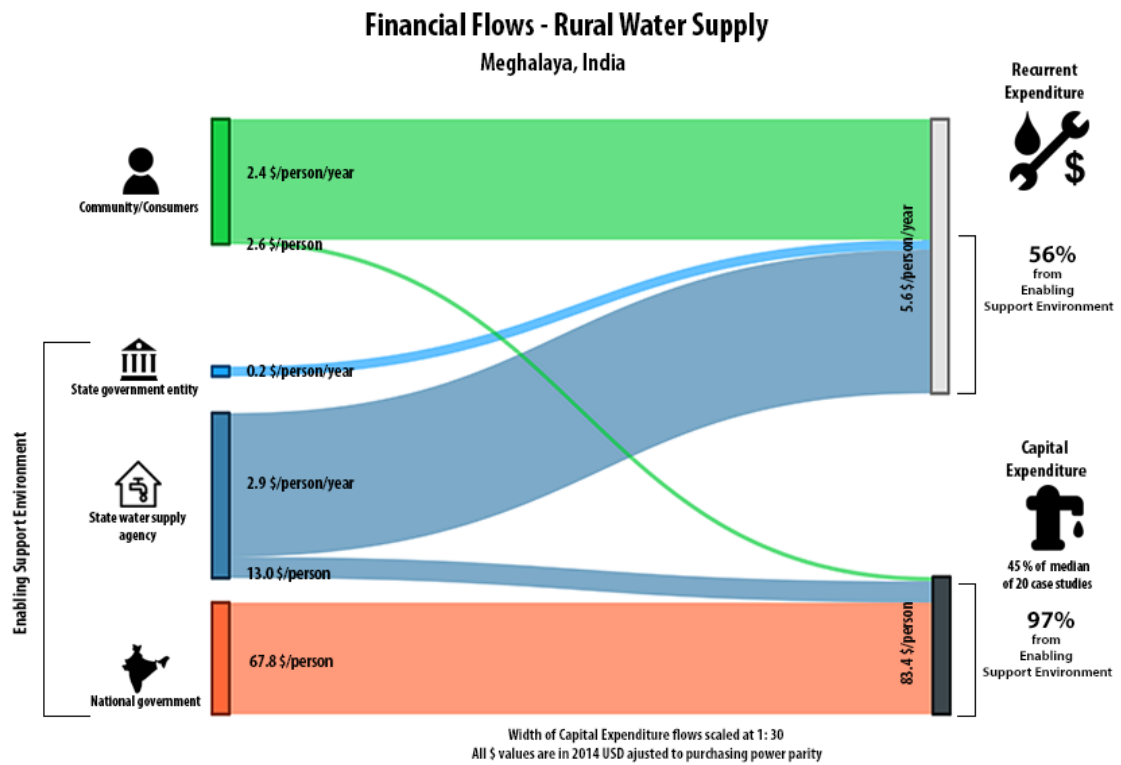
Notes: Assuming a 50/50 split of the funding for OpEx support to the community by the State water supply agency between the Government of India and the



**Figure 20: Financial Flow Diagram for case study 4 Chhattisgarh**

**Table 11: Summary Cost Table for case study 5 Meghalaya**

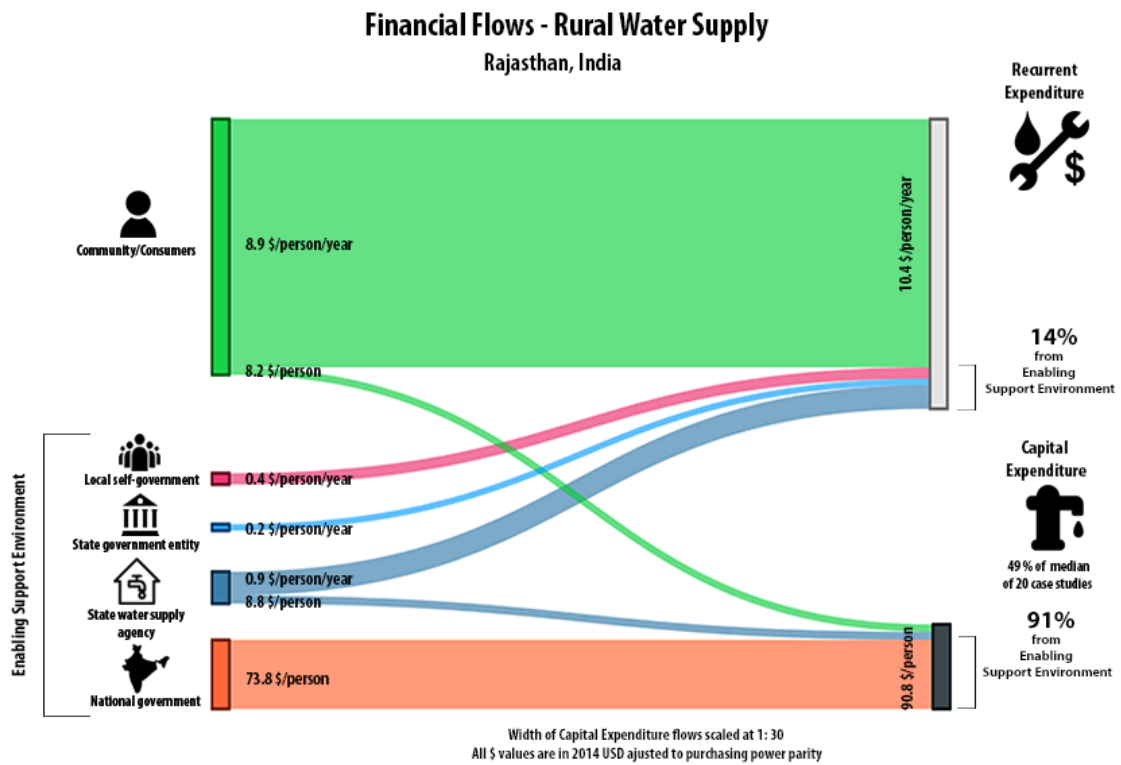
Source of funds	Use of funds - implementation			Use of funds - annual recurrent					RECURRENT EXPENDITURE TOTAL
	CapEx hardware	CapEx software	CAPEX TOTAL	OpEx labour & materials	OpEx power	OpEx bulk water	OpEx enabling support	CapManEx	
Community/consumers	\$ 2,61	-	\$ 2,61	\$ 2,18	\$ 0,26	-	-	-	\$ 2,44
Local self-government	-	-	-	-	-	-	-	-	-
State government entity	-	-	-	-	\$ 0,20	-	-	-	\$ 0,20
State water supply agency	\$ 13,00	-	\$ 13,00	-	-	-	\$ 2,81	\$ 0,11	\$ 2,91
Government of India	\$ 67,76	-	\$ 67,76	-	-	-	-	-	-
NGO national & international	-	-	-	-	-	-	-	-	-
International donor	-	-	-	-	-	-	-	-	-
TOTALS	\$ 83,38	-	\$ 83,38	\$ 2,18	\$ 0,46	-	\$ 2,81	\$ 0,11	\$ 5,55
Median of 20 case studies			\$ 184,16						\$ 11,78
'Plus' %age	97%	-	97%	0%	44%	-	100%	100%	56%
Median of 20 case studies			95%						57%



**Figure 21: Financial Flow Diagram for case study 5 Meghalaya**

**Table 12: Summary Cost Table for case study 6 Rajasthan**

Source of funds	Use of funds - implementation			Use of funds - annual recurrent					RECURRENT EXPENDITURE TOTAL
	CapEx hardware	CapEx software	CAPEX TOTAL	OpEx labour & materials	OpEx power	OpEx bulk water	OpEx enabling support	CapManEx	
Community/consumers	\$ 8,20	-	\$ 8,20	\$ 3,20	\$ 2,56	-	-	\$ 3,10	\$ 8,86
Local self-government	-	-	-	\$ 0,31	\$ 0,10	-	-	-	\$ 0,40
State government entity	-	-	-	-	\$ 0,23	-	-	-	\$ 0,23
State water supply agency	\$ 3,16	\$ 5,68	\$ 8,84	\$ 0,37	-	-	\$ 0,48	-	\$ 0,85
Government of India	\$ 73,79	-	\$ 73,79	-	-	-	-	-	-
NGO national & international	-	-	-	-	-	-	-	-	-
International donor	-	-	-	-	-	-	-	-	-
TOTALS	\$ 85,15	\$ 5,68	\$ 90,83	\$ 3,88	\$ 2,89	-	\$ 0,48	\$ 3,10	\$ 10,35
Median of 20 case studies			\$ 184,16						\$ 11,78
'Plus' %age	90%	100%	91%	18%	11%	-	100%	0%	14%
Median of 20 case studies			95%						57%

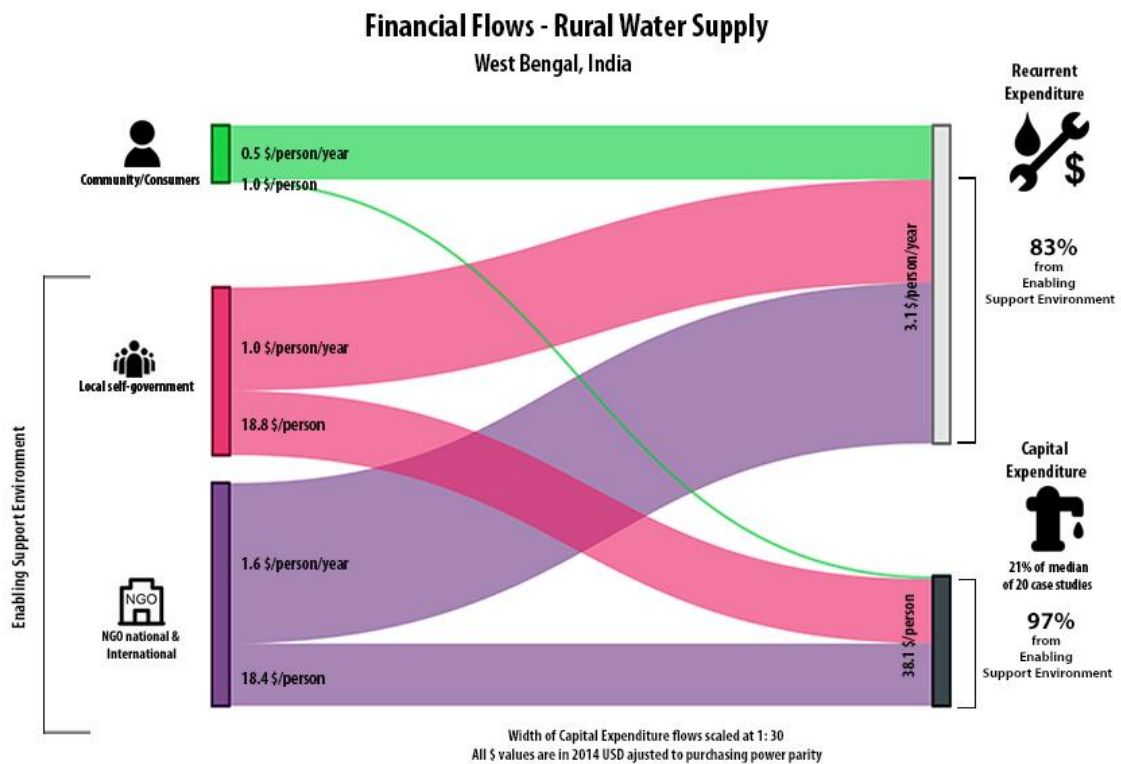


**Figure 22: Financial Flow Diagram for case study 6 Rajasthan**

**Table 13: Summary Cost Table for case study 7 West Bengal**

Source of funds	Use of funds - implementation			Use of funds - annual recurrent					RECURRENT EXPENDITURE TOTAL
	CapEx hardware	CapEx software	CAPEX TOTAL	OpEx labour & materials	OpEx power	OpEx bulk water	OpEx enabling support	CapManEx	
Community/consumers	\$ 0,97	-	\$ 0,97	\$ 0,41	-	-	-	\$ 0,12	\$ 0,53
Local self-government	\$ 16,93	\$ 1,87	\$ 18,80	-	-	-	\$ 0,03	\$ 0,98	\$ 1,01
State government entity	-	-	-	-	-	-	-	-	-
State water supply agency	-	-	-	-	-	-	-	-	-
Government of India	-	-	-	-	-	-	-	-	-
NGO national & international	\$ 16,60	\$ 1,76	\$ 18,35	-	-	-	\$ 1,57	-	\$ 1,57
International donor	-	-	-	-	-	-	-	-	-
TOTALS	\$ 34,50	\$ 3,62	\$ 38,12	\$ 0,41	-	-	\$ 1,60	\$ 1,10	\$ 3,11
Median of 20 case studies			\$ 184,16						\$ 11,78
'Plus' %age	97%	100%	97%	0%	-	-	100%	89%	83%
Median of 20 case studies			95%						57%

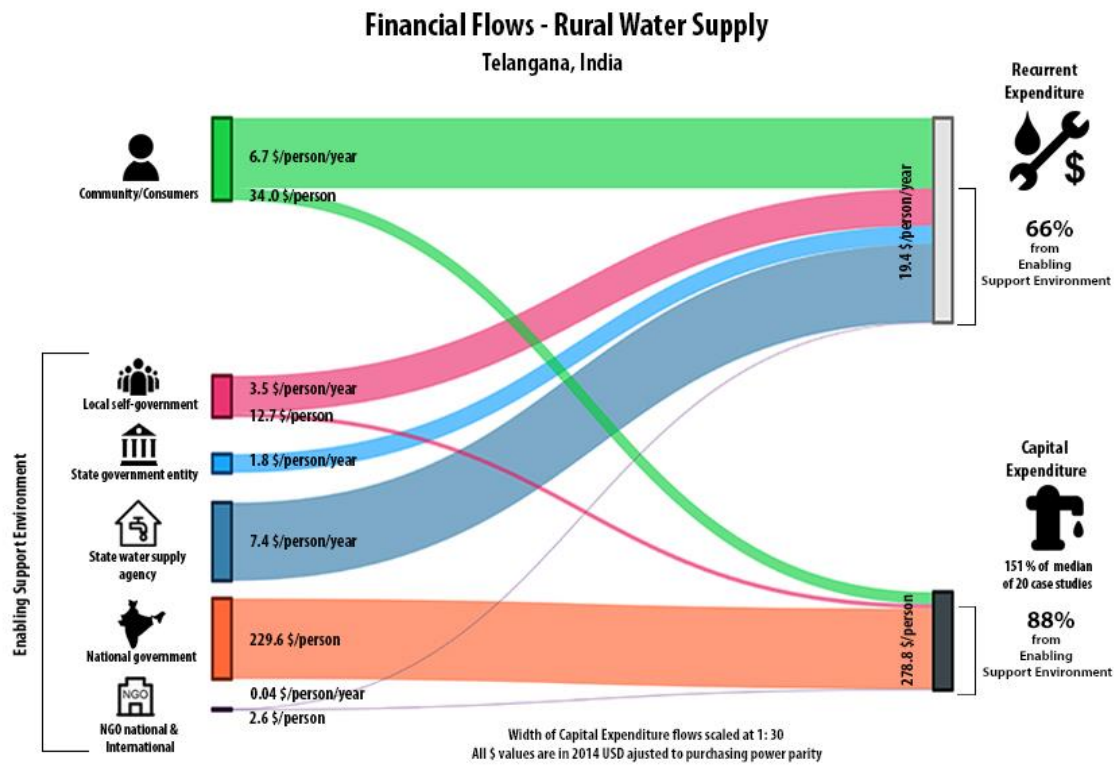
Notes: Data is for the village Digambarpur only, as no data could be obtained for the other best practice villages



**Figure 23: Financial Flow Diagram for case study 7 West Bengal**

**Table 14: Summary Cost Table for case study 8 Telangana**

Source of funds	Use of funds - implementation			Use of funds - annual recurrent					RECURRENT EXPENDITURE TOTAL
	CapEx hardware	CapEx software	CAPEX TOTAL	OpEx labour & materials	OpEx power	OpEx bulk water	OpEx enabling support	CapManEx	
Community/consumers	\$ 33.96	-	\$ 33.96	\$ 3.59	\$ 2.32	-	-	\$ 0.78	\$ 6.69
Local self-government	\$ 12.72	-	\$ 12.72	\$ 2.29	\$ 1.22	-	-	-	\$ 3.51
State government entity	-	-	-	-	\$ 1.77	-	-	-	\$ 1.77
State water supply agency	-	-	-	-	-	-	\$ 0.73	\$ 6.70	\$ 7.42
National Government	\$ 229.56	-	\$ 229.56	-	-	-	-	-	-
NGO national & international	\$ 1.17	\$ 1.38	\$ 2.55	-	-	-	-	\$ 0.04	\$ 0.04
International donor	-	-	-	-	-	-	-	-	-
TOTALS	\$ 277.41	\$ 1.38	\$ 278.79	\$ 5.88	\$ 5.31	-	\$ 0.73	\$ 7.52	\$ 19.44
Median of 20 case studies			\$ 184.16						\$ 11.78
'Plus' %age	88%	100%	88%	39%	56%	-	100%	90%	66%
Median of 20 case studies			95%						57%

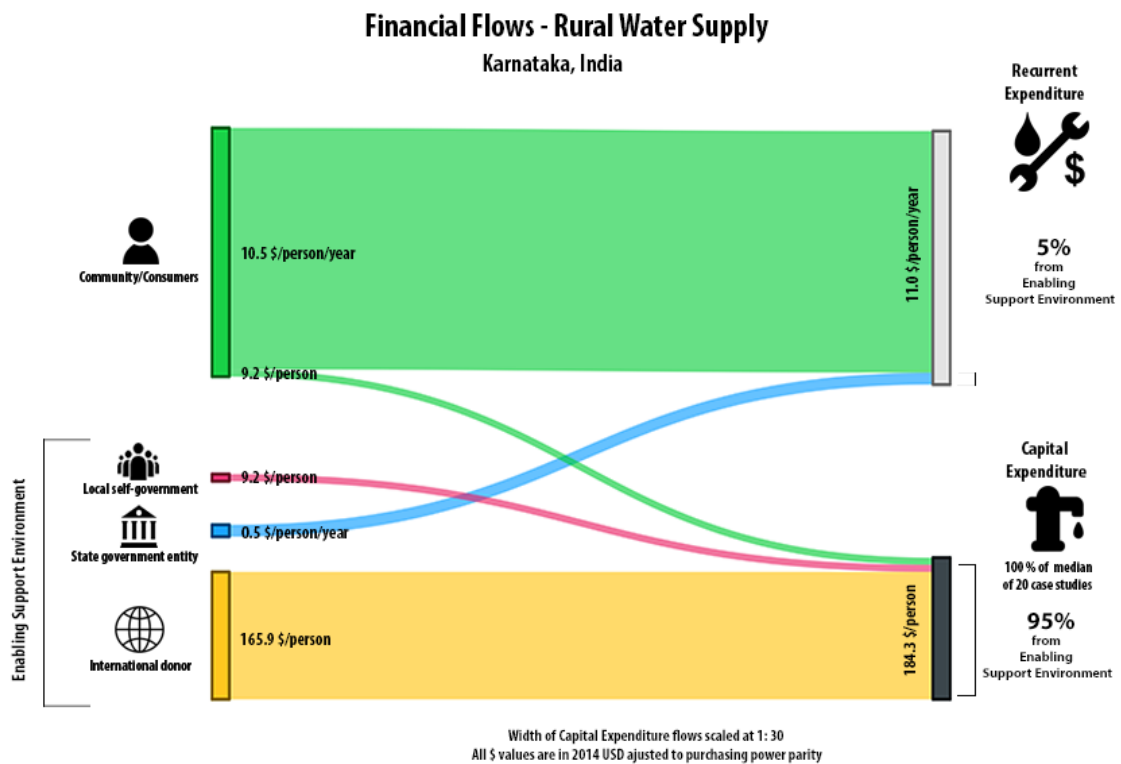


**Figure 24: Financial Flow Diagram for case study 8 Telangana**

**Table 15: Summary Cost Table for case study 9 Karnataka**

Source of funds	Use of funds - implementation			Use of funds - annual recurrent					RECURRENT EXPENDITURE TOTAL
	CapEx hardware	CapEx software	CAPEX TOTAL	OpEx labour & materials	OpEx power	OpEx bulk water	OpEx enabling support	CapManEx	
Community/consumers	\$ 8,87	\$ 0,34	\$ 9,22	\$ 6,05	\$ 4,43	-	-	-	\$ 10,48
Local self-government	\$ 8,87	\$ 0,34	\$ 9,22	-	-	-	-	-	-
State government entity	-	-	-	-	-	-	\$ 0,52	-	\$ 0,52
State water supply agency	-	-	-	-	-	-	-	-	-
Government of India	-	-	-	-	-	-	-	-	-
NGO national & international	-	-	-	-	-	-	-	-	-
International donor	\$ 159,73	\$ 6,16	\$ 165,89	-	-	-	-	-	-
TOTALS	\$ 177,48	\$ 6,84	\$ 184,32	\$ 6,05	\$ 4,43	-	\$ 0,52	-	\$ 11,00
Median of 20 case studies			\$ 184,16						\$ 11,78
'Plus' %age	95%	95%	95%	0%	0%	-	100%	-	5%
Median of 20 case studies			95%						57%

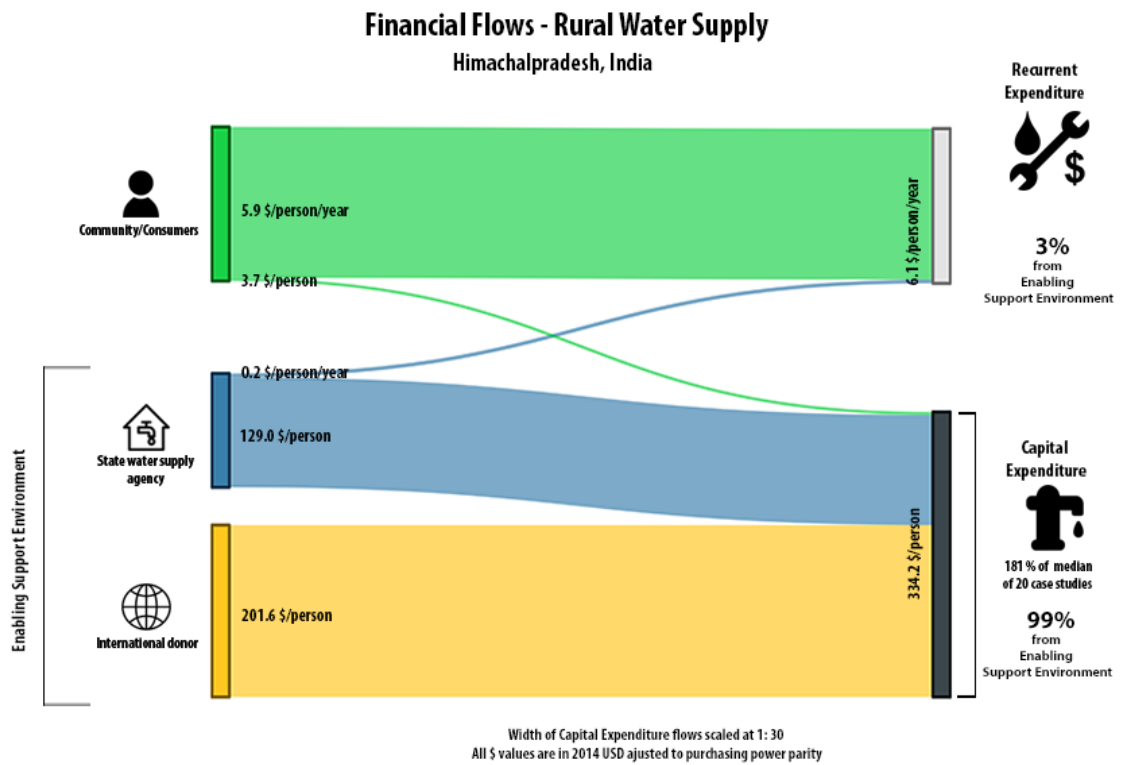
Notes: CapManEx funded by State water supply agency; no costs incurred to date.



**Figure 25: Financial Flow Diagram for case study 9 Karnataka**

**Table 16: Summary Cost Table for case study 10 Himachal Pradesh**

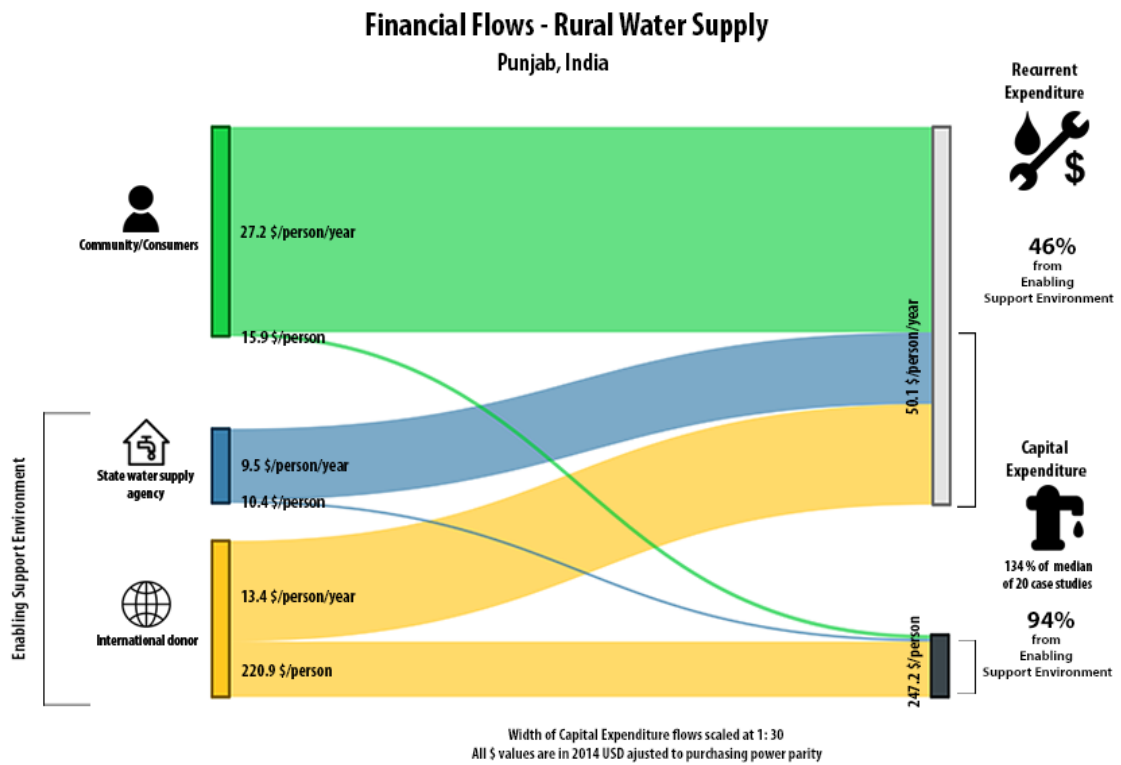
Source of funds	Use of funds - implementation			Use of funds - annual recurrent					RECURRENT EXPENDITURE TOTAL
	CapEx hardware	CapEx software	CAPEX TOTAL	OpEx labour & materials	OpEx power	OpEx bulk water	OpEx enabling support	CapManEx	
Community/consumers	\$ 3,66	-	\$ 3,66	\$ 5,69	-	-	-	\$ 0,21	\$ 5,90
Local self-government	-	-	-	-	-	-	-	-	-
State government entity	-	-	-	-	-	-	-	-	-
State water supply agency	-	\$ 128,93	\$ 128,93	\$ 0,15	-	-	-	-	\$ 0,15
Government of India	-	-	-	-	-	-	-	-	-
NGO national & international	-	-	-	-	-	-	-	-	-
International donor	\$ 123,45	\$ 78,13	\$ 201,58	-	-	-	-	-	-
TOTALS	\$ 127,11	\$ 207,06	\$ 334,18	\$ 5,84	-	-	-	\$ 0,21	\$ 6,05
Median of 20 case studies			\$ 184,16						\$ 11,78
'Plus' %age	97%	100%	99%	3%	-	-	-	0%	3%
Median of 20 case studies			95%						57%



**Figure 26: Financial Flow Diagram for case study 10 Himachal Pradesh**

**Table 17: Summary Cost Table for case study 11 Punjab**

Source of funds	Use of funds - implementation			Use of funds - annual recurrent					RECURRENT EXPENDITURE TOTAL
	CapEx hardware	CapEx software	CAPEX TOTAL	OpEx labour & materials	OpEx power	OpEx bulk water	OpEx enabling support	CapManEx	
Community/consumers	\$ 15,92	-	\$ 15,92	\$ 6,12	\$ 15,21	-	-	\$ 5,89	\$ 27,22
Local self-government	-	-	-	-	-	-	-	-	-
State government entity	-	-	-	-	-	-	-	-	-
State water supply agency	\$ 7,93	\$ 2,43	\$ 10,37	\$ 0,04	-	-	\$ 9,47	-	\$ 9,51
Government of India	-	-	-	-	-	-	-	-	-
NGO national & international	-	-	-	-	-	-	-	-	-
International donor	\$ 213,47	\$ 7,42	\$ 220,88	-	-	-	\$ 1,81	\$ 11,53	\$ 13,35
TOTALS	\$ 237,32	\$ 9,85	\$ 247,17	\$ 6,15	\$ 15,21	-	\$ 11,29	\$ 17,42	\$ 50,07
Median of 20 case studies			\$ 184,16						\$ 11,78
'Plus' %age	93%	100%	94%	1%	0%	-	100%	66%	46%
Median of 20 case studies			95%						57%



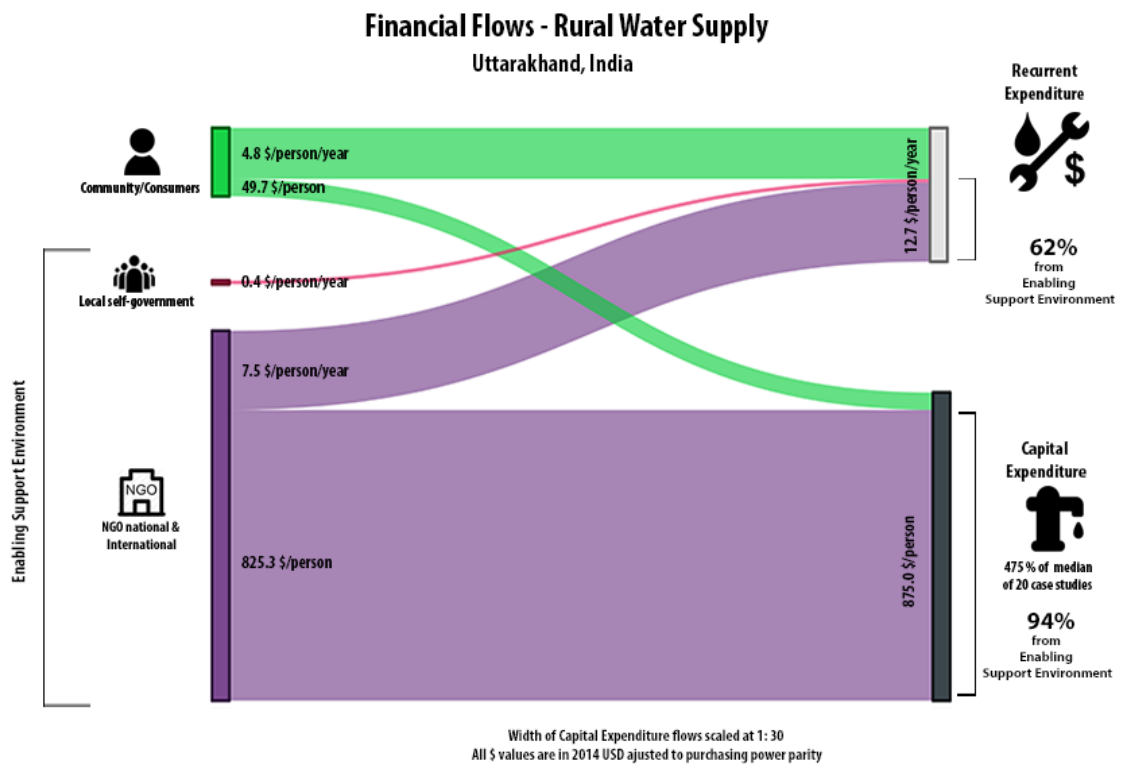
**Figure 27: Financial Flow Diagram for case study 11 Punjab**



**Table 18: Summary Cost Table for case study 12 Uttarakhand**

Source of funds	Use of funds - implementation			Use of funds - annual recurrent					RECURRENT EXPENDITURE TOTAL
	CapEx hardware	CapEx software	CAPEX TOTAL	OpEx labour & materials	OpEx power	OpEx bulk water	OpEx enabling support	CapManEx	
Community/consumers	\$ 38,65	\$ 11,00	\$ 49,65	\$ 1,03	-	-	-	\$ 3,79	\$ 4,82
Local self-government	-	-	-	-	-	-	-	\$ 0,35	\$ 0,35
State government entity	-	-	-	-	-	-	-	-	-
State water supply agency	-	-	-	-	-	-	-	-	-
Government of India	-	-	-	-	-	-	-	-	-
NGO national & international	\$ 571,08	\$ 254,22	\$ 825,30	-	-	-	\$ 5,09	\$ 2,38	\$ 7,48
International donor	-	-	-	-	-	-	-	-	-
TOTALS	\$ 609,73	\$ 265,22	\$ 874,95	\$ 1,03	-	-	\$ 5,09	\$ 6,53	\$ 12,65
Median of 20 case studies			\$ 184,16						\$ 11,78
'Plus' %age	94%	96%	94%	0%	-	-	100%	42%	62%
Median of 20 case studies			95%						57%

Notes: NGO refers to the cost borne by HIHT and the Himmotthan Society

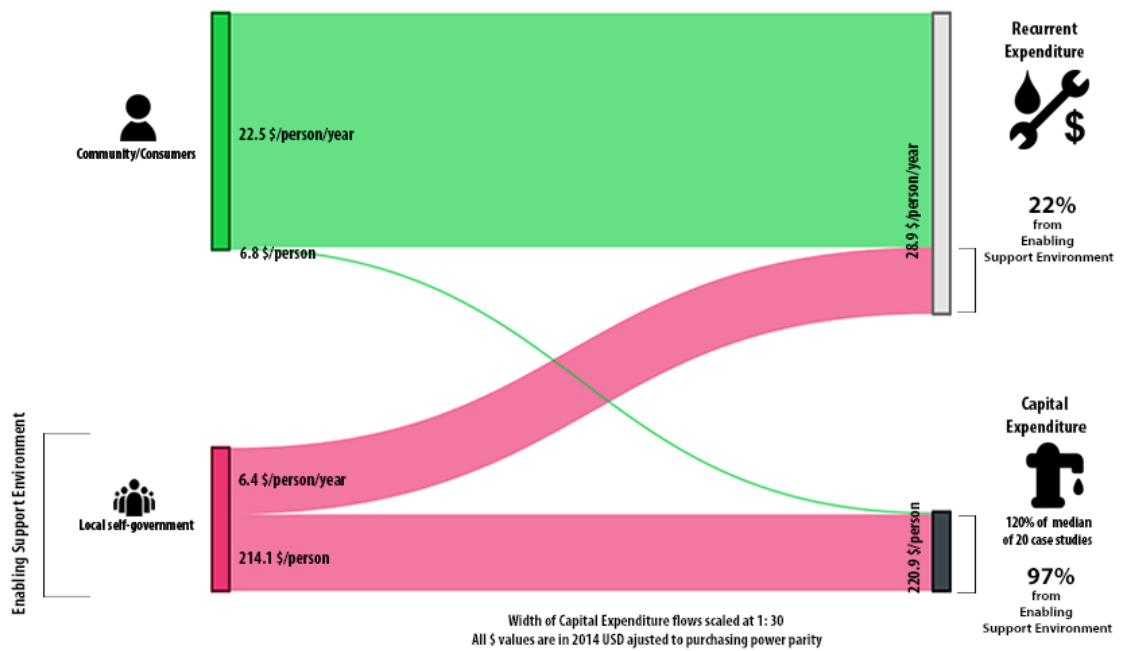


**Figure 28: Financial Flow Diagram for case study 12 Uttarakhand**

**Table 19: Summary Cost Table for case study 13 Kerala (Kodur)**

Source of funds	Use of funds - implementation			Use of funds - annual recurrent					RECURRENT EXPENDITURE TOTAL
	CapEx hardware	CapEx software	CAPEX TOTAL	OpEx labour & materials	OpEx power	OpEx bulk water	OpEx enabling support	CapManEx	
Community/consumers	\$ 6,77	-	\$ 6,77	\$ 9,69	\$ 4,20	-	-	\$ 8,61	\$ 22,50
Local self-government	\$ 214,13	-	\$ 214,13	-	-	-	-	\$ 6,40	\$ 6,40
State government entity	-	-	-	-	-	-	-	-	-
State water supply agency	-	-	-	-	-	-	-	-	-
Government of India	-	-	-	-	-	-	-	-	-
NGO national & international	-	-	-	-	-	-	-	-	-
International donor	-	-	-	-	-	-	-	-	-
TOTALS	\$ 220,90	-	\$ 220,90	\$ 9,69	\$ 4,20	-	-	\$ 15,01	\$ 28,90
Median of 20 case studies			\$ 184,16						\$ 11,78
'Plus' %age	97%	-	97%	0%	0%	-	-	43%	22%
Median of 20 case studies			95%						57%

**Financial Flows - Rural Water Supply**  
Kerala Kodur, India

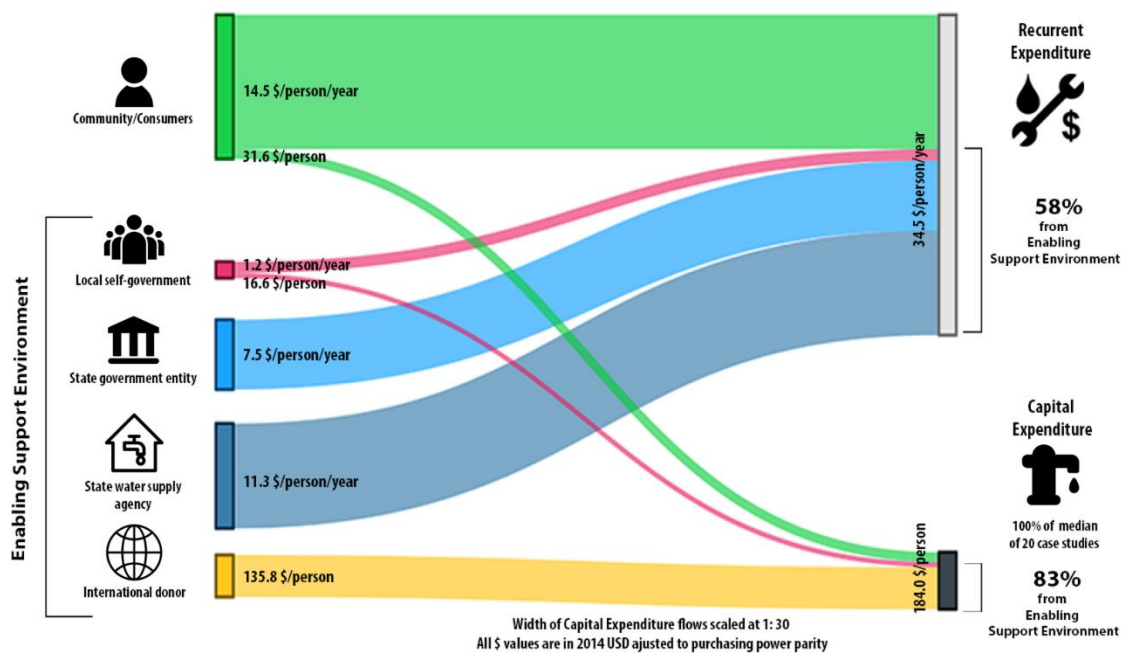


**Figure 29: Financial Flow Diagram for case study 13 Kerala (Kodur)**

**Table 20: Summary Cost Table for case study 14 Kerala (Nenmeni)**

Source of funds	Use of funds - implementation			Use of funds - annual recurrent					RECURRENT EXPENDITURE TOTAL
	CapEx hardware	CapEx software	CAPEX TOTAL	OpEx labour & materials	OpEx power	OpEx bulk water	OpEx enabling support	CapManEx	
Community/consumers	\$ 31.57	-	\$ 31.57	\$ 9.75	\$ 3.74	-	-	\$ 0.96	\$ 14.46
Local self-government	\$ 16.59	-	\$ 16.59	\$ 1.21	-	-	-	-	\$ 1.21
State government entity	-	-	-	-	\$ 7.52	-	-	-	\$ 7.52
State water supply agency	-	-	-	-	-	-	-	\$ 11.30	\$ 11.30
National Government	-	-	-	-	-	-	-	-	-
NGO national & international	-	-	-	-	-	-	-	-	-
International donor	\$ 100.75	\$ 35.07	\$ 135.82	-	-	-	-	-	-
TOTALS	\$ 148.92	\$ 35.07	\$ 183.99	\$ 10.96	\$ 11.27	-	-	\$ 12.26	\$ 34.49
Median of 20 case studies			\$ 184.16						\$ 11.78
'Plus' %age	79%	100%	83%	11%	67%	-	-	92%	58%
Median of 20 case studies			95%						57%

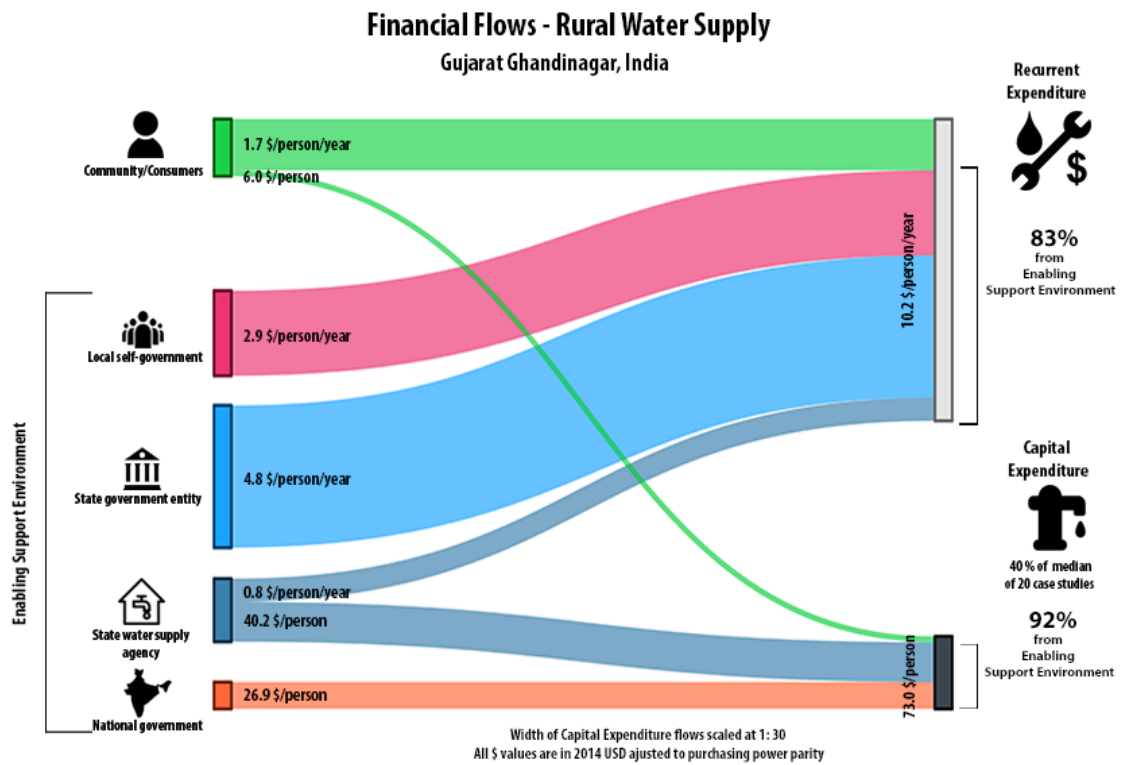
**Financial Flows - Rural Water Supply**  
Kerala Nenmeni, India



**Figure 30: Financial Flow Diagram for case study 14 Kerala (Nenmeni)**

**Table 21: Summary Cost Table for case study 15 Gujarat (Ghandinagar)**

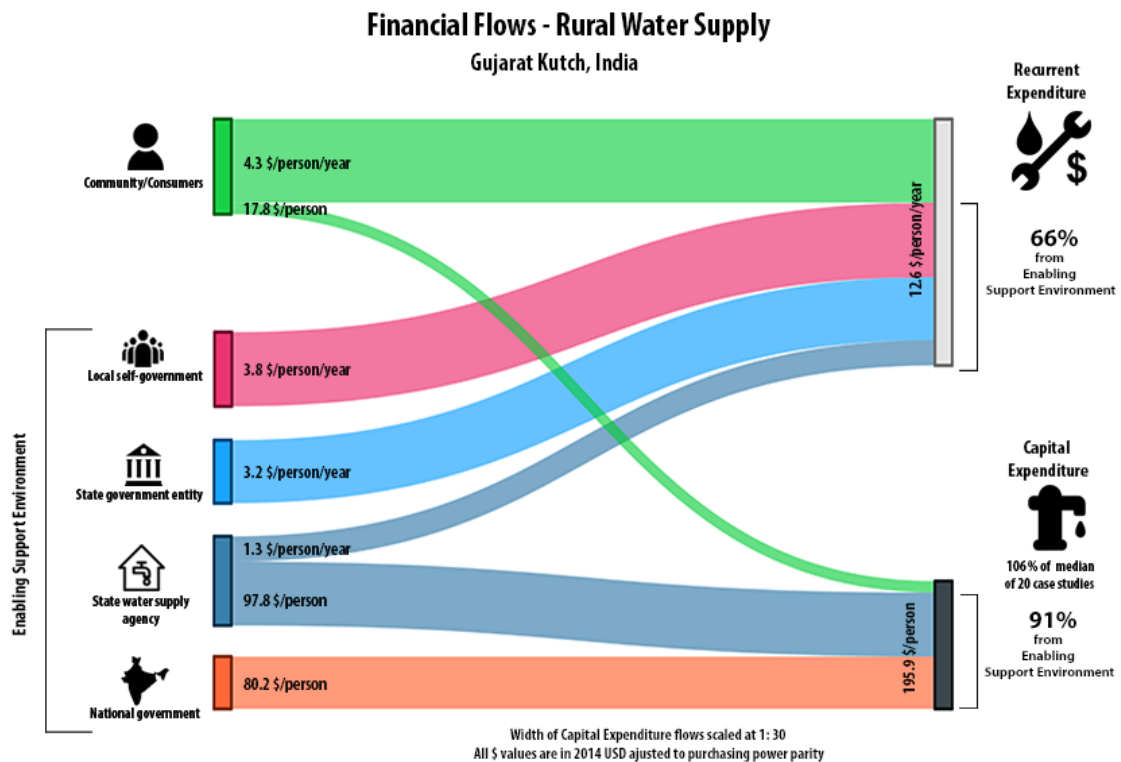
Source of funds	Use of funds - implementation			Use of funds - annual recurrent					RECURRENT EXPENDITURE TOTAL
	CapEx hardware	CapEx software	CAPEX TOTAL	OpEx labour & materials	OpEx power	OpEx bulk water	OpEx enabling support	CapManEx	
Community/consumers	\$ 5,97	-	\$ 5,97	\$ 1,50	-	\$ 0,22	-	-	\$ 1,72
Local self-government	-	-	-	-	\$ 2,72	-	-	\$ 0,14	\$ 2,86
State government entity	-	-	-	\$ 0,13	\$ 2,89	\$ 1,77	-	-	\$ 4,78
State water supply agency	\$ 26,88	\$ 13,27	\$ 40,15	\$ 0,24	-	-	\$ 0,54	-	\$ 0,78
Government of India	\$ 26,88	-	\$ 26,88	-	-	-	-	-	-
NGO national & international	-	-	-	-	-	-	-	-	-
International donor	-	-	-	-	-	-	-	-	-
TOTALS	\$ 59,72	\$ 13,27	\$ 73,00	\$ 1,87	\$ 5,61	\$ 1,99	\$ 0,54	\$ 0,14	\$ 10,15
Median of 20 case studies			\$ 184,16						\$ 11,78
'Plus' %age	90%	100%	92%	20%	100%	89%	100%	100%	83%
Median of 20 case studies			95%						57%



**Figure 31: Financial Flow Diagram for case study 15 Gujarat (Ghandinagar)**

**Table 22: Summary Cost Table for case study 16 Gujarat (Kutch)**

Source of funds	Use of funds - implementation			Use of funds - annual recurrent					RECURRENT EXPENDITURE TOTAL
	CapEx hardware	CapEx software	CAPEX TOTAL	OpEx labour & materials	OpEx power	OpEx bulk water	OpEx enabling support	CapManEx	
Community/consumers	\$ 17,81	-	\$ 17,81	\$ 3,65	-	-	-	\$ 0,61	\$ 4,26
Local self-government	-	-	-	\$ 0,87	\$ 2,91	-	-	-	\$ 3,79
State government entity	-	-	-	-	-	-	-	-	-
State water supply agency	\$ 80,16	\$ 17,67	\$ 97,83	\$ 0,38	-	-	\$ 0,91	-	\$ 1,29
Government of India	\$ 80,16	-	\$ 80,16	-	-	-	-	-	-
NGO national & international	-	-	-	-	-	-	-	-	-
International donor	-	-	-	-	-	-	-	-	-
TOTALS	\$ 178,14	\$ 17,67	\$ 195,81	\$ 5,03	\$ 6,00	-	\$ 0,91	\$ 0,61	\$ 12,56
Median of 20 case studies			\$ 184,16						\$ 11,78
'Plus' %age	90%	100%	91%	27%	100%	-	100%	0%	66%
Median of 20 case studies			95%						57%



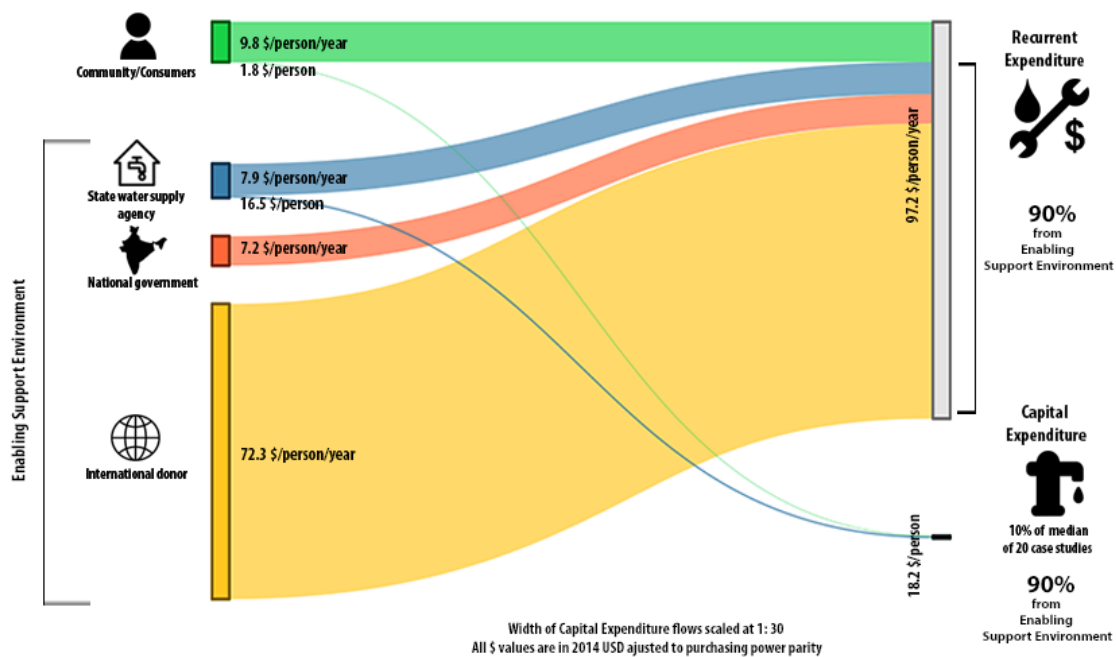
**Figure 32: Financial Flow Diagram for case study 16 Gujarat (Kutch)**

**Table 23: Summary Cost Table for case study 17 Tamil Nadu (Morappur)**

Source of funds	Use of funds - implementation			Use of funds - annual recurrent					RECURRENT EXPENDITURE TOTAL
	CapEx hardware	CapEx software	CAPEX TOTAL	OpEx labour & materials	OpEx power	OpEx bulk water	OpEx enabling support	CapManEx	
Community/consumers	\$ 1,75	-	\$ 1,75	\$ 0,49	\$ 1,46	\$ 1,25	-	\$ 6,61	\$ 9,81
Local self-government	-	-	-	-	-	-	-	-	-
State government entity	-	-	-	-	-	-	-	-	-
State water supply agency	\$ 15,78	\$ 0,71	\$ 16,49	\$ 3,15	\$ 0,90	-	\$ 2,25	\$ 1,56	\$ 7,85
Government of India	-	-	-	\$ 1,76	\$ 0,90	-	-	\$ 4,56	\$ 7,21
NGO national & international	-	-	-	-	-	-	-	-	-
International donor	-	-	-	-	-	\$ 72,31	-	-	\$ 72,31
TOTALS	\$ 17,53	\$ 0,71	\$ 18,24	\$ 5,39	\$ 3,25	\$ 73,56	\$ 2,25	\$ 12,73	\$ 97,18
Median of 20 case studies			\$ 184,16						\$ 11,78
'Plus' %age	90%	100%	90%	91%	55%	98%	100%	48%	90%
Median of 20 case studies			95%						57%

Notes: CapEx and CapManEx data is for the village Ramianahalli only; the entire part of OpEx bulk water not covered by the community has been apportioned to JICA

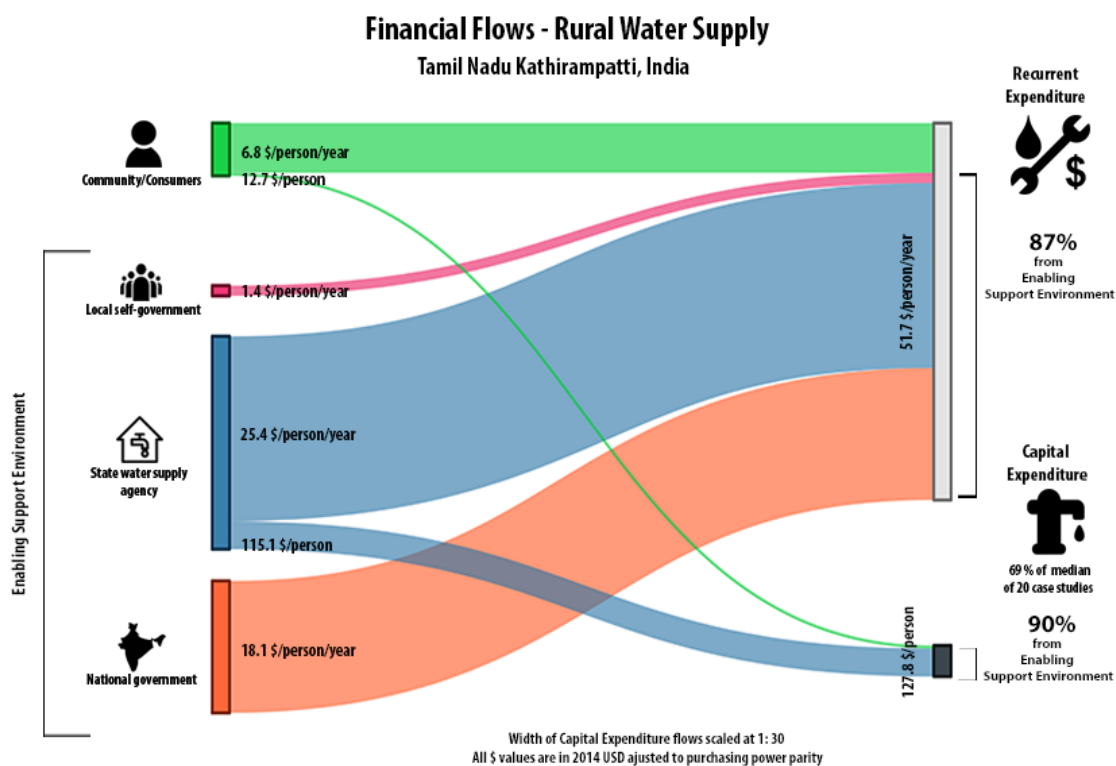
**Financial Flows - Rural Water Supply**  
Tamil Nadu Morappur, India



**Figure 33: Financial Flow Diagram for case study 17 Tamil Nadu (Morappur)**

**Table 24: Summary Cost Table for case study 18 Tamil Nadu (Kathirampattir)**

Source of funds	Use of funds - implementation			Use of funds - annual recurrent					RECURRENT EXPENDITURE TOTAL
	CapEx hardware	CapEx software	CAPEX TOTAL	OpEx labour & materials	OpEx power	OpEx bulk water	OpEx enabling support	CapManEx	
Community/consumers	\$ 12,71	-	\$ 12,71	\$ 2,98	\$ 3,62	\$ 0,21	-	-	\$ 6,81
Local self-government	-	-	-	\$ 1,41	-	-	-	-	\$ 1,41
State government entity	-	-	-	-	-	-	-	-	-
State water supply agency	\$ 114,39	\$ 0,73	\$ 115,12	\$ 0,87	-	-	\$ 2,43	\$ 22,06	\$ 25,36
Government of India	-	-	-	\$ 1,50	\$ 13,19	\$ 1,03	-	\$ 2,37	\$ 18,10
NGO national & international	-	-	-	-	-	-	-	-	-
International donor	-	-	-	-	-	-	-	-	-
<b>TOTALS</b>	<b>\$ 127,10</b>	<b>\$ 0,73</b>	<b>\$ 127,83</b>	<b>\$ 6,77</b>	<b>\$ 16,81</b>	<b>\$ 1,24</b>	<b>\$ 2,43</b>	<b>\$ 24,43</b>	<b>\$ 51,68</b>
Median of 20 case studies			\$ 184,16						\$ 11,78
'Plus' %age	90%	100%	90%	56%	78%	83%	100%	100%	87%
Median of 20 case studies			95%						57%

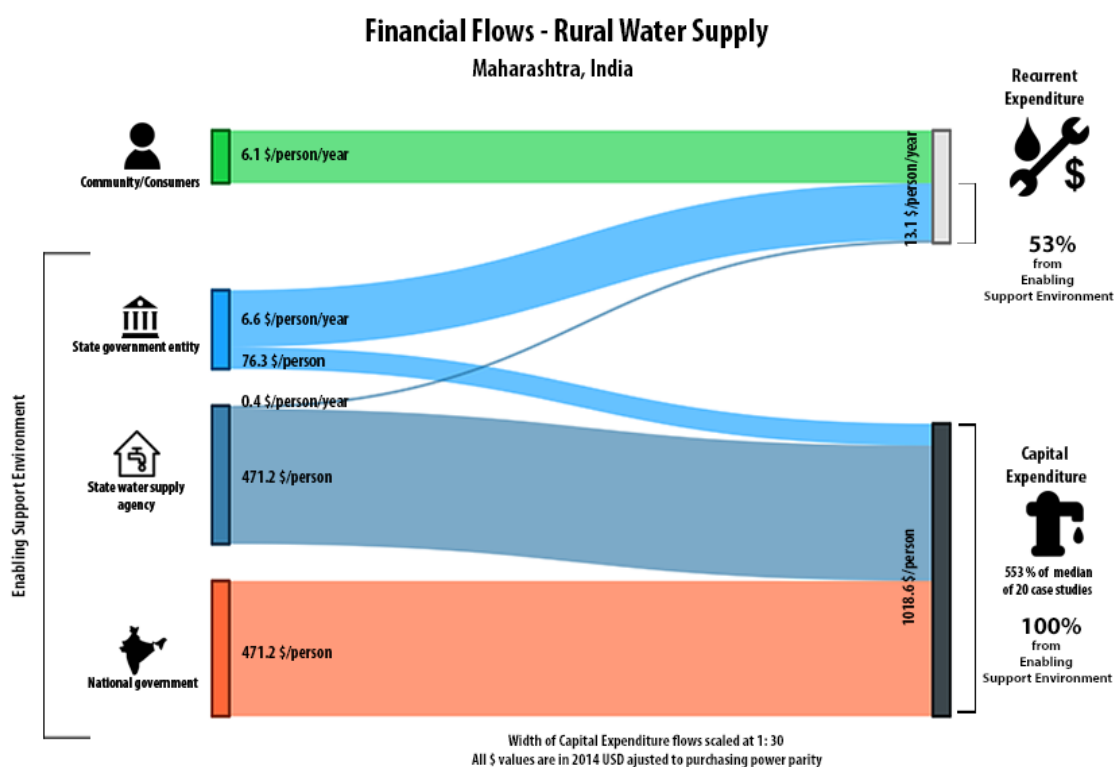


**Figure 34: Financial Flow Diagram for case study 18 Tamil Nadu (Kathirampattir)**

**Table 25: Summary Cost Table for case study 19 Maharashtra**

Source of funds	Use of funds - implementation			Use of funds - annual recurrent					RECURRENT EXPENDITURE TOTAL
	CapEx hardware	CapEx software	CAPEX TOTAL	OpEx labour & materials	OpEx power	OpEx bulk water	OpEx enabling support	CapManEx	
Community/consumers	-	-	-	\$ 3,52	\$ 0,06	\$ 0,04	-	\$ 2,50	\$ 6,12
Local self-government	-	-	-	-	-	-	-	-	-
State government entity	\$ 76,26	-	\$ 76,26	\$ 3,74	\$ 0,17	\$ 0,04	-	\$ 2,65	\$ 6,60
State water supply agency	\$ 471,17	-	\$ 471,17	-	-	-	\$ 0,35	-	\$ 0,35
Government of India	\$ 471,17	-	\$ 471,17	-	-	-	-	-	-
NGO national & international	-	-	-	-	-	-	-	-	-
International donor	-	-	-	-	-	-	-	-	-
TOTALS	\$ 1 018,60	-	\$ 1 018,60	\$ 7,26	\$ 0,23	\$ 0,08	\$ 0,35	\$ 5,15	\$ 13,07
Median of 20 case studies			\$ 184,16						\$ 11,78
'Plus' %age	100%	-	100%	51%	73%	51%	100%	51%	53%
Median of 20 case studies			95%						57%

Notes: per capita costs have been calculated for the entire rural part of the service area of this multi-village scheme

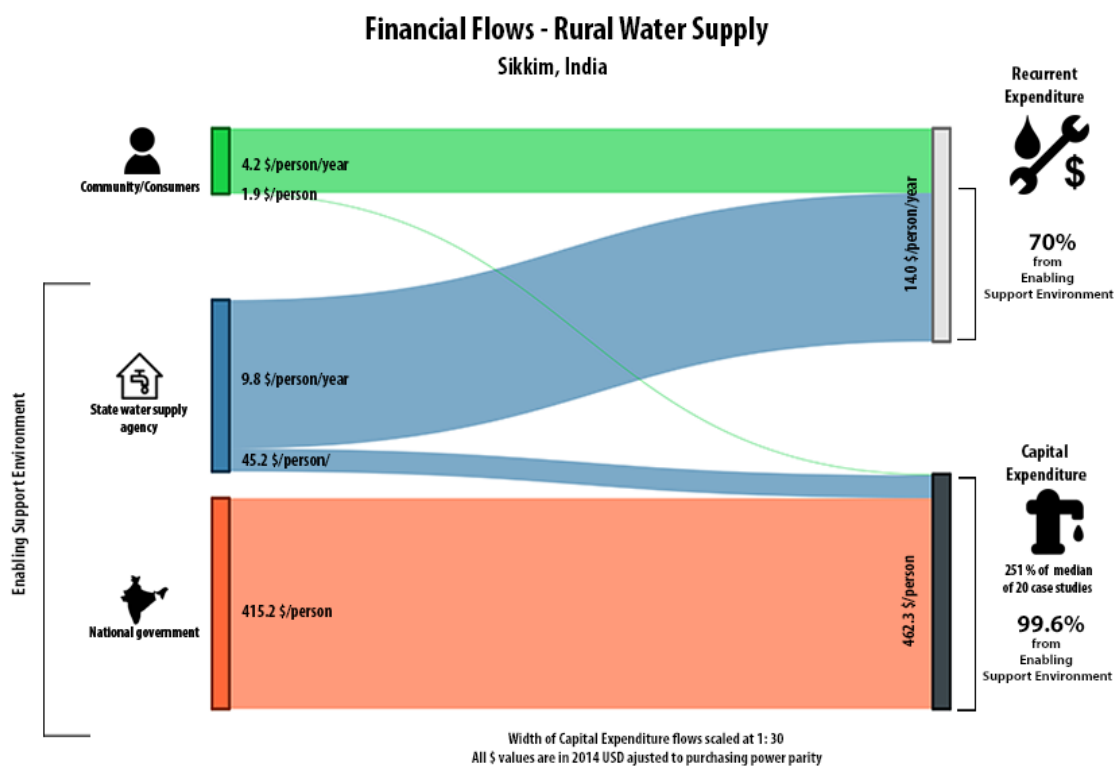


**Figure 35: Financial Flow Diagram for case study 19 Maharashtra**



**Table 26: Summary Cost Table for case study 20 Sikkim**

Source of funds	Use of funds - implementation			Use of funds - annual recurrent					RECURRENT EXPENDITURE TOTAL
	CapEx hardware	CapEx software	CAPEX TOTAL	OpEx labour & materials	OpEx power	OpEx bulk water	OpEx enabling support	CapManEx	
Community/consumers	\$ 1,90	-	\$ 1,90	\$ 3,35	-	-	-	\$ 0,89	\$ 4,24
Local self-government	-	-	-	-	-	-	-	-	-
State government entity	-	-	-	-	-	-	-	-	-
State water supply agency	\$ 43,77	\$ 1,40	\$ 45,17	\$ 2,10	-	-	\$ 7,31	\$ 0,34	\$ 9,76
Government of India	\$ 415,24	-	\$ 415,24	-	-	-	-	-	-
NGO national & international	-	-	-	-	-	-	-	-	-
International donor	-	-	-	-	-	-	-	-	-
TOTALS	\$ 460,91	\$ 1,40	\$ 462,31	\$ 5,45	-	-	\$ 7,31	\$ 1,23	\$ 14,00
Median of 20 case studies			\$ 184,16						\$ 11,78
'Plus' %age	100%	100%	99,6%	39%	-	-	100%	28%	70%
Median of 20 case studies			95%						57%



**Figure 36: Financial Flow Diagram for case study 20 Sikkim**