Analysis of Slipback of Rural Water Supply Systems in India using FIETS Framework and IMIS database – Gujarat Case Study

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Abstract

The objective of this project is to address the failure rate or "slipback" of rural water supply systems in India by analyzing performance of previous water projects using the national government database called IMIS. Data analysis and visualization tools are used on the IMIS in combination with the FIETS framework for sustainability enabling the categorization of variables into Financial, Institutional, Environmental, Technological, and Social factors.

This analysis provides an evaluation of the IMIS database and how it can be used to meet the FIETS categories. It also provides quantitative metrics of slipback of water supply systems based on the available variables, helping identify correlations to problem areas and FIETS variables, enabling data-driven actions to promote sustainability. This assessment is designed based on the state of Gujarat – a generally successful model of water management projects in India - for the developing stage. The Jamnagar district was selected for the sub-district level analysis.

Results show that IMIS database has data that satisfy FIETS factors at state and district levels. There are some limitations on data visibility between these two geographical levels but in both cases a complete analysis of FIETS factors is possible. A gap data analysis provides a detailed list of what are the available variables and which ones are missing from the database.

In the case of Gujarat there is a high coverage of water supply in the rural areas, which makes challenging to find correlations with FIETS factors. Significant positive correlation was identified between low covered areas and districts with high Scheduled Tribal population. There was no correlation between expenditures and low coverage areas or built infrastructure. At sub-district level there are less variables available for analysis and correlations were found to be similar to the state findings. Field visits were made to several villages in Jamnagar that raised questions about the water quality data as well as coverage.

The use of IMIS database to improve the rural water supply sector is very recent and further research is recommended to improve the data collection process, enabling decision-makers to understand better IMIS data, and pilot test this analysis to improve the annual planning of water supply systems at district and state levels.

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Chapter 1. Introduction

Problem Introduction

Water supply systems have been an important sector for India's government since its independence in 1947. Despite decades of experience and improvement, today the country still faces challenges to maintain and scale water supply program solutions that provide sustainable water supply service in rural communities.

According to UNESCO (2012), India has improved its water supply services, reaching 97% of urban areas and 90% of rural communities (though these data are questioned). These programs have a wide range of applications within the "water ecosystem" of a rural community, such as drinking water supply, hand-pumps, latrines, and sanitation units. However, these programs are not always successful as they fail to adapt to site-specific conditions and may not offer sustainable service for users. According to the World Bank the programs implemented in India continue to have challenges with operation, maintenance, and water quality, reporting a 30-40% rate of failure (World Bank 2011).. This phenomenon is known as "slipback" or "slippage" of projects, when projects are completed and then fail after the community takes ownership of the system

In order to solve the slipback problem, the government policy towards water service supply in India has shifted its focus towards sustainability. Based on a report from the International Water and Sanitation Center (IRC), India's emphasis on the sustainability of water supply programs started in 2002 with the implementation of the "Swajaldara" project (James 2011). However, when slippage continued to be a challenge, as water coverage rates fell from 95% in 2001 to 67% in 2009 (James 2011), the Government of India developed a new strategy through the National Rural Drinking Water Program (NRDWP) in 2009.

The NWRDP focuses on sustainability of water supply with the objectives of providing water at a household level, with multiple sources of water, and enabling community ownership of water supply systems by 2022. These goals encourage each state to provide "drinking water security at the local level through sustainability of sources and systems" (NRDWP 2013). This new perspective on sustainability has a holistic approach that considers factors aligned with recently developed sustainability assessment frameworks for Water and Sanitation (WASH) sector.

Sustainability assessment frameworks in the WASH sector have been used for the past decade by several organizations and countries with the objective of providing quantitative evaluations of projects and programs. These evaluations help implementing organizations, funding agents, and governments identify the value of the investment for providing service for the community.

Most of sustainability assessment tools use the FIETS approach based on five (5) factors: Financial, Institutional, Environmental, Technical, and Social. FIETS was developed by the Dutch WASH Alliance and is founded on five pillars to provide sustained service for as long as possible and requiring local ownership and management (Dutch WASH Alliance 2014). FIETS framework has a holistic approach with results that can help assess the NWRDP approach in India. The FIETS approach also gives some flexibility to adapt the five pillars holistic approach to the water sector in India, and in the future to include the sanitation sector as well. Even though water projects are not presently implemented in conjunction with sanitation and hygiene projects in India, these two sectors are closely related and this approach provides the flexibility to assess them together.

Research questions and goals

The objective of this thesis is to address the challenge of sustainability of programs in rural India by evaluating the performance of projects in a state perceived as the most successful in providing rural water supply services, the state of Gujarat. The assessment is based on existing frameworks for sustainability using the FIETS approach and adding historical performance data for rural drinking water projects in Gujarat. This assessment will provide quantitative metrics for the sustainability of service of projects, identifying variables that drive the success or failure of the programs. This assessment is tested in the state of Gujarat with the intention of being used in other states of India.

Based on analysis and data available for rural water supply programs, this research focuses on the following questions:

- Is it possible to assess sustainability of water supply programs at the village, district, and state levels with current IMIS data?
- What metrics of sustainability can be found with current IMIS data?
- What analysis can be done with those metrics to assess sustainability?
- What gaps can be filled and further analysis and applications can be done with additional study?

The results from this research will quantify key factors in the success of water programs in the state of Gujarat using existing government data. This data is publicly available to implementing organizations and funding agencies, which enables them to track the performance of water supply interventions in India.

Structure and approach

This research is presented in 6 chapters. Chapter 1 introduces the problem, goals, and methods of this study. Chapter 2 provides an overview of slipback globally and in India.

Chapter 3 presents an overview of the slipback problem in the water sector from a global perspective and in India. It also evaluates current assessment frameworks and methods used to evaluate slipback globally and in India. This chapter ends with a summary of the method selected for this research.

Chapter 4 and 5 provide a summary of the water supply landscape in India and the case study of the state of Gujarat, respectively. This information provides the context of the slipback problems in India and its relation with Gujarat as a case study.

Chapter 6 presents a detailed description of the data source for the analysis (IMIS), looking at the structure, data entry process and frequency, and involvement of different government levels.

Chapter 7 presents the analysis of data and results for Gujarat state and Jamnagar district. Within this chapter a data gap analysis is presented and detailed results are presented so they can be easily compared and used for future researches.

Chapter 8 summarizes the findings of the analysis and results, providing recommendations for sustainability assessment using the FIETS approach and IMIS database. It also provides insights into how this data analysis could be improved to resolve sustainability challenges of rural water supply in India and countries with similar types of database.

Methodology

This section provides a description of the analytic process used in this research to evaluate factors related to Slipback in India. Chapters 2 through 4 describe the context of rural drinking water issues globally, in India, and in Gujarat.

The data source used in this study is examined intensively in chapter 5. It consists of primary data from the IMIS database, and it is limited to the time frame and variables available in this source. The time frame ranges from 2009 to more recent years.

Using that database the various factors identified as causes of slipback are categorized under the FIETS framework providing a holistic perspective of possible causes of rural water supply system failures. The list of variables for each factor comes from previous researches in India, the process dynamic of water supply in rural India, and from field visits during this study.

Then a detailed description of the IMIS database is provided, presenting a gap data analysis between IMIS data and FIETS factors. Based on availability of data within IMIS to meet the FIETS factors list, a framework of analysis is created and tested with the state of Gujarat and Jamnagar district located within this state.

The framework is used for state and district level analyses to test strength of the evaluation from IMIS data and FIETS framework. Data analysis for each geographical level includes each FIETS variable that is available. Data update will vary based on the IMIS data entry cycles described in the chapter 4.

Each FIETS factor is analyzed separately for each of the data variables. The data analysis consists of descriptive statistics, histograms, historical trends, and ranking of most problematic areas. This provides a summary of current status, positive and negative trends and identifies changes that require further analysis.

After each FIETS factor is evaluated, a quantitative and qualitative analysis of relationship between failure and variables is provided. Quantitative analysis of relations between FIETS and IMIS data is done using statistical correlation. Correlation analysis of all variables will be done after the FIETS categories are evaluated independently. Correlations found between variables indicate statistical relationships between successes, failures, and FIETS factors. This analysis would validate expectations for each variable versus data analysis results. Discrepancies between expectations and data findings provide recommendations to improve the IMIS database.

The study ends by providing conclusions from the analysis and recommendations for variables that require further analysis, a summary of positive and negative trends in the water sector at each geographical level, and recommendations on how to improve data collection within the IMIS database. These findings will be presented to stakeholders at national, state, and district level for consideration and further development.

Chapter 2. Slipback and Sustainability

This chapter provides the fundamental concepts and context of the "slipback" problem in the rural water supply sector from a global perspective. This first section gives the definition of slipback within the water supply sector and analytical tools currently used to analyze slipback by several countries and organizations. These tools consist of several formats of analysis that have been used by local and international water organizations in developing countries in Asia, Africa, and America. A general evaluation about their application, advantages and limitations is provided. Since India is the focus country of research, a summary of the slipback situation in India is then provided.

Slipback and Sustainability

Slipback is defined as a premature failure of water systems to provide adequate quantity and/or quality of drinking water to the community. This definition of premature failure is from the perspective of service to the community. This focus on service is the new perspective of sustainability in the water supply sector. Sustainability problems are seen as functionality failures that gradually stop providing water to the community. From this perspective, slipback can be defined as unsustainability of service from water supply systems.

As mentioned, sustainability of service of water does not only come from physical failures, but also from other factors such as financial, institutional, and management capacity of the organization responsible for the system. However, sustainability of water systems continues to be measured using factors that only look at infrastructure perspective as shown in Table 1.

Table 1 shows that there is not a single standard to report sustainability of service for rural water supply systems. These factors are selected based on the specific characteristics of the country making it difficult to compare countries and sometimes within regions of the same country.

Table 1 Indicators used to measure Sustainability of Rural Water Supply (Lockwood and Smits 2011, 60)

Country	Proxy formal indicator for sustainability of rural water supply	Value	Source
Benin	Functionality of water facilities	73% (handpumps) 79% (springs) 52% (dug wells) 69% (small piped systems)	Adjinacou, 2011
Burkina Faso	Functionality of water facilities	82% (handpumps) 66% (small piped systems)	Zoungrana, 2011
Ethiopia	Functionality of water facilities	67%	Chaka et al., 2011
Ghana	Functionality of water facilities		Case studies report functionality of boreholes varying from 58 to 90% (Skinner, 2009; and Bakalian and Wakeman, 2009 respectively)
Honduras	Composite indicator classifying performance of service into four levels	78% not classified as requiring major intervention	SANAA, 2009
India	Extent of slippage[A]	30%	GoI, 2008
Mozambique	Functionality – for handpumps only	85%	DAR/DNA, 2010
Uganda	Functionality of water facilities	81%	MWE/DWD, 2010

[A] While the concept of slippage is not an indicator but rather a descriptive term used by Indian authorities, it is a useful guide to the state of rural water services.

Honduras is the only country from the list that uses a composite indicator including assessment of infrastructure as well as management of the system, making it the most comprehensive assessment of sustainability in this list. In the case of India, Slippage or slipback is defined as failure to provide adequate water coverage to communities. If a community was covered and then fails to remain covered then is considered a slipback. This approach goes beyond service sustainability as it considers different reasons for lack of adequate access to water. However this approach fails to detect the actual reason for slippage or to identify best ways to avoid it

Composite indicators like the ones used in Honduras are becoming more popular to improve sustainability of rural water supply systems (Lockwood and Smits 2011). This assessment is periodically measured by field surveys using locally developed software to qualify the system within the four (4) categories. Details of the Honduras assessment are shown in the following table:

Table 2 Composite Factors for Sustainability in Honduras (Lockwood and Smits 2011)

Category	Status of the system	Recommended intervention
A	The system functions well and there is potable water every day. Water is treated with chlorine. There is a water committee which meets regularly, and an operator carrying out O&M tasks.	Activities geared towards optimising community participation and continued strengthening of management tasks by the water committee.
B	The system may be working but there are management gaps that may put the sustainability at risk. No investment in infrastructure is required to move to category A, but should be geared towards strengthening the capacity of the water committee.	Supporting and strengthening management capacity. Supporting accountability and participation of the users.
C	The system may function only partially but there are management and physical deficiencies that put the sustainability at risk. Infrastructure investment is needed to move to category A, but that can be done with existing funds of the community.	Same as B, but support to the water committee in defining the work that need to be done, their budgeting and identifying of sources of funding.
D	The system is in such bad management and physical state that the costs of improving it and bringing it to category A, are beyond the possibilities of the community. Its life span may be over.	Define feasibility to be considered in future investment plans.

Source: SANAA, 2009

The overall performance of the countries in figure 1 reveals that there is an average of 20-40% of non-functionality or not adequate service delivery. Based on a UNICEF 2009 report, 36% of hand pumps in 20 countries of Africa fail. In India, 30-40% of habitations fail to remain covered by water service. In Honduras 43% of the systems presented problems and 22% needed major interventions. In Mozambique the sustainability score of systems reached only 50-75% indicating high probability of failure (Lockwood and

Smits 2011). All these metrics indicate that the challenge of sustainability is complex and remains a global problem that requires attention and solutions.

Interestingly, all these countries have sustainability measures but only two of them have national targets that specifically mention sustainability goals. In the case of Honduras the target to reach 41% of category "A" systems was met and in Uganda the target of 86% functionality of systems by 2009 fell short at 81%. By setting specific targets of sustainability these countries keep better track of sustainability of water supply systems that benefit the community. With clear goals and metrics more effective strategies can be implemented, inducing better performance or progress.

Monitoring Water Supply Systems

Monitoring is important to measure progress of water supply in the rural sector as well as to identify indicators of sustainability. There are two main types of monitoring that have been identified: implementation monitoring and service provided monitoring. The use of either of these approaches depends on the type of institutional and regulatory system used in the country. In countries where the main goal is to create infrastructure and coverage, monitoring is designed to measure that goal. For example, in the United States where regulations are focused on implementation, the monitoring system measures the number of systems built and number of people served (Lockwood and Smits 2011).

Countries monitoring service provided have more comprehensive monitoring systems, such as Honduras. These monitoring systems, as seen in Table 2, assess additional intangible factors such as management factors. More countries are looking at comprehensive monitoring systems, like Mozambique, which is collaborating with UNICEF to include status of delivery points, maintenance frequency, community financial contributions, and community institutional participation.

The disadvantage of the comprehensive monitoring systems is that they require more time and resources. However, they bring higher value as they allow better analysis and are flexible for collecting more data. By having more data it is possible to develop more accurate policies and strategies to improve water supply systems on the ground.

With the development of technology, new data management systems are becoming popular for channeling large amounts of data from local to national governments, which enables data-driven planning strategies at macro levels. This new technology reduces the cost of implementing a comprehensive data collection system every time evaluation is needed. Once the infrastructure is in place it is able to monitor and collect data for analysis as needed with less manual effort.

This type of integrated monitoring system is used in India with the Integrated Management Information System (IMIS) and in Ghana with the District Monitoring Evaluation System (DiMES) (Lockwood and Smits 2011). These systems consist of large online databases that gather data at district offices to develop annual plans and monitor progress on it. These web-based databases allow the possibility of coordinating activities with other organizations in the water sector, and increasing the visibility of projects and progress.

The reliability of these databases varies based on the formats established for data entry and reporting. Accessibility of data is another important feature of monitoring systems, since in most cases it would not otherwise be visible to district and lower levels. In Honduras there is little to no access of non-state officials to findings from their data and analysis. There are countries where data are visible and accessible online, as in India, however these data are not easy to understand for the general public.

The use of databases varies across countries, since data are not always analyzed and used to improve strategies and performance. Uganda collects limited number of factors, but its performance sheets are used to gain a better understanding of the water supply sector, analyze trends, and make changes based on these key factors. (Lockwood and Smits 2011). Data collection is the first step but further data analysis is required to actually make better use of monitoring systems.

Sustainability Assessment Frameworks

Based on current practices of sustainability assessment, there are three main frameworks used in the water and sanitation sector: 1) the Triple-S building blocks from the IRC; 2) the WaterAid Sustainability Framework; and 3) the FIETS principles from the Dutch Water Alliance (DWA) (AKVO 2015).

Triple-S:

The International Water and Sanitation Center (IRC) created this framework which is based on factors identified to be "building blocks" of long lasting water supply systems (IRC 2015). This framework has been used in India, Malawi, Honduras, and Bolivia. The ten (10) building blocks identified and listed in this framework are:

1. Professionalization of the community management
2. Recognition and promotion of alternative service provider options
3. Monitoring service delivery and sustainability
4. Harmonization and coordination
5. Support of service providers
6. Capacity support for local government
7. Learning and adaptive management
8. Asset management
9. Regulation of rural services and service providers
10. Financing to cover all life-cycle costs

WaterAid Sustainability Framework:

WaterAid developed this theoretical framework specifically for countries where they work (Figure 1). This framework is designed to provide external support for community management of WASH programs. The variables considered in this framework are shown in the following figure.

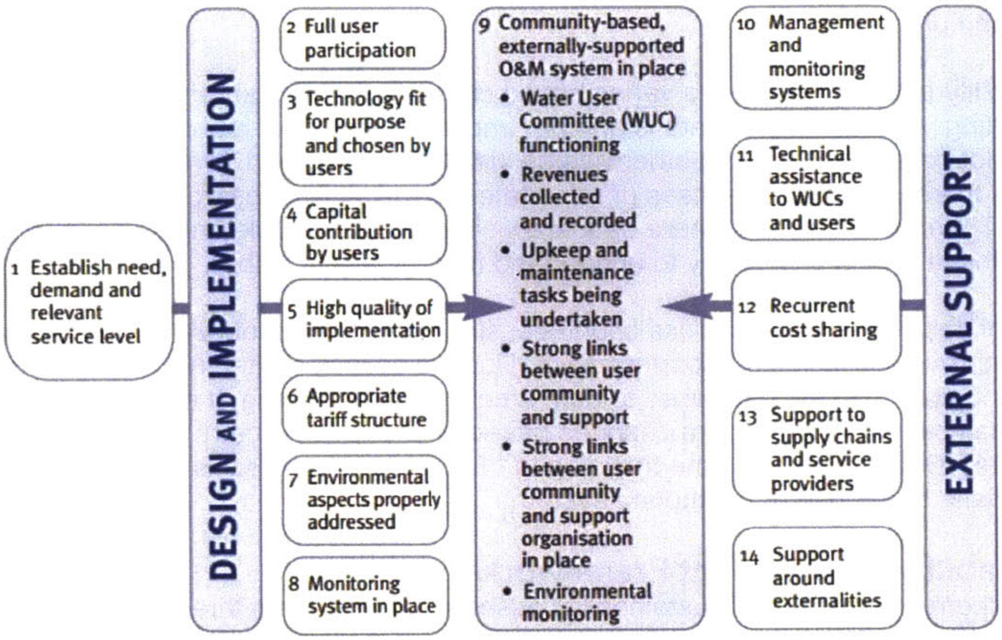


Figure 1 WaterAid Sustainability Framework Elements (AKVO 2015)

FIETS Sustainability Approach:
FIETS stands for Financial, Institutional, Environmental, Technology, and Social factors for sustainability. The Dutch Water Alliance (DWA) identified these five factors as the pillars for sustainability of water and sanitation systems implemented by the DWA and their partners. FIETS offers a guide for all sustainability programs (including other frameworks) that can categorize variables under these five principles (AKVO 2015).

There are two main differences between the three frameworks:

- The Triple-S model is designed only for the rural water sector, while the other two can look at water and sanitation sectors.
- FIETS framework looks at the sustainability of the programs after third party interventions are ended. The other two consider external financing as part of their sustainability plan.

From these three frameworks the FIETS is the one that has been used more widely for the development of tools in the WASH sector. The other two offer frameworks with more categories that make it more complex to use. Triple-S has 10 categories and the WaterAid framework has 14 categories, making them less flexible for developing analytical tools in the water and sanitation field.

The FIETS Framework

The FIETS framework is an approach developed by the Dutch WASH Alliance (DWA) to ensure long-term sustainability of Water, Sanitation and Hygiene programs. The DWA is a consortium of six (6) Dutch NGOs (Simavi, AKVO, Amref Flying Doctors, ICCO, RAIN, and WASTE) that work in the water and sanitation sector in Asia and Africa.

The DWA program is operating for five (5) years from 2011-2015 with the vision of helping people have access to sustainable water and sanitation services. There are 780 million people in the world that do not have access to safe water and 2.5 billion (40% of world's population) that have no access to adequate sanitation facilities. Part of the problem occurs when systems are built but fail to deliver service few years after completion.

FIETS was developed as a systematic approach to the sustainability of WASH programs after the implementation agencies complete their work. A description of each of the principles is provided as follows:

Financial sustainability: this factor is based on promoting local financing to operate and maintain water, sanitation, and hygiene programs in the community. This includes establishing financial contributions from users (tariffs, fees, taxes), local service providers (mechanics, operators), and local government financing programs.

Institutional sustainability: the institutional structure is established and operates to effectively deliver WASH services to the community. Each organization is recognized and has clear responsibilities and roles within the WASH ecosystem. All stakeholders are involved and actively participating to ensure adequate service.

Environmental Sustainability: interventions always have an impact on the environment and the actors interacting with it. Considering these interactions between changes in processes, inflows, outflows, and stakeholders should be part of the analysis for environmental sustainability.

Technical sustainability: technology and infrastructure meets users' needs; and the community can operate, maintain, and repair it. The infrastructure will not deplete natural, social or financial resources on which they depend.

Social sustainability: provides equity, inclusion, gender equity, cultural sensibility, and needs-based interventions. These social characteristics ensure a proper social environment for current and future generations.

The FIETS framework has been used with positive results in the following countries: Uganda, Ethiopia, Nepal, Bangladesh, Benin, Ghana, Mali, and Kenya. In these countries DWA counts on local partners being able to implement FIETS successfully.

Tools used to Assess Sustainability

Since not all countries have a centralized database or collect all data needed for sustainability assessments, there is a need for additional assessment tools. Several tools have been developed in the last decade and in July 2014 the International Water and Sanitation Organization (IRC) made an assessment of tools available for the water and sanitation (WASH) sector.

IRC found 191 tools used to measure sustainability of WASH systems, but only 25 met the minimum requirements of track record, specific content, clear and reproducible process, and synthesis of data as output. Donor agencies, implementing organizations, researchers, and consultants developed these 25 tools and have applied them in 52 countries. See the next figure for a list of these 25 tools.

TOOL	ORGANISATION/INDIVIDUAL
PROJECT OR PROGRAMME TOOLS	
Sustainability Assessment Tool (SAT)	AGUASAN Group
Gender Analysis Snapshot (GAS)	CARE International
Governance into Functionality Tool (GiFT)	CARE International
Local Government IWRM Support Assessment	CARE International
WASH Life-cycle Assessment	Chalmers University of Technology/ University of South Florida
Sustainability Monitoring Framework (SMF)	Dutch WASH Alliance
WASHCost Tool	IRC
Planning-Oriented Sustainability Assessment (POSAF)	Starkl et al (2013)
Sustainability Check (SC)	UNICEF
Sustainability Index Tool (SIT)	USAID/Rotary International (Aguaconsult Ltd)
Tool for Planning, Predicting & Evaluating Sustainability (ToPPES)	Water and Sanitation for Africa (WSA)
Methodology for Participatory Assessment (MPA)	Water and Sanitation Program (WSP) /IRC
SECTOR	
WASH Sustainability Sector Assessment Tool	IRC / Aguaconsult
Water, Sanitation & Hygiene Bottleneck Analysis Tool (WASH-BAT)	UNICEF
Sub-sector scorecard*	Water and Sanitation Program/National Governments
Enabling Environment Assessment	Water and Sanitation Program
Sector Wide Investment and Financing Tool (SWIFT)	Water and Sanitation Program
Rural Water and Sanitation Information System (SIASAR)	Water and Sanitation Program/National Governments
TECHNOLOGY OR INFRASTRUCTURE FOCUS	
Check Up Program for Small Systems (CUPPS)	Environmental Protection Agency (US-EPA)
Financing for Environmental, Affordable and Strategic Investments that Bring on Large-scale Expenditure (FEASIBLE)	OECD/EAP Task Force and COWI
Technology Applicability Framework (TAF) & Technology Introduction Process (TIP)	Skat Foundation
OTHER (BASIN, COMMUNITY, ORGANISATION)	
Road - map for Integrated Water Resource Management (IWRM) in River Basins	CARE International
Sustainability Snapshot	WaterAid
Water for Life Sustainability Rating	Improve International
Sustainability Self-Assessment	SustainableWASH.org

Figure 2 Sustainability Assessment Tools Inventory (Schweitzer, Grayson, and Lockwood 2014)

All of these tools were developed in the past 10 years by different organizations and none of them have been applied more than 10 times. However, half of the tools have been developed and used in the African continent (Schweitzer, Grayson, and Lockwood 2014).

The IRC assessment of this tool provided the following findings:

Audience: The target audience is mostly towards implementing agencies with 37% of the tools, 23% for donors, 19% for national government, 8% for local government, 8% for service providers, and 6% for community use.

Stage of use: Looking at the stage of use, 30% of tools are designed for long-term assessment after investment or outside project completion scope, 25% of the tools evaluate performance after completion, 18% for pre-construction design, 15% during implementation, and 13% for planning stage. Since tools can be used for more than one phase, the percentages do not add to 100%.

Frequency of use: Most of the tools are designed to be used on a once a year basis or less frequently, up to every 5 years. From the 25 tools, 9 can be used annually, 3 can be used every 3-5 years, and only 3 tools can be used as needed. This leaves little flexibility to do frequent assessments of the programs.

Data Source: Primary data is the most popular type of source for analysis. Primary data is generated during the implementation of the tool and secondary data analyzes data already on records. From the 25 tools, 15 use exclusively primary data, 9 tools use both primary and secondary data sources, and only 1 uses exclusively secondary data-sources.

Sector of use: The rural water sector has most availability of tools followed by the rural sanitation. Since WASH sector includes water, sanitation, hygiene, or a combination of two or all of them, the assessment shows 32% of the tools are in the water sector, 38% in all WASH, 22% in sanitation, 4% for hygiene as well as for water and sanitation (WATSAN). The type of sector is further categorized as rural into urban areas. The results show that 63% are rural, 36% general, and only 1% urban.

Data visualization: most tools use bar charts or radar diagrams. Only three (3) tools use a ranking of three levels of performance (low, medium, and high). Most use a simple weighting method with a total aggregated number. Only one tool uses complex statistical methods of performance. There were no tools using geographical mapping of results. For this research the mapping is considered of high relevance but due to time limitations it was not included in the scope.

Impact: The impact of these tools has not been able to be fully assessed since they have been used for short periods of time. However, based on the IRC study it was determined that current users are eager to continue using these tools and hope to see progress in the development of these tools. Users also like to see validation of tools as they are still in an early development stage (Schweitzer, Grayson, and Lockwood 2014).

Cost: Cost of tools ranges between $5,000 and $65,000 per application, varying based on the level of effort to use the tool (Schweitzer, Grayson, and Lockwood 2014). The level of effort is translated into low, medium, or high based the time of implementation. Low level involves days or weeks, medium involves weeks to few months, and high more than few months. From the 25 tools, 6 are low effort, 10 have medium effort, and 8 have high effort.

The list of the 25 tools used for this evaluation is shown in Figure 2. Looking at all these tools and different sectors and levels of applications, there is great diversity of sustainability assessment methods currently being used around many different countries.

Based on the 25 tools evaluated by the IRC, these were categorized further based on their use in the general WASH sector, removing those with specific focus on a technology or an organization aspect of sustainability (Boulenouar, Schweitzer, and Lockwood 2013). All of these tools have been pilot tested and have quantifiable outputs. The list of these five main tools is presented in Table 3.

Table 3 WASH-Focus Sustainability Assessment Tools (Boulenouar, Schweitzer, and Lockwood 2013)

Organisation (type)	Tool	Stage of development	Frequency	Country experience to date
AGUASAN (network)	Sustainability Assessment Tool	Three years (full application-once; limited application-three times)	Initial detailed assessment then 3-4 years	Kosovo, Haiti, Nepal, Mali
Dutch Water Alliance (consortium of NGOs)	Sustainability Monitoring Framework	One year (full application-twice)	Unspecified	Ghana, Uganda
UNICEF Mozambique (NGO)	Sustainability Check	Five years (full application-five times in Mozambique)	Annual during programme implementation	Mozambique (similar framework applied in three other countries)
USAID-Rotary International (collaboration)	Sustainability Index Tool	Two years (full application-three times)	3,5,and 10 years following implementation	Philippines, Ghana, Dominican Republic
Water and Sanitation for Africa (NGO)	Tool for Planning, Predicting and Evaluating Sustainability	One year (pilot testing underway)	Annual	Ghana

All of these tools use the FIETS principles for assessment, and others use some additional factors that can be related to the three main frameworks of sustainability. The following table shows the framework and data collection methods for each tool.

Table 4 Frameworks and Data-Collection of Sustainability Tools (Boulenouar, Schweitzer, and Lockwood 2013)

	Framework											Data Collection Methods				
	Sustainability Categories															
	Environment	Financial	Institutional	Social	Technical	Management	Service Delivery	Sanitation/ Hygiene	Knowledge/ Capacity	Indicators	Sub-Indicators	Focus Group	Key Informant	Household Survey	Technical Audit	Document Review
AGUASAN-Sustainability Assessment Tool	x	x	x	x	x				x	22	110		x		x	x
DWA-Sustainability Monitoring Framework	x	x	x	x	x					45+	N/A	x		x		x
UNICEF-Sustainability Check		x	x	x	x		x	x		26	59	x	x	x	x	
USAID/RI-Sustainability Index Tool	x	x	x		x	x				14-23*	56-92*	x	x	x	x	x
WSA-ToPPES	x	x	x	x	x	x	x			23	92	x	x		x	

* N.B. The indicators and sub-indicators are dependent on the intervention type. The total number of indicators and sub-indicators cannot be determined without knowing the different intervention types in each programme.

Table 4 shows that three (3) of the tools use FIETS framework, and the other 2 tools use at least 3 of the FIETS factors. All of these tools are based on surveys, requiring considerable time and resources, and are limited to uses based on the sample size for data analysis. The survey aspect and weighting of results leaves some subjectivity in the data. Data validation is needed and the triangulation method is typically used.

Using FIETS to analyze Slipback in India

Based on the slipback situation in India and the overview of sustainability assessment frameworks, this research will use the FIETS principles to analyze slipback in India.

Using FIETS categories includes tangible and intangible factors that cause slipback in India, which is a combination that has not been largely documented as of today. This approach will leverage data available that goes beyond physical infrastructure and water supply coverage.

This research will use exclusively primary data from India's Integrated Management Information System (IMIS). This is the first attempt to use the government rural water database for this type of analysis, focused on slipback of water supply in India using FIETS principles.

For this analysis, slipback will be defined based on Indian standards of quantity and quality of water supply. The quantity of water is established at a minimum 40 liters per capita per day (lpcd) and 10 lpcd for safe drinking and cooking water. The maximum distance for water access is 1.6 Km horizontal distance or less than 100 meter elevation (Department of Drinking Water Supply 2010). For quality the standards are given in the National Drinking Water Standards measuring biological and chemical pollution.

There is no standard duration of failure to qualify as a slipback in India. Failures can last a week, a month, or a year but there is no minimum time of water supply failure to categorize it as slipback. However, there is a life expectancy established for water systems infrastructure of 15-20 years that can be used as a reference for premature failures. Since the data is reported annually, current failures will be considered between financial years.

In addition, the existing National Rural Drinking Water Program (NRDWP) guidelines establish that the operation and maintenance (O&M) of the system is 100% the responsibility of the community. Government intervention is only provided if the community is not able to solve the problem with local funding, and requests government intervention.

Based on system life expectancy and O&M funding standards, any system failure that requires government re-investment before the expected life of the system (15-20 years) may be considered a slipback. Since the IMIS tracks projects funded by national and state governments, all projects reported as not fully covered or quality affected and that were fully covered would qualify as slipback.

Slipback in India

According to the UNESCO (2012), India has improved considerably water supply services, reaching 97% of urban areas and 90% of rural communities (though these data are questioned). However, these programs are not always successful as they fail to adapt to site-specific conditions and may not offer sustainable service for users. According to the World Bank the programs implemented in India continue to have challenges with operation, maintenance, and water quality, reporting 30-40% failures or slipback. These failures consist of completed water supply systems that fail prematurely few years after they are handed over to the community. These projects are known as "slipback" projects (World Bank 2011) and are a considerable factor of vulnerability in rural areas.

India has a population of 1.2 billion and 70% of the population lives in rural areas; this means that the potential impact of slipback can reach almost 900,000 people. There are 600,000 villages in India and based on the World Bank data, about 250,000 are directly affected by slipback projects.

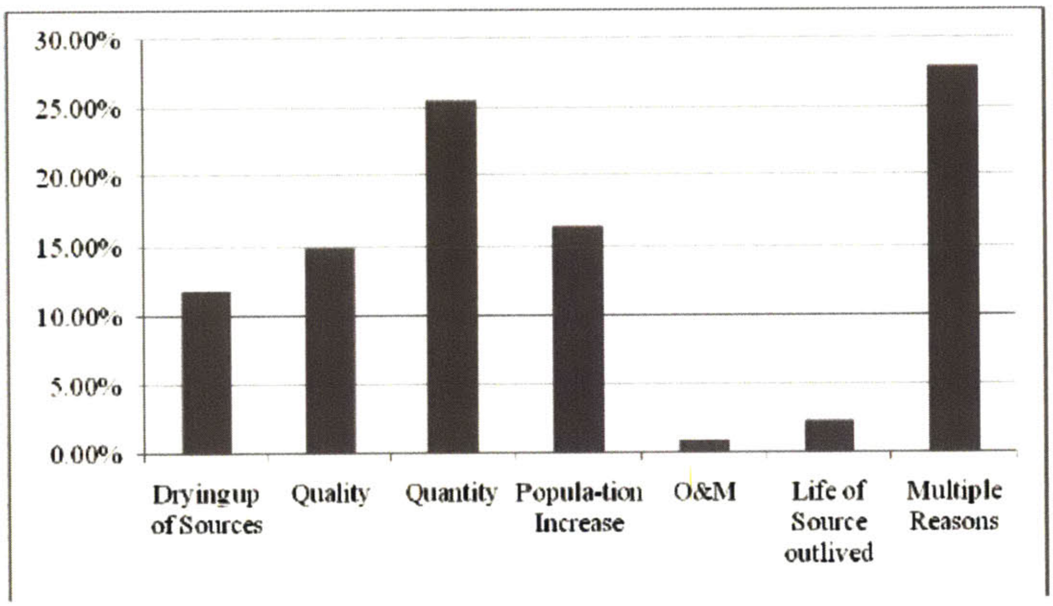
In order to solve the slipback problem, India shifted its focus towards sustainability in 2002 by the implementing a program called "Swajaldara". However, when slipback continued to be a challenge as reported coverage rates fell from 95% in 2001 to 67% in

2009 the Government of India developed a new strategy through the National Rural Drinking Water Program (NRDWP) in 2009 (James 2011).

In 2009, the Government of India (GoI) listed six (6) main reasons for slipback as the following (Reddy, Rao, and M. Venkataswamy 2010):

1. Drying up of sources
2. Quality
3. Quantity
4. Population increase
5. O&M expenditure
6. Life of source outlived

Based on the results reported by the GoI in 2008, the national incidence of each of these causes for slipback or slippage is shown in the following figure (Reddy, Rao, and M. Venkataswamy 2010).



Source: GoI (2008)

Figure 3 Slipback reason across India (Reddy, Rao, and M. Venkataswamy 2010)

This graphic shows that the most relevant reason for slipback is lack of adequate quantity of water, followed by population growth, and quality of water. However the "Multiple Reasons" category shows the highest frequency, which indicates the lack of data about causes of slipback in India and how these reflect the ground reality. Also, the categories are not mutually exclusive, i.e. population increase can be a reason for quality failure.

Reports shows that there are parameters that should be accounted for slipback and are a reflection of successful water systems, such as education and health (Reddy, Rao, and M. Venkataswamy 2010). These two factors are listed as negative correlation with slippage. If health and education are high within a community the slipback will be low.

Chapter 3. Water Supply Sustainability in India

Water resources in India

India is located in South Asia and is the 2nd most populated country and the 7th largest country in the world with 3.3 million km^2 of surface area. Based on the last census in 2011, the total population is 1.21 billion of whom 68.8% live in rural areas. The country is divided into 29 states and 6 Union Territories as of 2015.

India's water budget, according to the Ministry of Water Resources, is 1,123 billion cubic meters (BCM) and the water used is 634 BCM. Other budgets calculated at a higher evapotranspiration rate estimate the actual water availability at 654 BCM (UNICEF 2013). According to the Water Resources Group, in 2030 India will face a large gap between supply and demand with 50% of demand (UNICEF 2013). This ratio of demand and availability across the country represents the critical situation of water sustainability in India.

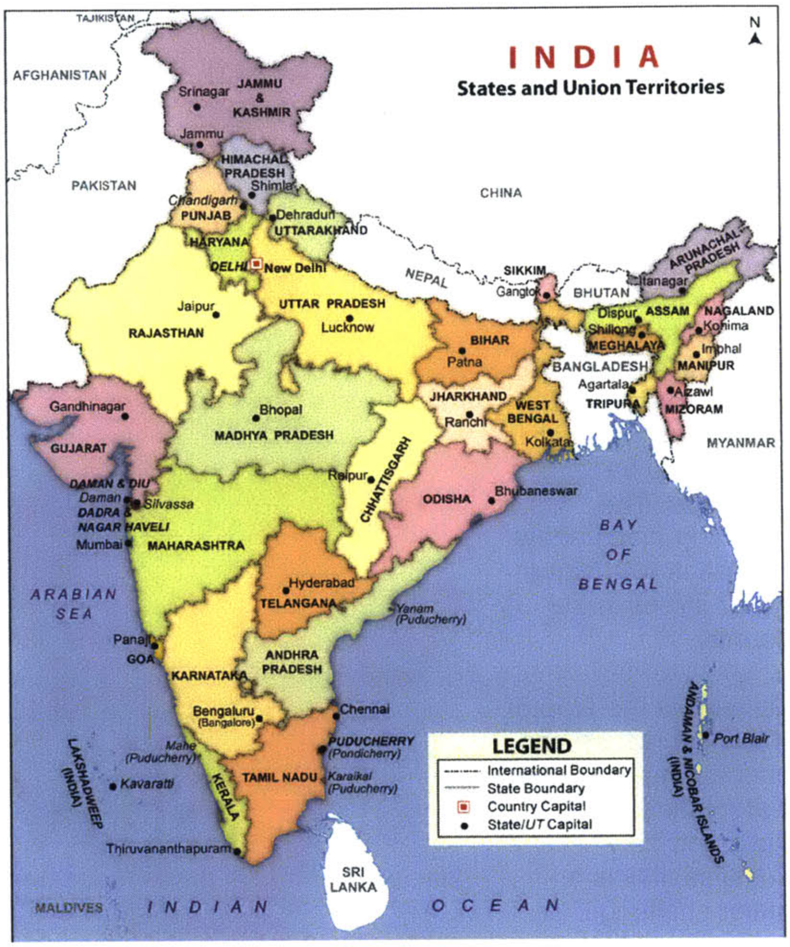


Figure 4 Political Map of India 2015

Water resources in India have a wide variation between seasons as well as geographic areas. Rainfall is concentrated during the monsoon season, once a year in most of the country. On the geographical aspect, water availability is highly concentrated on the north east of India, at the confluence of three rivers: Ganges, Brahmaputra, and Meghna. This extreme distribution leaves 36% of the land with 71% of water sources of the country, while the remaining 64% of the country only has 29% of the total national water resources available (UNICEF 2013).

The following table from the UNICEF report of 2013 provides a better perspective on population growth and water availability per person. The international standards categorize water-stress area under 1,700 m3/year of water availability per person, and water-scarce areas where availability is under 1,000 m3/year per person (UNICEF 2013).

Table 5 India Average Water Availability per Capita (UNICEF 2013, 13)

Year	Population (Million)	Per capita Average Annual Availability (m3/year)
2001	1029 (2001 census)	1816
2011	1210 (2011 census)	1545
2025	1394 (Projected)	1340
2050	1640 (Projected)	1140

Based on these projections, India's water availability is moving from water-stress into water-scarce in the next 35 years, and data on water availability are believed to be optimistic. The following maps show the areas with higher water-stress in the country.

Looking at the type of water source we can understand better the water landscape in India and how sustainability is a major challenge.

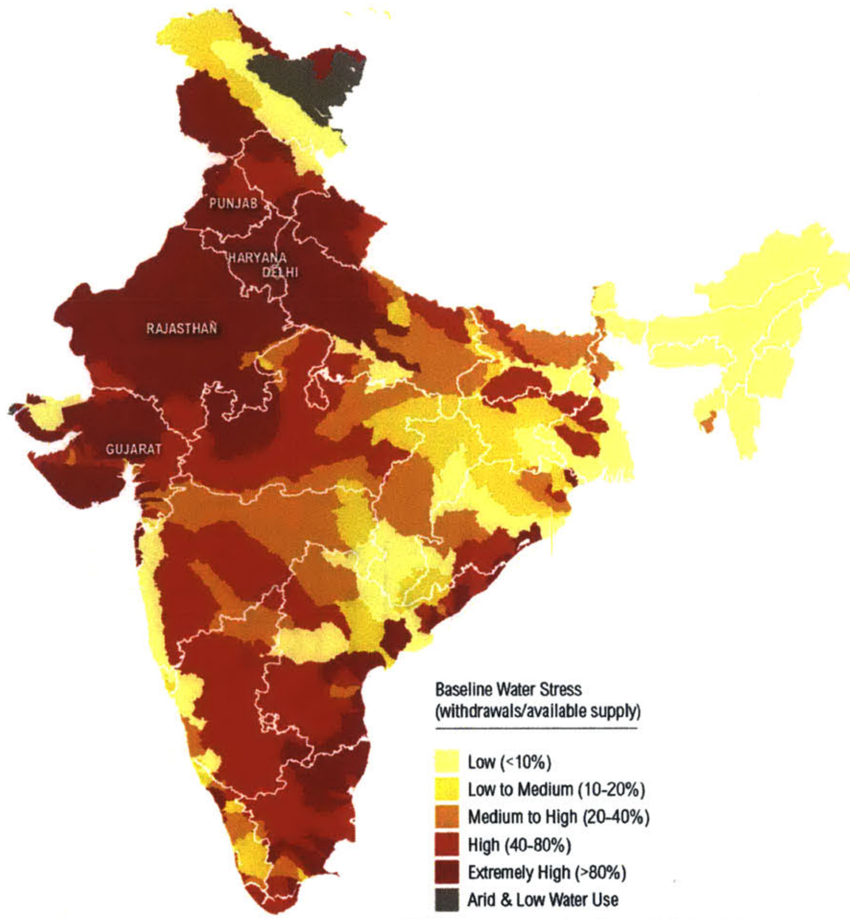


Figure 5 High Water-Stressed Regions in India (WRI, 2015)

Surface Water Sources: these consist of rivers, lakes, dams, etc. These are part of the ecosystem as well as being traditional sources of water in Indian culture. The country is divided into 20 major river basins, where the Ganga-Brahmaputra-Meghna is the largest with 110 million hectares. The government has built several dams on all the major basins, creating a total water storage capacity of 212.8 BCM, and this will increase by 76 BCM from projects under construction. The total water availability potential of all river basins and storage is estimated at 1869 BCM, and 1123 BCM after evapotranspiration loses (reference?). This total capacity is divided into 690 BCM on surface water and 433 BCM of renewable ground water sources. While there is pressure to increase storage, and link river basins, sustainability concerns associated with surface water include the long-term impact of dams on the ecosystem and displacement of people.

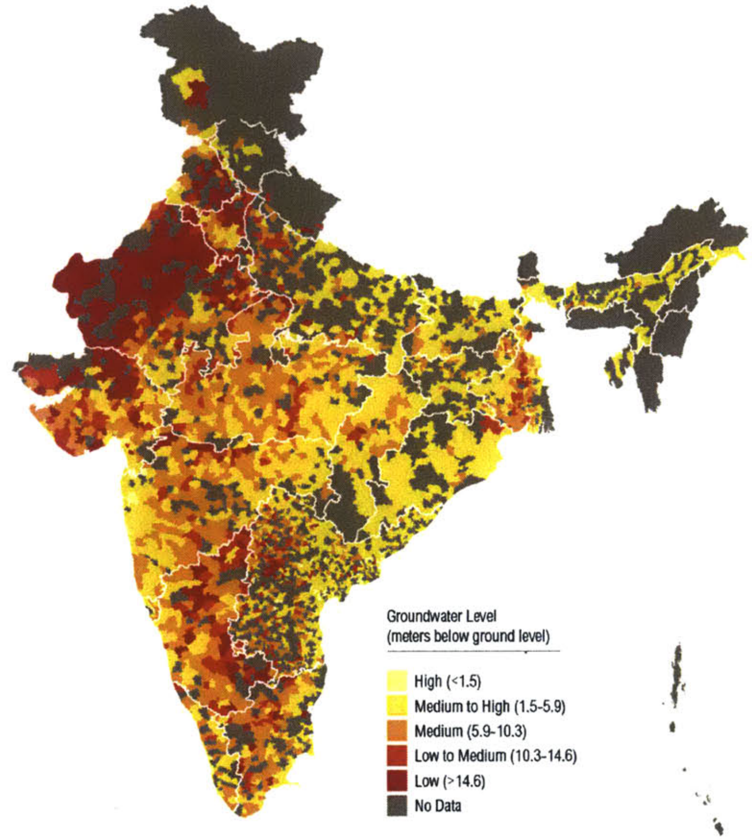


Figure 6 Groundwater Levels in India (WRI, 2015)

Ground Water: India is the country with largest consumption of groundwater in the world (UNICEF 2013). The estimated withdrawal is 230 km3 per year, which is used to cover 60% of the country's agriculture demand and 80% of domestic demand. In terms of domestic consumption, 90% of the rural sector currently uses groundwater as their main source (UNICEF 2013). The overconsumption of groundwater has also being encouraged by the fact that groundwater rights are based on land ownership. This over-exploitation of water leads to the current stress on groundwater and the government strategy to shift this demand back toward using more surface water. However, due to the uneven distribution that is a challenge that requires interstate agreements and large infrastructure. The map shows how groundwater levels are dropping dramatically across 54% of well across the country (World Resources Institute (WRI) 2015). The high dependence of rural communities on ground water is a major challenge for the sustainability of water in India, not only for human consumption but also for agriculture development.

Rainfall: the monsoon season between June and October drives rainfall in India. This distribution also varies widely from an annual average of 0 to 1,000 centimeters per year. The following map shows the variations across the country.

Policies and Programs:

The history of water programs in India can be divided in five (5) phases: Beginning, Expansion, Mission, Reforms, and Sustainability (James 2011, 15).

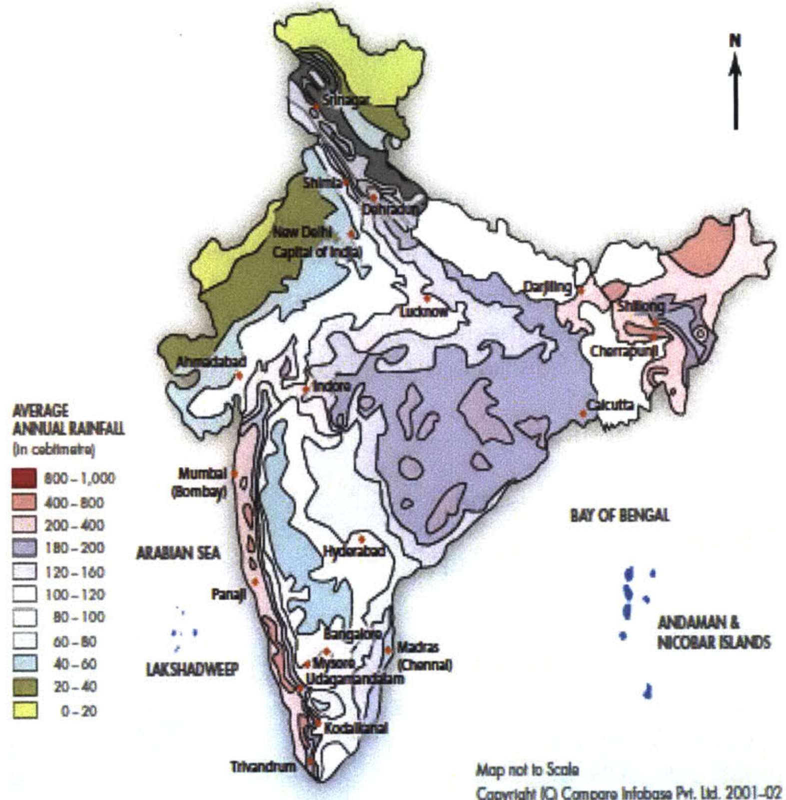


Figure 7 Average Annual Rainfalls in India (James, 2011, p. 7)

Beginnings (1950-1967): Official government programs for rural drinking water supply started in 1950, three (3) years after India's independence in 1947. The Government of India (GoI) recognized the unmet water needs of regions around the country and took responsibility to provide water as a right of the citizens. It was included in the constitution that state governments have responsibility over water resources and central government has some reserved rights. During this period it was recognized that the monsoon rainfall were not enough to expand beyond traditional systems for water supply.

Expansion (1968-1981): This phase was created after the terrible famine of Bihar in 1967. This event accelerated the creation and implementation of water policies at central and state levels to cope with the critical situation. The "problem villages" were identified and solutions were implemented under the Accelerated Rural Water Supply Program (ARWSP) created in 1972. In 1974 the Minimum Needs Program was also created but in 1977 it was included under the ARWSP umbrella. The best technology available was hand pump technology, which was widely used as the prescribed solution for water supply using ground water sources.

Mission (1981-1990): This decade was known as the International Decade of Water Supply and Sanitation. This was a campaign promoted by the UN to provide water and sanitation for everyone around the world. With this high international visibility, the GoI established the National Drinking Water Mission in 1986. In 1987 the first national water policy was released and right after the country was affected by a severe drought the same year. All these events helped fundraising at national and international level, which was invested in the traditional supply-driven or top-down approach of water supply systems.

Reform (1991-1999): This stage was marked by reflection of results. As the central government performed national surveys that did not show positive results. Reported numbers of "problem villages" were 153,000 in 1962, 231,000 in 1980, 227,000 in 1986, and 140,975 in 1994. In addition to poor performance, the investment on rural water supply increased from 5 billion Rupees between 1967-1974 to 420 billion Rupees within 1992-1997 (James 2011).

Third parties were called in to provide other assessments. The National Commission on Water (NCW 1999), the India Water Partnership report (IWP 2000), and the most comprehensive review from the Government of India and the World Bank (GoI-World Bank 1999), all performed major national surveys. The results showed that India's water resource scarcity is a critical problem with increasing demand and high inequality of distribution.

These reports made sustainability a focus topic in the water sector of India. The most important recommendation from the GoI and World Bank report was the introduction of strategies that focused on community participation to change the supply-driven approach into a demand-driven approach. Making water supply systems suitable to the actual needs and involving the community to ensure sustainability of the systems and avoid slipback is essential.

NGOs were testing community participatory strategies since the 1970s in Orissa, Karnataka, and Gujarat. Also, during the 1990s Tamil Nadu, Kerala, and Uttar Pradesh included pilots with active community participation. The key findings from all these pilot projects were summarized as the following: (a) support community ownership and participation, incentivized by cost-sharing, (b) revitalize of traditional water systems, (c) focus on community needs and desires as a demand-driven strategy, (d) ensure equity of water supply for all groups in the community to bring inclusion, (e) encourage women to be leaders of water projects and initiatives to ensure gender inclusion (James 2011).

Important policy changes during this reform period were the 73rd and 74th amendments to the Constitution, which provided official recognition of community groups as water leaders. This allowed, for the first time in India, direct funding allocation to the village governance institutions or Gram Panchayats as well as the water committees. With the new policies established by the new amendments, the GoI in partnership with UNICEF renamed the National Rural Drinking Water Mission from 1986 as the Rajiv Gandhi National Drinking Water Mission (RGNDWM) in 1999. This mission was created to perform the Sector Reform Pilot Projects (SRPP) covering 67 districts around the nation. The SRPP followed the findings from the previous pilot projects, and established the community cost sharing for projects at 10% of capital costs and 100% of operation and maintenance (James 2011).

The SRPP enabled the fundamental change of the supply-driven perspective of governance into a demand-driven approach for water supply systems. The RGNDWM provided the foundations for the creation of the Department of Drinking Water Supply (DDWS) in 1999 under the Ministry of Rural Development to provide dedicated attention on drinking water and sanitation.

In 2002, only three (3) years after the pilot program the Prime Minister announced the national roll out of the SRPP, and it was called the Swajaldhara Program. This national implementation was official before the pilot programs were systematically analyzed for improvements, so this was considered a premature launch of the program.

Sustainability (2002-Present): With the announcement of Swajaldhara it was expected to see a new bottom-up approach to water supply systems. However, the projects continued to be implemented as the ARWSP program, with the traditional supply-driven approach.

In 2003, the DDWS implemented a format for results reporting at the state level. This format requires all states to give baseline status of water coverage at the habitation level, create an annual plan based on these findings, and report frequent progress on the approved plan. States that underperformed on their annual plan would receive lower allocations the next year, and these funds would be assigned to the best performing states. The state governments rejected this last funding allocation approach and the GoI withdrew it.

In 2009, national surveys showed that habitation water coverage dropped from 95% in 2001 to 65%, indicating that the funds allocated from Swajaldhara were not being properly used. States were either over-reporting failed systems to receive more funding or not building the projects as planned.

In 2010 the GoI responded to this poor performance. It renamed the Department Drinking Water and Sanitation, and in 2011 it became the Ministry of Drinking Water and Sanitation (MDWS). This new ministry provides a central nodal institution for policy, planning, funding and coordination of programs to improve rural drinking water supply and sanitation (Ministry of Drinking Water and Sanitation (MDWS) 2011a). The Ministry of Drinking Water and Sanitation has three areas of main focus: water, water quality, and sanitation; and each of these sectors has specific programs. The leading programs currently being implemented are the National Rural Drinking Water Program (NRDWP) under the water unit and the Total Sanitation Campaign under the sanitation unit (Ministry of Drinking Water and Sanitation (MDWS) 2011a).

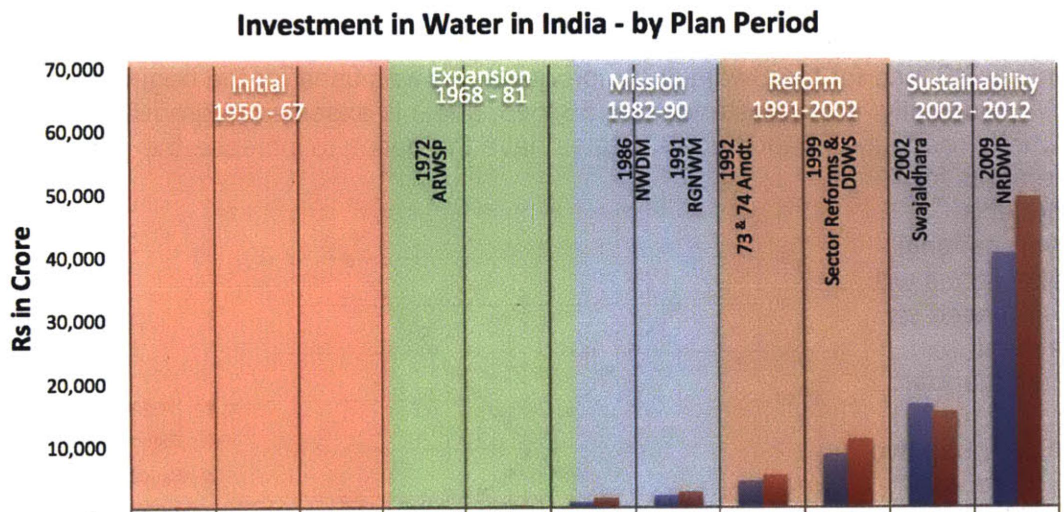
The NRDWP was launched in 2010 and is the current program for water supply systems in rural India. This program provides detailed guidelines for implementation, results, and reporting that were released in 2010. The guidelines continue to be revised and they were last updated in 2013 after the 12th - five-year plan of GoI (NRDWP 2013). The program is planned to run from 2010-2022. More details about this program are provided in a following section.

Financials of India's Water Supply Sector

India is the country with the third largest capital expenditure on water infrastructure, spending from $1.57 billion USD in 2010 to an expected $2.52 billion USD in 2016 (PwC 2015). Expenditures in the rural water supply sector have come mainly from two sources, central government and state government. Based on records, states started funding since 1951 while central government contributions are registered from 1972 with the introduction of the Accelerated Rural Water Supply Program (ARWSP).

Looking at national data, the period from the first five-year plan of the Government of India in 1951 to the 11th five-year plan ending in 2011, the total amount of investment in water supply was reported as 125,000 crores Rupees ($20.8 billion USD) in rural drinking water only (Ministry of Drinking Water and Sanitation (MDWS) 2011a). This expenditure only includes the central government and not the state funding.

The state expenditure is separate from the national government, and the total from state and central governments is summarized in the graphic below. The graphic shows each of the government plans since India's independence on the horizontal axis. The stages of water supply programs in India are differentiated by colors.



	1st (1951-56)	2nd (1956-61)	3rd (1961-66)	4th (1969-74)	5th (1974-79)	6th (1980-85)	7th (1985-90)	8th (1992-97)	9th (1997-2002)	10th(2002-2007)	11th(2007-2012)
Center	-	-	-	34	157	895	1,906	4,140	8,455	16,254	40,150
State	3	30	48	208	348	1,530	2,471	5,084	10,773	15,102	49,000

■ Center ■ State

Figure 8 Rural Water Supply Expenditure in India (Ministry of Drinking Water and Sanitation (MDWS) 2011b, 10)

Using these data, the total expenditure for rural water supply in India until 2012 was Rs. 156.6 crores or $26 billion USD. National expenditures represent 54% of expenses and state the remaining 46%.

The amount provided by the states increased by 2.5 times from 10th plan to the 11th plan, while the national expenditures increased by 3.2 times. Some of this additional expenditure corresponds to the implementation of the National Rural Drinking Water Program in 2009, which is explained in more detail in the next section.

Based on these financial data it is reasonable to say that there has been considerable funding towards building infrastructure and systems to provide water in rural India. However, based on the World Bank report the sustainability challenge remains.

The National Rural Drinking Water Program (NRDWP)

The NRDWP is the current program implemented for rural water supply in India. It was established in 2009 after continuing slipback problems in rural water supply system. The main goal for NRDWP is to "provide every rural person with adequate safe water for drinking, cooking and other domestic basic needs on a ***sustainable basis***" (NRDWP 2010). This goal requires standards for quantity and quality of water for basic human needs. It also has a specific focus on sustainability.

On the other hand, the current strategic plan for the rural water sector is planned from 2010-2022 and the goal for 2022 is that all rural areas have at least 70 liters per capita per day (lpcd) of adequate water within their household or a 50 meter radius (Department of Drinking Water Supply (DDWS) 2011). The minimum quantity per person was 40 lpcd for the Swajaldhara program and was used for the beginning of NRDWP. Currently, the new standard is 55 lpcd, and it is expected to gradually increase over time to reach the 70-lpcd goals. States have the option to increase the minimum requirements for their projects; however, national fund allocations will be given based on the national minimum standard.

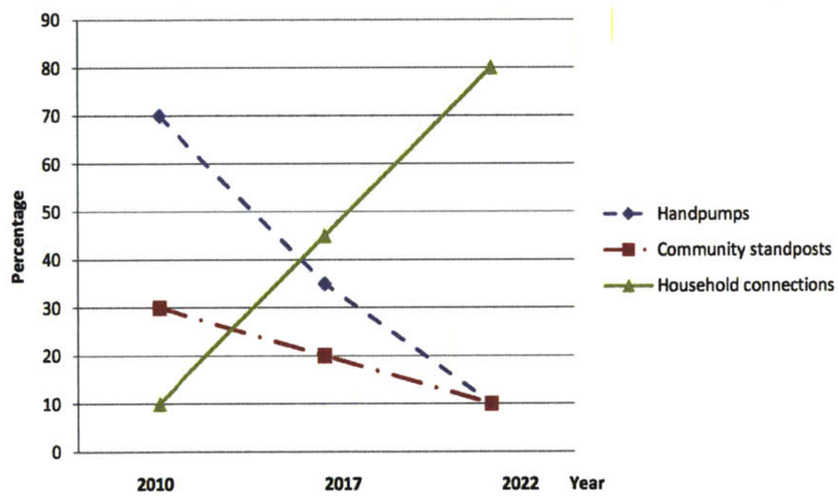


Figure 9 India Rural Water Sector Goals and Milestone

Based on these two goals, there is a tension to provide sustainability and at the same time provide adequate quantity of water for human needs. There are two important milestones to be considered for the NRDWP in 2017 and 2022 (Figure 9).

By 2017, at least 55% of households will have piped water supply and less than 45% of households will use hand pumps or other private water sources. For the 55% of piped water supply, 35% should have household connections while 20% use public taps. All rural habitations and schools have adequate coverage of water supply. Local communities should manage at least 60% of water supply schemes.

By 2022, at least 90% of households should have piped water supply and only 10% will use hand pumps or other private water sources. The 90% of piped water supply includes 80% who have household connections while 10% use public taps. Local communities will manage 100% of water supply systems.

Even though there is a focus on sustainability in the NRDWP, none of these goals have explicit targets that measure sustainability performance.

Institutional Arrangement of NRDWP

It is important to understand how the NRDWP is implemented at different levels – from the village to district, state and national levels - and these institutional arrangement provides an overview of stakeholders, their roles and responsibilities, and how they are part of the overall goals of the NRDWP program.

Village Level: This is the lowest governance level with direct contact with the community.

1. **Village Water and Sanitation Committee (VWSC):** each village should establish a VWSC as the organization responsible for water and sanitation issues of the village and represent the communities' needs to the district level officials. The VWSC is a standing committee in the village government called the Gram Panchayat (GP), and a community meeting or Gram Sabha should elect all members. Once the VWSC is established, it is responsible for planning, implementation, operation, maintenance and management of in-village schemes/distribution network and providing annual reports on progress and performance. During the planning stage, the VWSC prepares the Village Water Security Plan considering water resources availability, use, quality, and reliability. This plan should use integrated water resource management approach explained in the NRDWP guidelines. The preparation of the plan allows the VWSC contact district officials with required financial or technical support. The VWSC and GP have the authority to select the contractors that will build the necessary infrastructure.

District Level:

1. **District Water and Sanitation Mission (DWSM):** this is the institution that is recognized by the state authorities to coordinate, manage, and monitor water projects of all villages within that district. Depending on the existing governance of districts, the Zilla Panchayat (ZP) or district government could also take the role of the DWSM without establishing this entity. The DWSM is responsible for

coordinating multidisciplinary water projects including other programs from agriculture, rural development, NREGA, financial departments, and others. Projects approved by the DWSM are included in the final annual plans.

The role of district offices is critical for the sustainability of water resources and development of the rural areas. The state and central governments provide training and capacity building for DWSM to be passed on to VWSC and GP.

State Level:

1. **State Water and Sanitation Mission (SWSM):** Each state should have a SWSM organization to overlook the policy management and support for community participation in the NRDWP. The SWSM were initiated during the Swajaldhara program. Under the SWSM there will be a group of state organizations involved in the water sector:
2. **Water and Sanitation Support Organization (WSSO)** will be involved in intangible infrastructure of water supply systems. This organization will be the facilitator between the community and the state government, ensuring the community receives adequate training, capacity building, access to laboratory facilities, testing kits, and computer access for data entry into the Integrated Management Information System (IMIS) platform. All projects within the village limits are supported by the WSSO.
3. **Public Health Engineering Department (PHED)** and Water Supply and Sewage Board (WSSB): these existing state organizations shall change their approach from service suppliers into facilitators. These entities are in charge of infrastructure design and implementation of projects to bring water to the limits of villages.
4. **State Technical Agency (STA):** state governments should assign an external engineering firm to provide technical support to PHED and WSSO. STA could also provide technical support to villages and WSSO as needed. This organization provides additional technical support, research and development, as well as third party feedback on water projects from several state organizations.
5. **State Level Schemes Sanctioning Committee (SLSSC):** each state should establish a SLSSC to approve, supervise, and monitor the implementation of NRDWP at state level. This organization approves all projects to be targeted within the annual plans, the community support activities, as well as quality monitoring. This committee meets once a year to ensure projects are approved and entered in the IMIS platform for each financial year planning.

National Level:

1. **Rajiv Gandhi National Drinking Water Mission (RGNDWM):** this group serves as the facilitator of NRDWP within multiple ministries.
2. **National Experts Group (NEG):** provides technical support and experts to participate as needed.
3. **National Technical Support Agency (NTSA):** advices RGNDWM and SWSM on new technologies and processes and supports research and development projects focused on the rural water and sanitation sector.

4. **National Informatics Center (NIC):** this organization develops and manages the online platform used by the NRDWP to monitor progress. NIC has offices at state level to provide local support and training and develop new applications as needed.

The following diagram shows the connections between all the agencies at all levels.

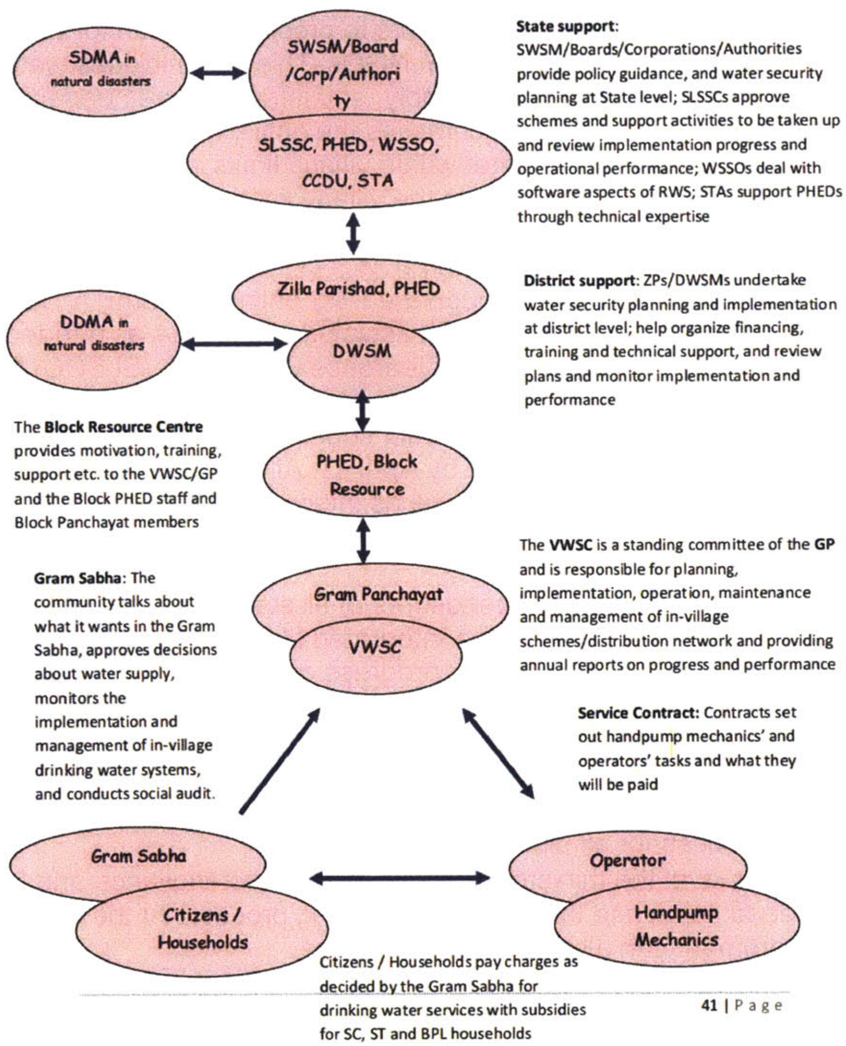


Figure 10 NRDWP Institutional Arrangement (Department of Drinking Water Supply (DDWS) 2011)

NRDWP Operation

This section provides a summary of how the National Rural Drinking Water Program (NRDWP) procedures are established among all the institutional levels mentioned before. The stages for the NRDWP operation can be categorized in planning, monitoring, and auditing.

Planning:
The governance level closest to the community, the VWSC or the GP, prepares a village action plan of water supply systems. All plans are compiled and then submitted online using the Integrate Management Information System (IMIS) platform. Plans must be submitted on annual basis at state and central level for annual budget allocation.

Village Action Plan (VAP): The Gram Panchayat (GP) or the Village Water and Sanitation Committee (VWSC) are responsible to prepare this plan for all habitations within the village limits with assistance from NGOs. This plan includes water availability, needs, capacity building, gaps of water supply, and infrastructure needed.
District Water Security Plan: This plan compiles the entire village VAPs to submit for state review. The projects to bring water within village limits are responsibility of the GP/VWSC. Projects to bring bulk water to the village limits are responsibility of the state agencies.
Comprehensive Water Security Action Plan (CWSAP): at the state level all districts water security plans are integrated through the IMIS online platform. A Detailed Project Report (DPR) is created for all projects with assistance of NTSA as needed. The DPRs are submitted to the State Level Scheme Clearance Committee (SLSCC) for approval. The approved projects are presented to the central government to be covered under the current financial year budget. All states should submit the CWSAP by February, review process in March, and budget allocation by April 1st. All habitations should be verified to be linked to the national census data as well as integrate population data.

Monitoring:
To monitor progress and financial expenditures of all states, the NRDWP established a standard results framework and uses the Integrated Management Information System (IMIS) website for all states to report their progress on monthly basis using a common format.

- States are responsible to provide personnel and infrastructure to install equipment to enter data into the NRDWP IMIS platform. An IT nodal officer, who shall be a member of the SWSM, is responsible for managing and supervising data entry process for all districts in the state.
- At the district level the ministry establishes a District Vigilance and Monitoring Committee to supervise the NRDWP reporting process. At the village level the state government can also select a committee.
- The National Technical Support Agency serves as the monitoring entity at the national level, reviewing the action plans at state and district levels.

The most important monitoring comes from the VWSC or GP to ensure daily water needs from the community are met, and create adequate action plans for their community.

Audits:
Audits of the State Water and Sanitation Mission (SWSM) are reconciled with the PHED by a chartered accountant within the first 6 months of the financial year. The Comptroller and Auditor General of India (C&AG) perform another audit covering

financial and quality monitoring and surveillance. State offices provide relevant information from audits to district offices. All these audits are focused on financial expenditure aspects.

Fund allocations in NRDWP

Based on the operation of the NRDWP, it is important to understand the NRDWP expenditure components since these are part of the structure of the Integrated Management Information System (IMIS) where progress and expenditures are closely monitored. Since its establishment, the NRDWP has had a national budget that is assigned for national use and state use. There is funding for sustainability infrastructure for the state allocation but not for the national components.

The central level components:

North East States: these states receive 10% of the annual NRDWP budget, as their share is 90% central and 10% state (90:10) contribution.

Desert Development Program (DDP): 5% of the NRDWP funds are allocated for DDP. These projects are 100% national contributions (NRDWP 2010). These funds are assigned to blocks in districts with very dry conditions. There are 235 blocks of 40 districts in 7 states that fall under this category. State governments are responsible that funds are transferred to the specified blocks (NRDWP 2010, 20).

Quality Affected Areas: 5% of NRDWP annual budget is allocation to states having chemical contamination problems at sources. These funds are allocated on a 50:50 share between central and state governments(NRDWP 2013).

Natural Calamity: 5% of the NRDWP is allocated to this fund and is used for cases where natural disasters happen.

Table 6 NRDWP Central Level Expenditure Components ((NRDWP, 2013)

Component, Purpose, Distribution and Centre-State Sharing pattern of the NRDWP at Central level.

	NRDWP Central Allocation	Centre-State sharing pattern
Non NE States	73 %	90:10 to NE States and J & K and 50:50 to other States.
NE States	10 %	90 :10
DDP Area States	10 %	100 % Central share
Water Quality (Earmarked) for chemical contamination & JE/ AES affected States.	5 %	90:10 to NE States and J & K and 50:50 to other States.
Natural Calamities	2 %	100 % Central share

State level components:

The state components of expenditures are assigned based on types of projects and needs (NRDWP 2013, 21). The state share is 50% except in cases where it is specified as another share of contribution. The state focus on sustainability includes in-village projects for traditional and rainwater harvesting. All state components are explained as follows:

Coverage: 47% of NRDWP funds are allocated to this category. This component provides water supply to habitations that are partially covered, not covered, or slipped back. Jammu and Kashmir receive 90:10 cost sharing while all other states receive 50:50 contributions. The coverage percent of NRDWP changed from 38% in 2009 to 47% in 2013.
Sustainability: a maximum of 10% of the NRDWP funds are used to promote local level projects to preserve water sources within village limits. This is also referred to as Swajaldhara, as village focused projects started with that program. These funds are 100% national contribution and are typically disbursed to the GP or VWSC. Guidelines about infrastructures considered under this fund are provided by the NRDWP. This component changed from 20% in 2009 to a maximum of 10% in 2013.
Quality: 20% of NRDWP budget addresses water quality issues. These funds are used to resolve problems at quality-affected habitations. Again, Jammu and Kashmir receive 90:10 sharing while all other states receive 50:50 contributions.
Operation and Maintenance (O&M): a maximum of 15% of the NRDWP budget is used to support operation, repairs, and replacement parts of water supply schemes (NRDWP 2013). This component changed from 10% in 2009 to a maximum of 15% in 2013.
Water Quality Monitoring and Surveillance (WQM&S): 3% of the NRDWP budget is provided for community capacity building to test water quality at the habitation level. This also includes field-testing kits given to the community. This is a 100% central government share contribution.
Support Activities: 5% of the NRDWP budget is allocated to provide community support projects, including Water and Sanitation Support Organizations (WSSO), Drinking Water and Sanitation Mission (DWSM), Information Education and Communication (IEC), Management Information System (MIS) and computerization, R&D, GIS mapping, training, brochures, etc. These activities are 100% central government contributions.

The allocation of NRDWP funds is given to states based on weightage criteria; these rules were established in 2010 and remained the same as of the latest guidelines in 2013.

The funding allocations from the NRDWP show the different levels of support for implementation of water supply programs. The sustainability focus of funds is given to infrastructure, operation and maintenance (O&M), and community support. These funds will help maintain the infrastructure built with coverage funds and ensure quality monitoring is performed for their communities.

Table 7 NRDWP State Level Expenditure Components (NRDWP, 2013)

Component, Purpose, Distribution and Centre-State Sharing pattern of the NRDWP at State level.

Component	Purpose	Distribution of State NRDWP allocation	Center-State Sharing pattern
Coverage	For providing safe and adequate drinking water supply to unserved, partially served and slipped back habitations	47%	90:10 (for NE States and J&K) 50:50(for other States)
Quality	To provide safe drinking water to water quality affected habitations.	20%	
Operation and Maintenance (O & M)	For expenditure on running, repair and replacement costs of drinking water supply projects.	15% Maximum	
Sustainability	To encourage States to achieve drinking water security at the local level through sustainability of sources and systems.	10% Maximum	100:0
Support	Support activities like WSSO, DWSM, BRCs, IEC, HRD, MIS and computerisation, R&D etc.	5 %	100:0
Water Quality Monitoring and Surveillance	For monitoring and surveillance of water quality in habitations at field level and for setting up, upgrading laboratories at State, district and sub-district levels.	3%	100:0
Total		100 %	

Table 8 NRDWP Weightage Criteria for States Allocation (NRDWP 2013)

S. No.	Criteria	Weightage (in %)
i)	Rural population	40
ii)	Rural SC and ST population	10
iii)	States under DDP, DPAP, HADP and special category Hill States in terms of rural areas	40
iv)	Rural population managing rural drinking water supply schemes weighted by a Management Devolution Index	10
	Total	100

** Within the DDP areas, considering the ratio of the population supported in these two areas, Hot Desert Areas would be given weightage of 90% and Cold Desert areas would be given weightage of 10%.*

Chapter 4. Case study – Gujarat

Gujarat was created as an independent state in 1960 when it and Maharashtra were separated from Bombay state. The state of Gujarat is located on the northwest coastal region of India and has the 10th largest population with 60.4 million according to 2011 census data. The distribution of population is mostly rural with 57% and 43% urban. Gujarat changed its local geographical configuration in August 2013, adding seven (7) new districts and 22 new blocks or Talukas (Narendra 2013).

Gujarat is considered as one of the growth engines of India. With only 5% of its population and 6% of its land, this state contributes to 7.3% of national GDP and has the fastest growing GDP with 10% average from 2006 (constant prices 2004-05) (Directorate of Economics and Statistics 2012). Gujarat also represents almost 10% of India's workforce and 22% of its exports (*The Economist* 2015).

The next table shows several statistical data points to compare the state of Gujarat with India, giving a good perspective of the state size and relevance within the country. It has been noted that while overall economic growth is high, some social indicators do not reflect that growth.

Table 9 Comparison of Gujarat and India Data (Directorate of Economics and Statistics 2012)

Parameter	Units	Gujarat	India	% Ratio
Total Towns	Number	348	7935	4.4%
Villages	Number	18225	640867	2.8%
Area	Km2	196244	3287469	6.0%
Total Population	Millions	60.44	1210.57	5.0%
Rural Population	Millions	34.695	833.463	4.2%
Urban Population	Millions	25.745	377.106	6.8%
Population Density		308	368	
Decadal Growth Rate (DGR)	%	19.28	17.68	
Rural DGR	%	9.31	12.23	
Urban DGR	%	36	31.8	
Literacy Rate	%	78	73	
Rural Literacy	%	72	68	
Urban Literacy	%	86	84	
Scheduled Caste	Millions	4.1	201.4	2.0%
Scheduled Caste	%	6.74	16.63	
Scheduled Tribes	Millions	8.9	104.3	8.5%
Scheduled Tribes	%	14.75	8.61	
GDP	Billion Rs.	6117.67	83534.95	7.3%

Per Capita Income	Rs.	89668	61564	
Agriculture Land	'000 Hect.	18810	305611	6.2%
No. of Factories	Number	21282	211660	10.1%
Infant Mortality Rate (IMR)	% per 1000 births	41	44	
Rural IMR	% per 1000 births	48	48	

Water Resources in Gujarat
Gujarat is located in the western region of India, which has high vulnerability from climate change impact as well as hydro-climatic hazards like drought, floods, cyclones, and tsunamis (IPCC 2007). Water resources vary tremendously in the state causing high water scarcity problems for 50% of the rural population in the state (The World Bank 1993, 1).

Based on Figure 5, Figure 6, Figure 7, and Figure 11 it is shown that Gujarat has serious water scarcity and droughts due to geographical and environmental conditions. Gujarat had declared drought conditions in large areas of the state for 10 of the past 30 years (1985, 1986, 1987, 1998, 1999, 2000, 2001, 2002, 2003 and 2012) (Kishore 2013).

With such unreliable rainfall, farmers and communities rely more heavily on ground water sources. 88% of irrigated land in Gujarat uses groundwater as a water source (Kishore 2013). In addition to low availability, coastal areas of Gujarat present an additional problem of salinity intrusion affecting the quality of groundwater in coastal areas.

Water Supply Programs in Gujarat
It is assumed that several water supply systems started since 1951 as states gained autonomy and responsibility of water supply. However, since Gujarat was formed in 1960 records may be found under Bombay state.

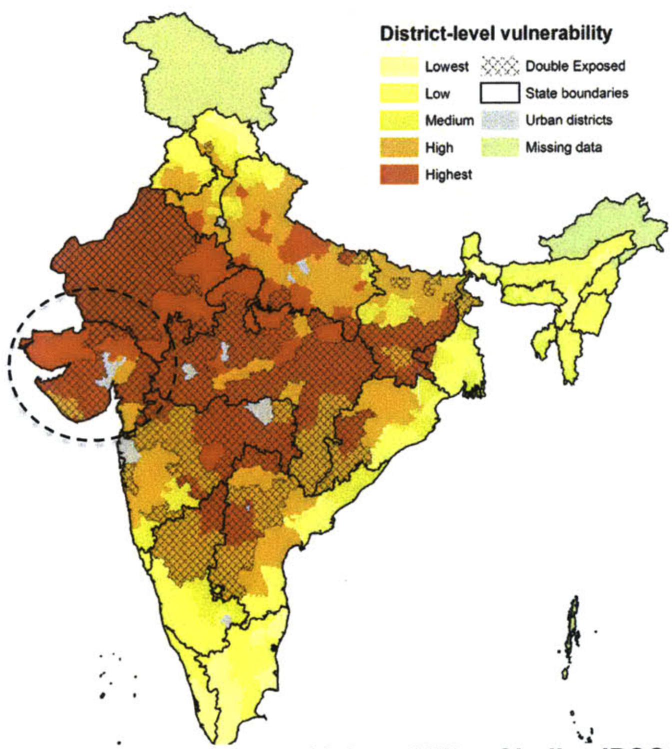


Figure 11 Climate Change Vulnerability of India –IPCC 2007

In 1979, the World Bank initiated the Gujarat Water Supply and Sewerage Project water needs in urban and rural areas of Gujarat. Based on this project, the Gujarat Water Supply and Sewerage Board (GWSSB) was created to collaborate with the Ahmedabad Municipal Corporation (AMC) to implement this project (The World Bank 1993).

The GWSSB was created to build and commission water and sewerage projects in rural and urban areas. Once projects were built and operational, these are handed over to local institutions by the GWSSB and AMC. In urban areas municipalities would take ownership of the systems, and in rural areas the villages authorities or Gram Panchayat would play this role.

The World Bank project plan was to be completed within 4-5 years, however a decade later the project was not completed and presented serious delays (The World Bank 1993).

In 1987, the Government of India (GoI) presented an urgent request to the Bank to provide support as Gujarat faced a terrible drought (The World Bank 1993). For three (3) consecutive years, 1985-87, monsoon seasons were dry and the state was in critical condition. This critical event promoted the implementation of new policies and regulation for water supply.

In 1987 the construction of the Sardar Sarovar Dam project was started, which was the second largest dam in the Narmada River. This project will provide water for the state population as well agriculture sector. This is a very important project in the water supply history of Gujarat and it is described later in more detail.

The World Bank provided support for three projects or missions to be implemented between 1987 and 1988 (The World Bank 1993).

In 1990, the state decided to use water from the Narmada River to provide safe water supply to Kutch district, Saurashtra, and North Gujarat. This project is called Sardar Sarovar and had the objective to cover drought prone areas consisting of 8,215 villages and 135 towns (Hirway 2005). This water supply system would also be used for irrigation purposes (Kishore 2013).

In 1991 the World Bank made an assessment of the projects it was sponsoring. Most of the infrastructure was completed, however the water tariff established at Rs. 6 per person was not implemented. The GWSSB tried to establish this within a year, unsuccessfully, leading to the closure of the project from the World Bank (The World Bank 1993).

In 1995 the Royal Netherlands Embassy collaborated with the Government of Gujarat on the Ghogha project (Government of Gujarat 2001).This program ran from 1997 to 2005 in 82 villages in three blocks of Bhavnagar district to provide drinking water supply and sanitation to these region, covering a population of around 200,000 (Rural Drinking Water Supply and Sanitation 2006). This project continued with the support of

NGOs as well as a newly established Community Management Support Unit (CMSU) in Bhavnagar. The CMSU had direct contact with village water committees for technical support. This project was completed successfully and villages took ownership of all water supply systems.

In 1998 the state launched the Sardar Patel Participatory Sahbhagi Jal Sanchay Yojana (SPPWCP) to encourage the construction of check dams as a way to provide water reservoirs for village as well as groundwater recharging. This program was funded by the state with cost sharing by the community: 60% is covered by the state and 40% by the community. This program has been very popular and more than 20,000 were built between 2002-03 (Hirway 2005).

In 1999 the implementation of the national Sector Reform Pilot Program included 13 districts within Gujarat. The state took the initiative to also implement and fund the same projects in the 12 remaining districts, enabling the promotion of a demand-driven strategy across the state. This state project is known as Sector Reform Scheme in Gujarat.

In 2001 an earthquake hit Gujarat, creating another calamity that had serious impact on water supply for many rural areas of the state. In response, the Government of Gujarat (GoG) implemented a project for earthquake-affected districts called ERR project. Four districts and 1,260 villages were highly affected by this event and were the focus target for the ERR project. The objective was to provide drinking water and sanitation facilities to these people and GoG partners with 40 NGOs to meet this goal. ERR was not only building infrastructures but also the capacity of the communities, establishing 3 CMSUs to work directly with the villagers(Rural Drinking Water Supply and Sanitation 2006).

In 2002, WASMO was established to support the Swajaldara national program, taking the role of the CMSU and expanding its scope across the state as facilitator between the communities and other state organizations like GWSSB (Government of Gujarat 2001). Since then, the community water supply systems in Gujarat have been managed by WASMO as the key facilitator to follow national and state driven programs.

The Sardar Sarovar Project

This is a very important project for water supply in Gujarat, since it brings water across the state for drinking and irrigation purposes, as well as power generation source. This is a very controversial project in India, especially among the states involved: Gujarat and Madhya Pradesh. The main controversy is the high environmental impact of this dam as well as the displacement of population, mainly tribal communities.

The interstate legal controversy started in 1964 and it continued until a judgment was awarded in 1979(Sardar Sarovar Narmada Nigam Ltd. (SSNNL) 2014b). This project is the largest dam in the Narmada River, world's second largest concrete gravity dam by volume, world's third highest spillway discharging capacity of 83,000 m^3/second (22 million US gps), and largest irrigation canal in the world with 1,133 m^3/second (300,000 US gps) (Sardar Sarovar Narmada Nigam Ltd. (SSNNL) 2014a).

This project started in 1987 with the main goal to irrigate 1.9 million hectares for about 1 million farmers. It also provides drinking water to 9,490 villages and 173 towns effecting about 29 million people. It provides 1,450 MW installed capacity of hydropower and a reservoir of 5,860 Million Cubic Meters (MCM) (Sardar Sarovar Narmada Nigam Ltd. (SSNNL) 2014a). The main controversies concern the large number of people displaced by the reservoirs as well as their environmental habitats, and the poor record of rehabilitation. Figure 12 shows the scope and progress of the SSNNL in Gujarat up to 2015.

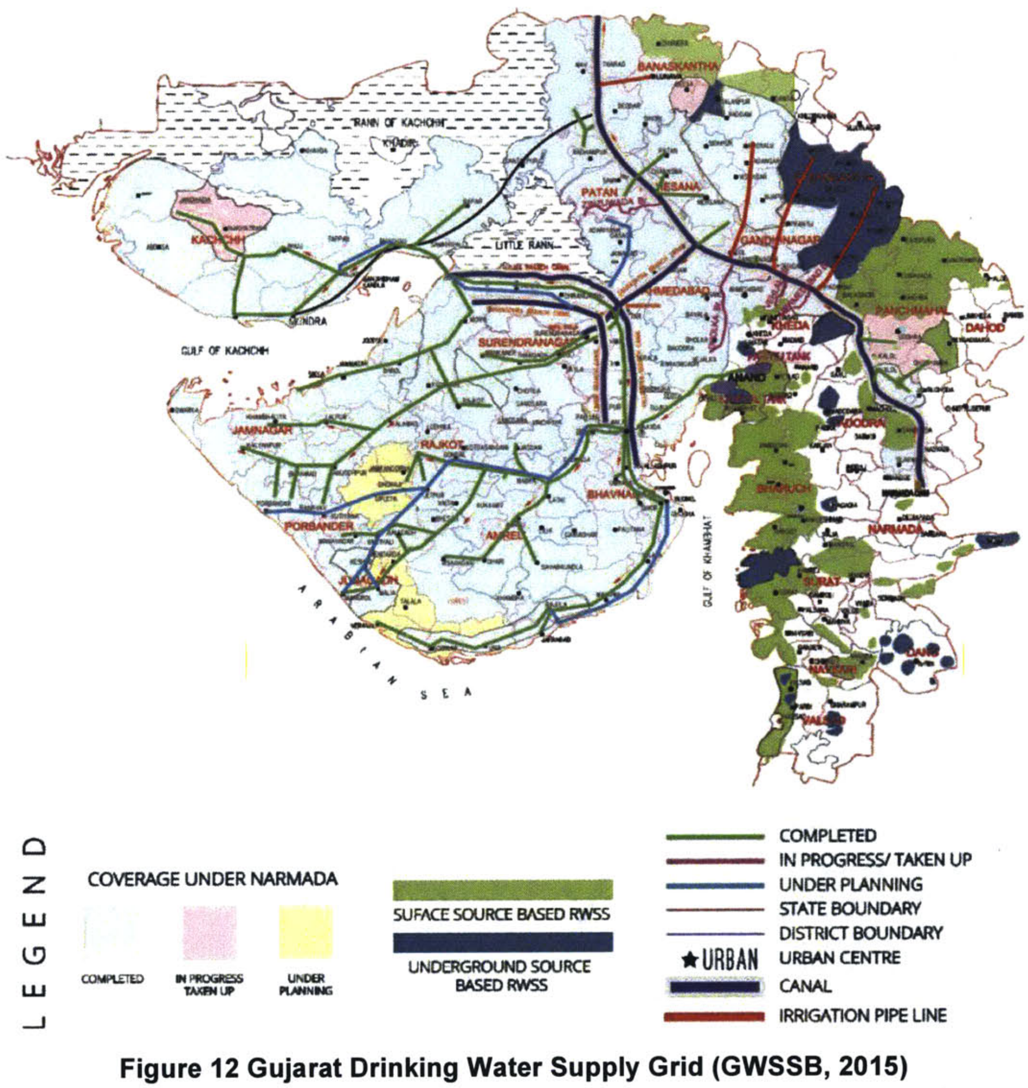


Figure 12 Gujarat Drinking Water Supply Grid (GWSSB, 2015)

Institutional arrangement in Gujarat

The water sector in Gujarat has three principal and autonomous departments: the Department of Water Supply, Department of Water Resources, and Department of

Narmada and Major Irrigation. There are other ministries that are related to water resources such as environment and agriculture. There are other water organizations, such as the Gujarat Water Resource Development Corporation, also autonomous, which is focused on the groundwater survey, monitoring, and development. Another important organization in the water sector is the Sardar Sarovar Narmada Nigam Ltd. (SSNNL) which manages the Sardar Sarovar project as an autonomous organization (Nautilus 2014).

Within the water supply sector, Gujarat has a unique institutional arrangement that evolved from its water supply program history, and it has an international perspective of being one of the most successful in India. The following table shows the institutions currently active in the water supply system in Gujarat and their responsibilities.

Table 10 Water Supply Agencies in Gujarat

Agency	Responsibility
Sardar Sarovar Narmada Nigam Limited (SSNNL)	Provides bulk water from the Narmada River to municipalities and industries. The GWIL and GWSSB purchase water from SSNNL. Also provides water to Mahi Right Bank Canal (MRBC) authority.
Gujarat Water Infrastructure Limited (GWIL)	Provides bulk drinking water as well as operation and maintenance of bulk water distribution systems.
Gujarat Water Sanitation Sewage Board (GWSSB)	Responsible for bulk water supply for rural areas, only outside village limits. Provides O&M of water distribution lines, treatment plants, and pump stations.
WASMO	This organization plays the WSSO role within the Swajaldhara and NRDWP programs. Supports rural villages to design, implement, operate and maintain in-village water supply projects. Provides technical and institutional supports for community involvement and sustainability of village systems.
Implementation Support Agencies (ISAs)	Provide assistance to WASMO projects by creating VWSCs, as well as community training and capacity building.
Village Water and Sanitation Committees (VWSC) or Pani Samitis	Design, implement, operate, and maintain village water supply systems (WSS). Establish water tariff system and collects them from the community to sustain WSS. WSS assets and 90% of their capital costs are from the state.
Gujarat Jalseva Training Institute (GJTI)	Water quality testing at state level, centralized data center for groundwater quality monitoring and surveillance program.

Water and Power Consultancy Services (India) Ltd.	Private consultants for water, power, and infrastructure projects. This private organization is the State Technical Agency (STA).

The creation of WASMO is considered one of the main contributions from the ERR pilot projects in Gujarat. This was the first time a community-driven approach was implemented in the state and is fundamental for sustainability of schemes within the community.

Water Quality Challenges in Gujarat

From the previous section it is understood that water scarcity is a problem in Gujarat. The water challenge increases with water quality challenges in this region as well. The main water quality challenges in Gujarat are fluoride, nitrate, salinity, and heavy metals such as cadmium, zinc, and mercury (WaterAid, n.d.). Biological contamination from e-coli and fecal coliform is also present, as open defecation remains a challenge in India; however chemical pollution is perceived as the highest quality problem.

In 2010, the Central Pollution Control Board (CPCB) declared Gujarat as the most polluted state in the country based on pollution and toxic waste (Daily News & Analysis (DNA) 2010). The problem is concentrated in industrialized districts, such as Valsad, Baruch, Vadodara, and Surat. This last is the textile capital of India where 40% of India textile exports are fabricated (London School of Economics 2014).

The following map shows the percentage of polluted sources from the Ministry of Drinking Water and Sanitation website. It is interesting that the districts with highest industrial activities mentioned earlier are not shown as having a high percentage of polluted sources.

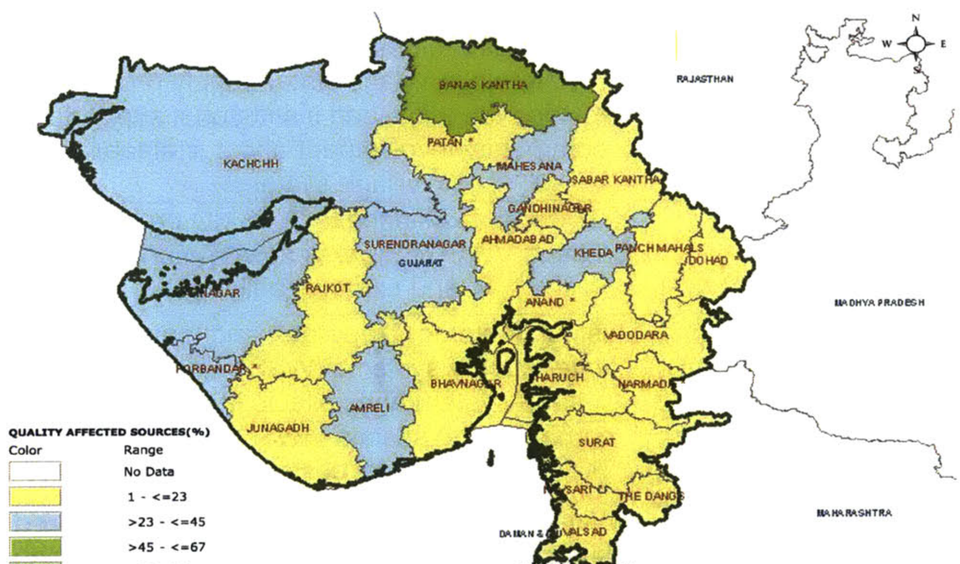


Figure 13 Percent of Quality Affected Sources in Gujarat (MDWS 2015)

Slipback in Gujarat

Gujarat is perceived as one of the most successful state to provide coverage of water supply in rural areas of India. It has been able to reach more than 96% of the total 18,066 villages establishing local institutions for water and sanitation. This effort to reach communities not only includes water supply, but also training and capacity building. Based on the high community engagement in this state it is perceived to have the largest scale of sustainability of water supply systems (James 2011); however this has not been documented in other researches.

The flagship of sustainability is based on the community engagement programs that started with the Ghogha project in 1995 and continue to be implemented by WASMO.

Figure 14 shows the formation of village water committees in Gujarat reported by WASMO in 2011 and is a key indicator of progress and success in the state.

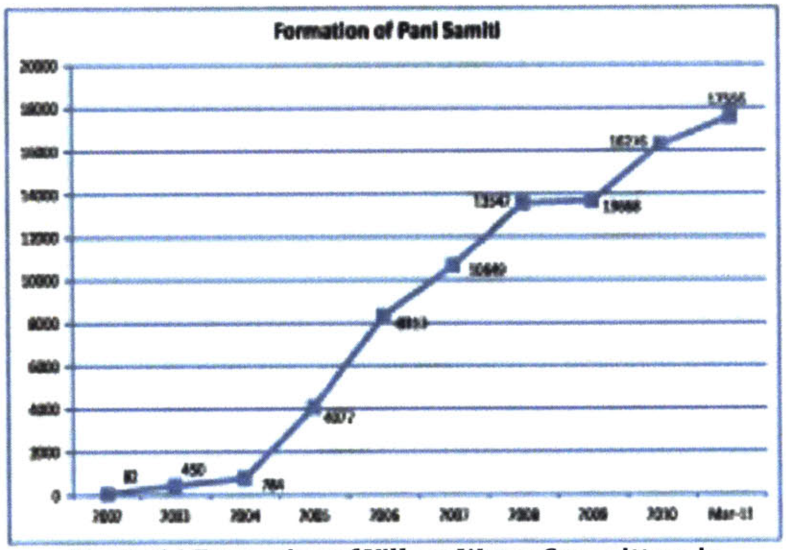


Figure 14 Formation of Village Water Committees in Gujarat (WASMO, 2011)

Chapter 5. Analysis of IMIS Data

In order to be able to identify the best data to analyze slipback or sustainability, it is important to describe what type of data are available within the Integrated Management Information System (IMIS). This section describes the origins and development of IMIS, data structure, how data is displayed, spatial and historical scoops, and the variety of data that are entered and are accessible in the system. The last portion of the chapter looks at current reports generated by IMIS for sustainability or slipback and how can they be used for this research.

IMIS creation and objectives

The IMIS database is the Management Information System used in India to monitor the rural water supply sector. IMIS is a web-based platform that enables online submission of data on the status of water supply across rural India. These data include annual plans, target projects, physical and financial progress, coverage of habitations and rural schools, and quality affected habitations. Data are accessible through a website that has data from all states down to habitation level dating back to 2005 and 2009. Despite having this large amount of data available, there has not been additional analysis of the data on sustainability performed using the IMIS database. A more detailed description of the data included in the IMIS is provided later in this chapter.

IMIS supports the National Rural Drinking Water Program (NRDWP) by providing an efficient, effective, and transparent system to monitor progress of rural water supply in India.

The IMIS started in 2003 with the first habitation survey of rural drinking water status across India. In 2006 this data survey was verified and accepted by third parties allowing the Government of India (GoI) to have a field-based numerical assessment of water coverage at the national level in 2007. However, these numbers were generic and it wasn't until 2008 that a report by habitation name was available. That year the GoI started monitoring each habitation's coverage under three (3) categories: quality affected (QA), slipback, and uncovered using the IMIS version 1 package. This was a major step towards online reporting for all states, allowing them to report physical and financial monthly reports to the central government. The annual habitation survey for all states was made a mandatory process for financial allocation from the GoI.

When the Department of Drinking Water Supply launched the NRDWP on April 1st 2009 provided the national standardization and guidelines that established the IMIS version 2 package. This new version of IMIS now includes monitoring of schemes and population coverage at the habitation level. Improvements to the IMIS have been made since 2009 but the core design remains the same. Some of these improvements are changes made in 2010 to allow states to submit the annual plan and add monthly financial reports at district level that were compiled at the state level reporting. The next modifications suggested are the linkages between financial and physical progress to the scheme's data and financial allocation. The following diagram summarizes the creation and development of the IMIS platform.

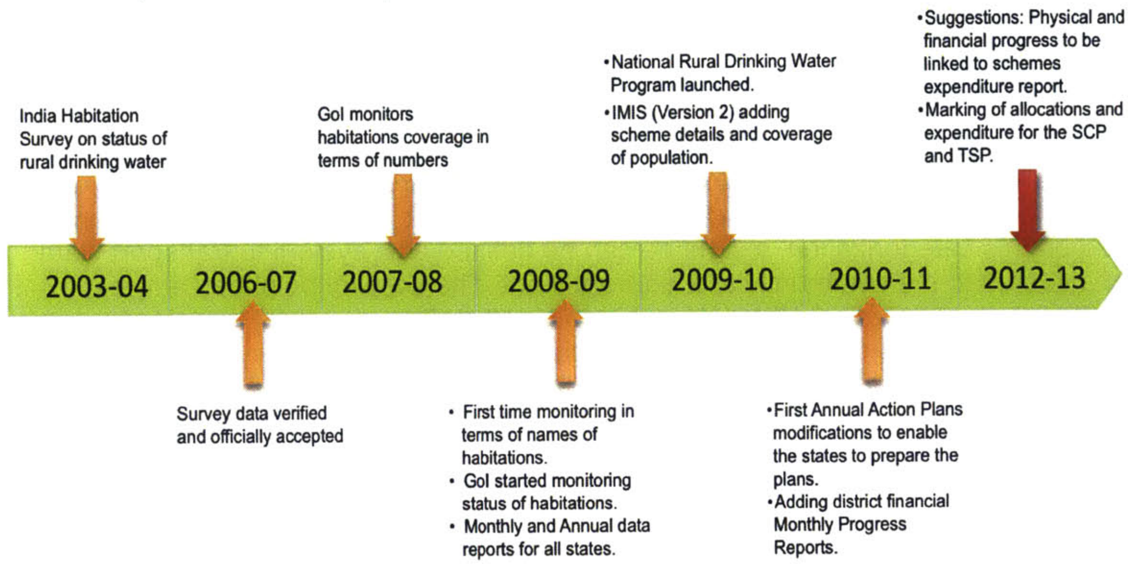


Figure 15 IMIS creation and development (*Modified from IMIS 2015*)

IMIS displays data reports to all stakeholders in all government levels as well as general public and has role-based accessibility for data entry and approval. These data entry stakeholders are the Ministry, State, District and Sub-District government departments within the rural water supply sector. General public can also access the website for common reports and send inquiries about a specific habitation. There are 91 reports or formats currently available in the IMIS website and they continue to grow based on national and state requests.

IMIS Data Structure

The IMIS data is structured in four (4) main entities: habitation data, scheme data, water source data, and water quality information data. Under each of these entities, there are attributes that provide the detailed information used to generate each of the 91 formats available in the IMIS website.

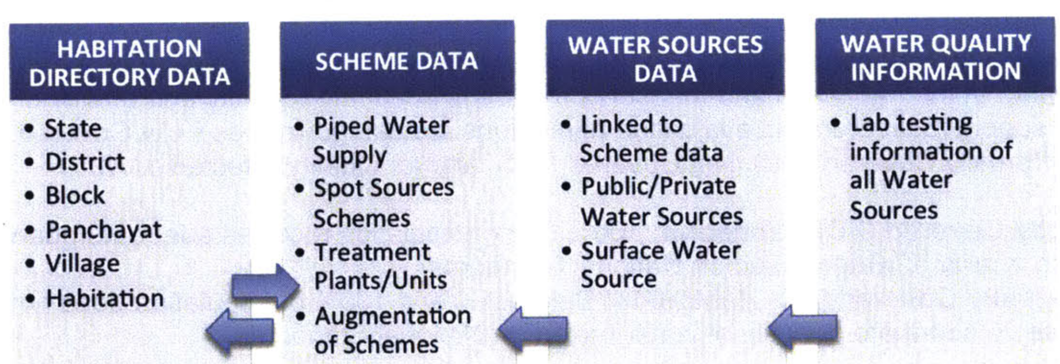


Figure 16 IMIS Data Structure (Modified from IMIS 2015)

Habitation: A habitation is defined as a group of families living close to each other within a village (IMIS 2015). A habitation is the fundamental spatial entity that indicates the water supply status for the community and it is aggregated up to other spatial levels. If a habitation is not covered, then it affects the coverage status at all higher spatial levels.
Scheme: There is no exact definition of a scheme within IMIS. However, a scheme within the IMIS consists of the following options: spot source, Piped Water Supply (PWS) schemes, augmentation schemes, treatment plant, and sustainability schemes. Based on this categorization, a scheme can be defined as a system to transport water from a source to the community at a delivery point. The delivery point has a few attributes such as location, status of test, and functionality.
Water Sources: This data is linked to the Scheme since this must have a source. Water sources are categorized as a ground or surface water source. Since there are many wells in rural areas, this dataset also defines ownership as public or private. The water source also has location coordinates.
Water Quality: This information category monitors water sources conditions that can affect one or more schemes. If the water quality is measured at the delivery point of the scheme, this data is still entered as a water source quality data.

The following diagram represents the interconnections between the four main entities of the IMIS as a system to be able to deliver water to the community.

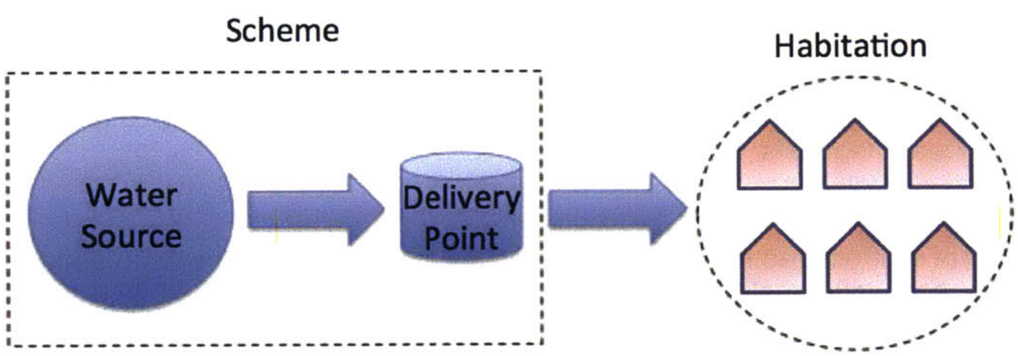


Figure 17 Water Supply System and IMIS main categories

A habitation is categorized based on the status of its water supply. This status is evaluated at the habitation and measures if there is adequate quantity and quality of water supply. Based on this evaluation habitations are categorized as Fully Covered (FC), Partially Covered (PC), Not Covered (NC), and /or Quality Affected (QA).

1. **Fully Covered (FC) Habitation:** 100% of the population receives adequate quantity and quality of water based on National Standards.
2. **Partially Covered (PC) Habitation:** Between 0 and 100% of population does not receive adequate quantity of water based on National Standards.

3. **Not Covered (NC) Habitation:** 0% of the population has access to adequate quantity nor quality of water supply based on National Standards.
4. **Quality Affected (QA) Habitation:** where the population receives water with quality below National Drinking Water Standards.

The reasons for changing status of a habitation from "FC" to any other status is currently entered in the IMIS as: quality, quantity, or seasonal (temporary) reasons. The data entry system also allows entering the type of pollutant causing the quality problem as detailed parameter for biological and chemical pollution.

A habitation can have one or more schemes and a water source can be linked to one or more schemes. Based on this, the following statements apply when evaluating failure of water supply:

1. If a habitation is NOT categorized as Fully Covered (FC), it means that ALL schemes for this habitation failed to meet the minimum requirements of water supply.
2. If a scheme fails, it does not necessary means that the habitation is not FC because there are often more than one scheme per habitation.
3. If a water source fails, it means the scheme(s) linked to this source fail, but not necessarily that the habitation is not FC.
4. If a source fails, if can affect more than one scheme. But if the scheme has multiple sources, then the scheme could remain functional.

Entities Diagram

The detailed information stored under each of the four (4) main categories is presented in the following tables. There are sub-groups for some of the categories and are grouped by color. Arrows represent specific data links between the main categories.

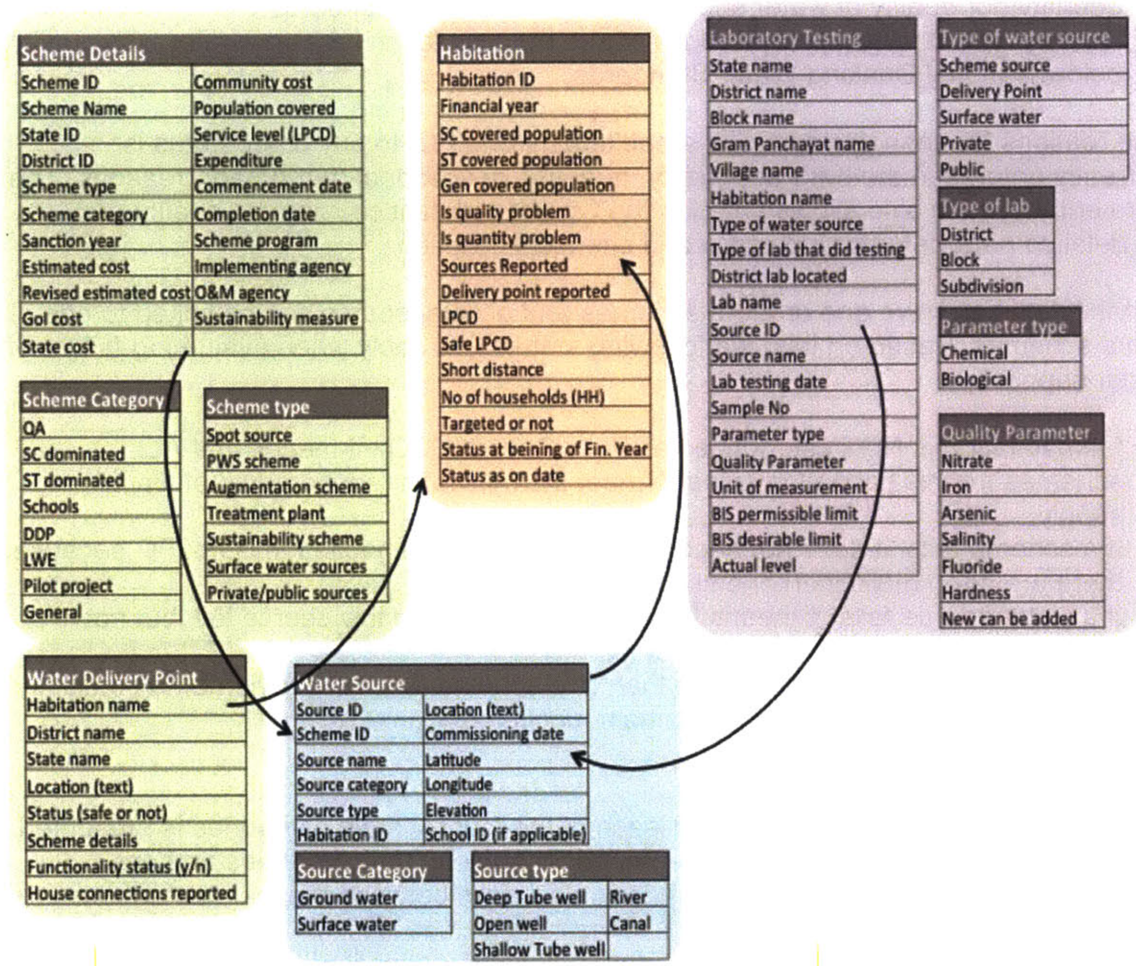
The tables and links help identify what data points are connected and available within the IMIS, allowing to select the right references to analyze water supply failures that affect the community or a scheme.

Data Entry and Approval Process

The information for these four (4) categories is entered at different spatial locations and organizations. The institutional structure changes by state. For example, in the case of the state of Gujarat, the Gujarat Water Sanitation and Sewage Board (GWSSB) enter the physical progress data, and the Gujarat Jalseva Training Institute (GJTI) enters the water quality data. The current national standard for data entry based on spatial locations is shown in .

There are four (4) different parts of data entry for IMIS: annual, monthly, regular, and masters.

Figure 18 IMIS Data bases and entities diagram



Annual Data Entry Process

The annual data entry is the largest and most relevant process. This report is required for annual financial planning and budget allocation at central and state government levels. Financial years start in April 1st and data should be entered, evaluated, and approved by March 30th.

Annual data entry provides the status of water coverage of all habitations in India. This is the only time when habitations are evaluated on their water supply as FC, PC, QA, or NC. It also provides census data for population of habitations, locations, and creation or abandonment of habitations. The specific categories within this data entry are:

1. Map villages to census villages
2. Data realignment
3. Approval of data realignment
4. Yearly data updating
5. Approval yearly data updating

6. Project shelf
7. Target habitation
8. Approval of target habitations
9. School targets
10. Annual action plan (support activities)
11. Financial Allocation

After the annual survey a group of projects is selected considering their priority and the budget availability, these projects are called Target Habitations and Schools. The annual plan for these target projects includes water system infrastructure, quality, and community support programs to be implemented within the financial year. The data is entered at subdivision, district, and state levels. Annual target projects can't be changed after the annual data period is closed.

Monthly Data Entry Process
Once the annual target projects are identified and budget is allocated, the monthly data entry reports progress status. There are four (4) categories of data included in monthly progress reports (MPR):

1. Physical MPR
2. Physical MPR state approval
3. District financial MPR
4. State approval financial MPR

All these categories include infrastructure and financial data for ongoing and completed schemes, water quality of sources, community support activities, and operation and maintenance. Data entry is only accessible to district offices for the district MPRs. Based on monthly progress reports; financial resources are approved and monitored at state government level. Monthly data has to be entered by the 15th of every month and can't be modified after state approval, unless a special request and explanations are submitted to the central IMIS office.

Regular Data Entry Process
The regular data entry process includes data sets that can be entered annually and/or monthly. The categories within this entry process are: scheme entry, water quality, school entry, and releases. These entries are accessible for both state and district offices.

The regular data entry captures details for four (4) sectors:

1. Scheme entry
2. Water quality
3. School entry
4. Releases

These categories capture data about type of sources such as spot sources, piped water supply schemes, augmentation schemes, treatment plants, sustainability schemes, surface water sources, private/public sources. From the water quality perspective it captures the laboratory facilities details, laboratory testing capabilities, and sanitary survey. For school only general details are found here. The releases are financial data to show transfer releases and district releases. Access to these data entries varies among the sectors between national, state, district, and block levels.

Master Data Entry

This data is entered on monthly basis and has only two categories:

1. Bank account details
2. Mark minorities habitations

The bank account data is only available for state users and allows entering the back account details for the Village Water and Sanitation Committee (VWSC). The minorities' habitations data entry is open for state and district offices to mark if habitation has any minority population dominance.

Data Approval Process

Data approval for each data entry process varies. For the annual data entry the approval starts at district offices, followed by state offices and receiving final approval and fund allocation at the central government level. For the Monthly data entry process the approval is done at state level only.

The following diagram shows the different spatial data collection, entry, and approval process.

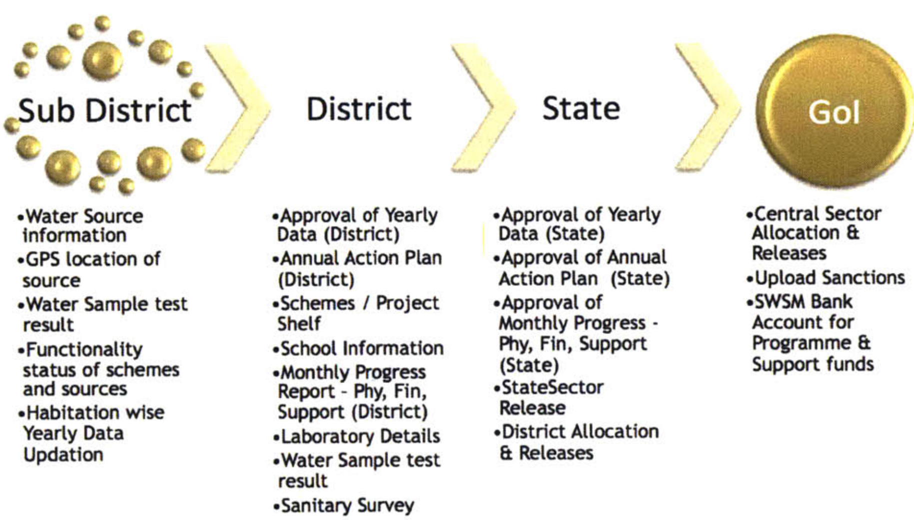


Figure 19 IMIS Data flow at different spatial levels (Source: IMIS 2015)

Data Display

The IMIS data is publicly displayed in its website and divided in four (4) main categories: basic and general information (habitation data), physical progress (schemes), financial progress, and water quality monitoring and surveillance. Under each of these categories data are shown in documents called "formats" where a set of information is presented in a tabular form. There are a total of 91 formats or reports showing several data sets within the four main categories.

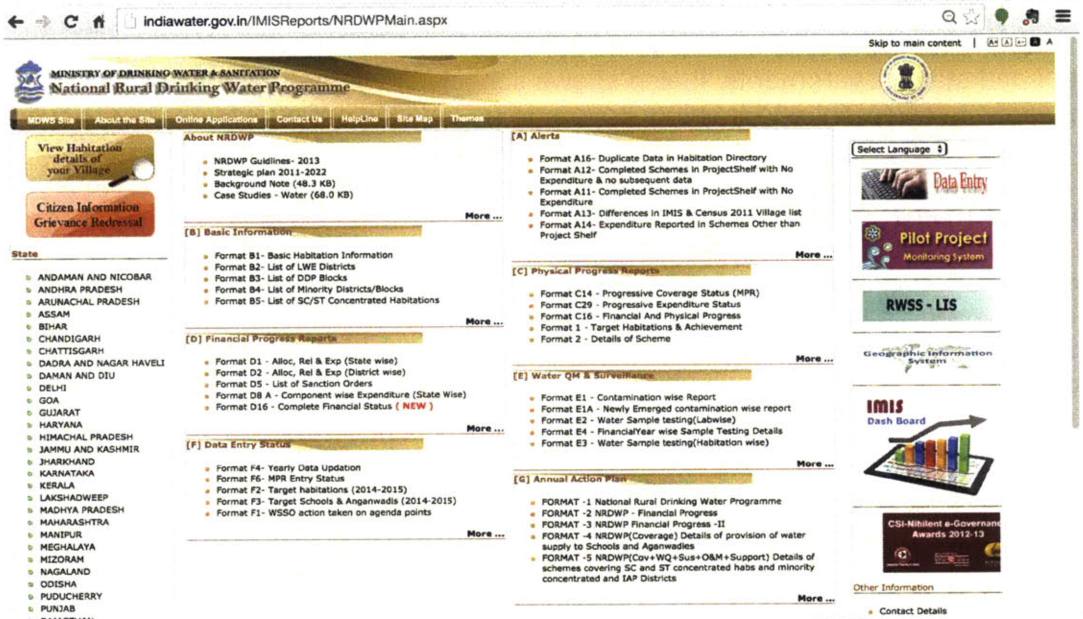


Figure 20 Snapshot from IMIS website – homepage (IMIS 2015)

In the home page of the IMIS website there are eight (8) sections with reports related to each section. These are:

About NRDWP: general information about the NRDWP strategy and objectives. It also has links to other related websites.
Alerts: provides 12 formats that monitor possible errors or not updated information, such as completed projects without expenditures and habitations where schemes do not exist.
Basic Information: this section contains 20 reports with data that sets the foundations for water supply, such as population, states with high minority population, schools, inventory of water sources and schemes, quality testing labs, and hand pumps.
Physical Progress Reports: this section has 37 formats that focus on infrastructure, such as schemes progress. It also includes progress of community support activities and laboratory testing for sources. Expenditure related to these activities is also found in this section.
Financial Progress Reports: in this section there are 17 reports focused on allocation, release, and expenditure of state and district offices.
Water QM & Surveillance: there are 28 reports in this section to describe the quality testing and monitoring of sources across India. It shows the progress of testing as well as the current contamination status of sources. This section has a separate financial, physical, and monthly progress report.

Data Entry Status: there are 10 formats that track data entry process for states and districts. This helps state and central offices make sure users are entering data promptly.
Annual Action Plans (AAP): have 11 reports that provide a summary of progress on the NRDWP including total expenditures per state and how much has been provided by central and state governments. It also shows schools coverage, habitations coverage, community involvement and training, coverage by piped water supply per panchayat. The AAP provides a general overview of progress and expenses.

Spatial and Time Scope
The spatial scope of IMIS includes all geographical divisions in India, these are national, state, district, block, panchayat, village, and habitation. Field surveys performed at habitation level create district level data. Data for some formats is not collected at all spatial levels, giving some limitations of data accessibility at district level and subdivisions.

Another important dimension of IMIS is the historical data. The age of records varies within IMIS formats since this database was launched for all spatial levels in 2009. Most of the data is available since that year and few from previous years during the early stages of IMIS development dating back to 2003. With updates and improvements of the information system, there are some data points that are only available from recent years. So there are some limitations on historical records available within IMIS due to its creation and development process.

Existing analysis of slipback with IMIS

During this research several formats currently available on the IMIS website were reviewed from different levels of government agencies. The most common formats used at the state level or that are directly related to slipback are described in this section and consist of formats C14, C17, B17, and F15.

Format C14 - Month wise Number of Total Habitations.

This format provides habitation covered from the Monthly Progress Report and serves as reference of progress towards the Annual Target. This format provides a list of habitations covered per financial year on monthly basis. Some limitations of using this format are that there are no details about the reason for poor water supply and there is no specification if it is a quantity and/or quality failure in the habitation.

Regarding historical data, this format is available from 2009 and allows seeing data from a single financial year at a time. Additional data mining process would be required to match habitations that have been covered more than once since 2009 and be able to determine frequency of coverage at that particular village.

An important factor to consider in format C14 is that it considers “Target” or “Total” projects. Target projects are included in the annual plan and budget for that financial year. The Total includes Target plus additional habitations that were not included in the Target but received coverage anyways. This indicates that these “non-target” habitations had emergencies that required a change in the priorities for coverage, hence could be qualified as unexpected failures. Based on this characteristic of Format C14 data, it can be used to calculate targeted failures and unexpected failures per year.

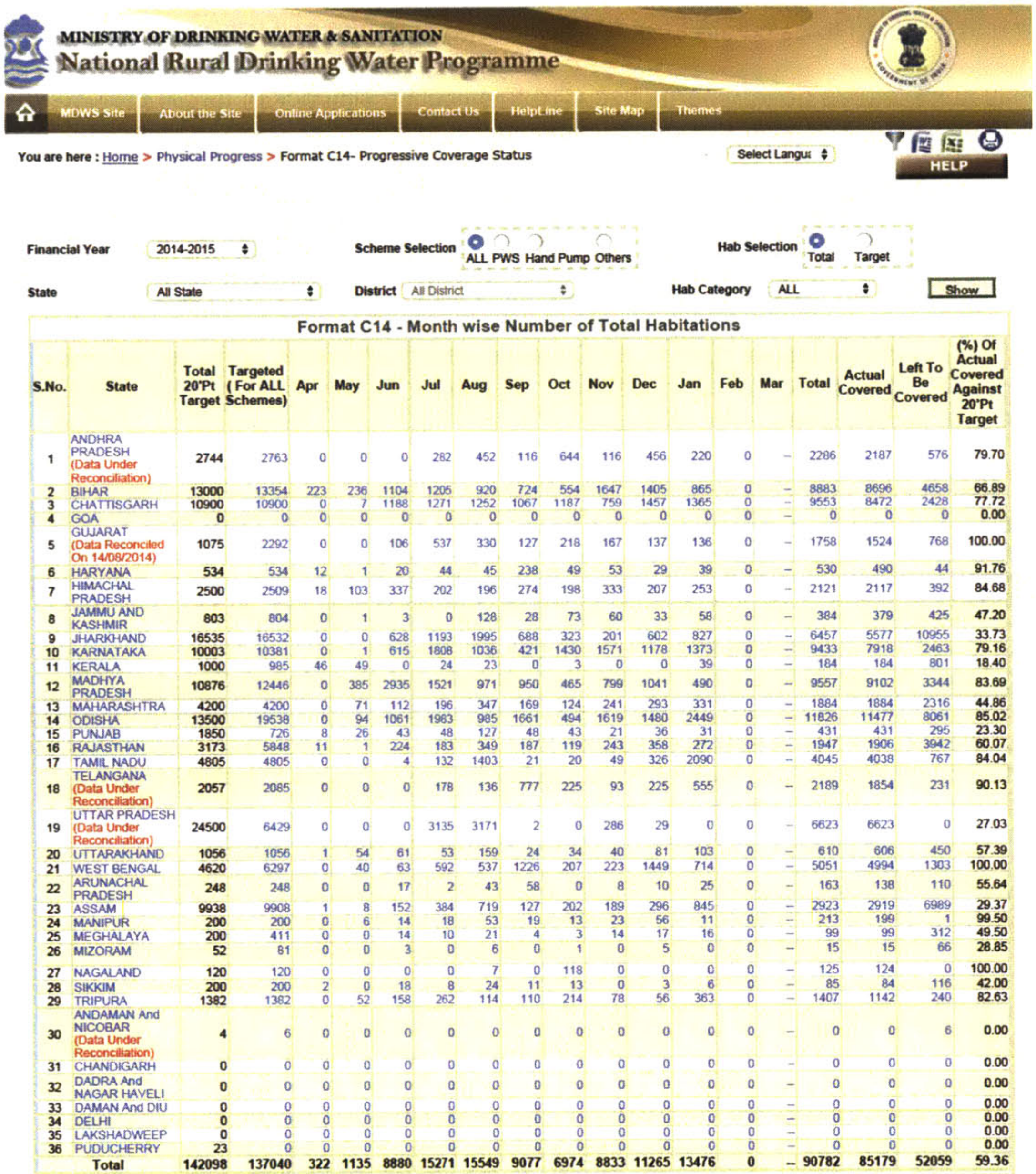
Currently some states governments use C14 to calculate slipback of target projects that are carried over to next year using the following formula:

Slipback = Total Target - Left to be Covered from Previous Year

This formula is used to calculate new habitations that will be covered during the most recent financial year. However, it still leaves out problem habitations not included in the Target, which does not capture all habitations that lack adequate access to water supply. The projects that are "Left to be Covered" represent those projects that were intended to be completed the previous financial year and now have to be included in the target for the current year.

For this research this format will not be used, but it is recommended as a way to quantify the number of target and non-target projects per financial year. This provides a reference of projects that require attention due to emergencies. These emergencies represent water failures within that year that could be correlated to slipback habitations. Non-target projects should be minimal, assuming that the annual survey and prioritization process are effective. If non-target projects increase or represent a large portion of total projects, this can indicate that categorization of target projects and emergencies require additional analysis and that slipback within a financial year have high occurrence. The time scope available for Format C14 is from 2011 and the spatial scope can be evaluated as low as habitation level. The formulas to be used are:

Non-target Projects = Total Projects – Target Projects



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You are here : Home > Physical Progress > Format C14- Progressive Coverage Status

Select Langu | HELP

Financial Year: 2014-2015 | Scheme Selection: ALL PWS Hand Pump Others | Hab Selection: Total Target

State: All State | District: All District | Hab Category: ALL | Show

Format C14 - Month wise Number of Total Habitations

S.No.	State	Total 20'Pt Target	Targeted (For ALL Schemes)	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Total	Actual Covered	Left To Be Covered	(%) Of Actual Covered Against 20'Pt Target
1	ANDHRA PRADESH (Data Under Reconciliation)	2744	2763	0	0	0	282	452	116	644	116	456	220	0	–	2286	2187	576	79.70
2	BIHAR	13000	13354	223	236	1104	1205	920	724	554	1647	1405	865	0	–	8883	8696	4658	66.89
3	CHATTISGARH	10900	10900	0	7	1188	1271	1252	1067	1187	759	1457	1365	0	–	9553	8472	2428	77.72
4	GOA	0	0	0	0	0	0	0	0	0	0	0	0	0	–	0	0	0	0.00
5	GUJARAT (Data Reconciled On 14/08/2014)	1075	2292	0	0	106	537	330	127	218	167	137	136	0	–	1758	1524	768	100.00
6	HARYANA	534	534	12	1	20	44	45	238	49	53	29	39	0	–	530	490	44	91.76
7	HIMACHAL PRADESH	2500	2509	18	103	337	202	196	274	198	333	207	253	0	–	2121	2117	392	84.68
8	JAMMU AND KASHMIR	803	804	0	1	3	0	128	28	73	60	33	58	0	–	384	379	425	47.20
9	JHARKHAND	16535	16532	0	0	628	1193	1995	688	323	201	602	827	0	–	6457	5577	10955	33.73
10	KARNATAKA	10003	10381	0	1	615	1808	1036	421	1430	1571	1178	1373	0	–	9433	7918	2463	79.16
11	KERALA	1000	985	46	49	0	24	23	0	3	0	0	39	0	–	184	184	801	18.40
12	MADHYA PRADESH	10876	12446	0	385	2935	1521	971	950	465	799	1041	490	0	–	9557	9102	3344	83.69
13	MAHARASHTRA	4200	4200	0	71	112	196	347	169	124	241	293	331	0	–	1884	1884	2316	44.86
14	ODISHA	13500	19538	0	94	1061	1983	985	1661	494	1619	1480	2449	0	–	11826	11477	8061	85.02
15	PUNJAB	1850	726	8	26	43	48	127	48	43	21	36	31	0	–	431	431	295	23.30
16	RAJASTHAN	3173	5848	11	1	224	183	349	187	119	243	358	272	0	–	1947	1906	3942	60.07
17	TAMIL NADU	4805	4805	0	0	4	132	1403	21	20	49	326	2090	0	–	4045	4038	767	84.04
18	TELANGANA (Data Under Reconciliation)	2057	2085	0	0	0	178	136	777	225	93	225	555	0	–	2189	1854	231	90.13
19	UTTAR PRADESH (Data Under Reconciliation)	24500	6429	0	0	0	3135	3171	2	0	286	29	0	0	–	6623	6623	0	27.03
20	UTTARAKHAND	1056	1056	1	54	61	53	159	24	34	40	81	103	0	–	610	606	450	57.39
21	WEST BENGAL	4620	6297	0	40	63	592	537	1226	207	223	1449	714	0	–	5051	4994	1303	100.00
22	ARUNACHAL PRADESH	248	248	0	0	17	2	43	58	0	8	10	25	0	–	163	138	110	55.64
23	ASSAM	9938	9908	1	8	152	384	719	127	202	189	296	845	0	–	2923	2919	6989	29.37
24	MANIPUR	200	200	0	6	14	18	53	19	13	23	56	11	0	–	213	199	1	99.50
25	MEGHALAYA	200	411	0	0	14	10	21	4	3	14	17	16	0	–	99	99	312	49.50
26	MIZORAM	52	81	0	0	3	0	6	0	1	0	5	0	0	–	15	15	66	28.85
27	NAGALAND	120	120	0	0	0	0	7	0	118	0	0	0	0	–	125	124	0	100.00
28	SIKKIM	200	200	2	0	18	8	24	11	13	0	3	6	0	–	85	84	116	42.00
29	TRIPURA	1382	1382	0	52	158	262	114	110	214	78	56	363	0	–	1407	1142	240	82.63
30	ANDAMAN And NICOBAR (Data Under Reconciliation)	4	6	0	0	0	0	0	0	0	0	0	0	0	–	0	0	6	0.00
31	CHANDIGARH	0	0	0	0	0	0	0	0	0	0	0	0	0	–	0	0	0	0.00
32	DADRA And NAGAR HAVELI	0	0	0	0	0	0	0	0	0	0	0	0	0	–	0	0	0	0.00
33	DAMAN And DIU	0	0	0	0	0	0	0	0	0	0	0	0	0	–	0	0	0	0.00
34	DELHI	0	0	0	0	0	0	0	0	0	0	0	0	0	–	0	0	0	0.00
35	LAKSHADWEEP	0	0	0	0	0	0	0	0	0	0	0	0	0	–	0	0	0	0.00
36	PUDUCHERRY	23	0	0	0	0	0	0	0	0	0	0	0	0	–	0	0	0	0.00
	Total	142098	137040	322	1135	8880	15271	15549	9077	6974	8833	11265	13476	0	–	90782	85179	52059	59.36

Figure 21 Format C14 Snapshot (Source: IMIS website)

Format C17 - Status of Coverage of Habitation (PC, FC, QA)

This format is the reference to check the habitation status for all states in India, which is the principal source for coverage of water supply. This provides the data source to quantify the number of habitations affected by poor water supply. At the national level it shows the total number habitations, and the number of Partially Covered, Quality Affected and Fully Covered. There are zero Non Covered habitations in India based on these records; meaning that all habitations have a source of water available.

Time records for this data start from 2011 until today, limiting the analysis to the past 4 years.

Format C17 - Status Of Rural Habitation With Respect To Drinking Water Supply AsOn (01/04/14)

S.No.	State	Total No Of Habitation	Fully Covered No Of Habitation	Partially Covered No Of Habitation	Quality Affected No Of Habitation
1	ANDHRA PRADESH (Data Under Reconciliation)	47397	29231	16612	1554
2	BIHAR	107640	50203	50838	6599
3	CHHATTISGARH	73616	61483	8038	4095
4	GOA	347	345	2	0
5	GUJARAT (Data Reconciled On 14/08/2014)	34548	32726	1567	255
6	HARYANA	7251	6796	440	15
7	HIMACHAL PRADESH	53604	39274	14330	0
8	JAMMU AND KASHMIR	15798	8049	7739	10
9	JHARKHAND	119667	116003	3637	27
10	KARNATAKA	59753	24480	32900	2373
11	KERALA	11883	3338	7717	828
12	MADHYA PRADESH	127559	125145	677	1737
13	MAHARASHTRA	100488	87339	12200	949
14	ODISHA	157296	101810	48766	6720
15	PUNJAB	15370	12563	2788	19
16	RAJASTHAN	121133	69085	28092	23956
17	TAMIL NADU	100018	85946	13657	415
18	TELANGANA (Data Under Reconciliation)	25139	13212	10308	1619
19	UTTAR PRADESH (Data Under Reconciliation)	260110	259539	73	498
20	UTTARAKHAND	39142	24195	14913	34
21	WEST BENGAL	98120	45419	41087	11614
22	ARUNACHAL PRADESH	7412	2386	4939	87
23	ASSAM	87888	41990	35214	10684
24	MANIPUR	2870	2089	781	0
25	MEGHALAYA	9326	1918	7356	52
26	MIZORAM	777	339	438	0
27	NAGALAND	1530	503	989	38
28	SIKKIM	2084	662	1422	0
29	TRIPURA	8132	3215	598	4319
30	ANDMAN And NICOBAR	400	323	77	0
31	CHANDIGARH	18	0	18	0
32	DADRA & NAGAR HAVELI	70	0	70	0
33	DAMAN & DIU	21	0	21	0
34	DELHI	0	0	0	0
35	LAKSHADWEEP	9	0	9	0
36	PUDUCHERRY	248	89	150	9
	Total	1696664	1249695	368463	78506

Figure 22 Format C17 snapshot of National level data

For the state levels, it shows the same format of Total Habitations, FC, PC, and QA habitations. If further details are required for each of the categories, click on the number of PC habitations and it will list all the habitations per state that are receiving less than the national standards (40 and 55 LPCD). This list only shows population for each habitation as Total Population, General Population, Scheduled Caste, and Scheduled Tribe. This detailed information allows analysis if there is a type of disadvantaged population that is more affected by poor access to water.

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You are here : Home > Physical Progress > Format C17- Coverage of Habitation(PC,FC,QA) > Details

Select Langu:

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32

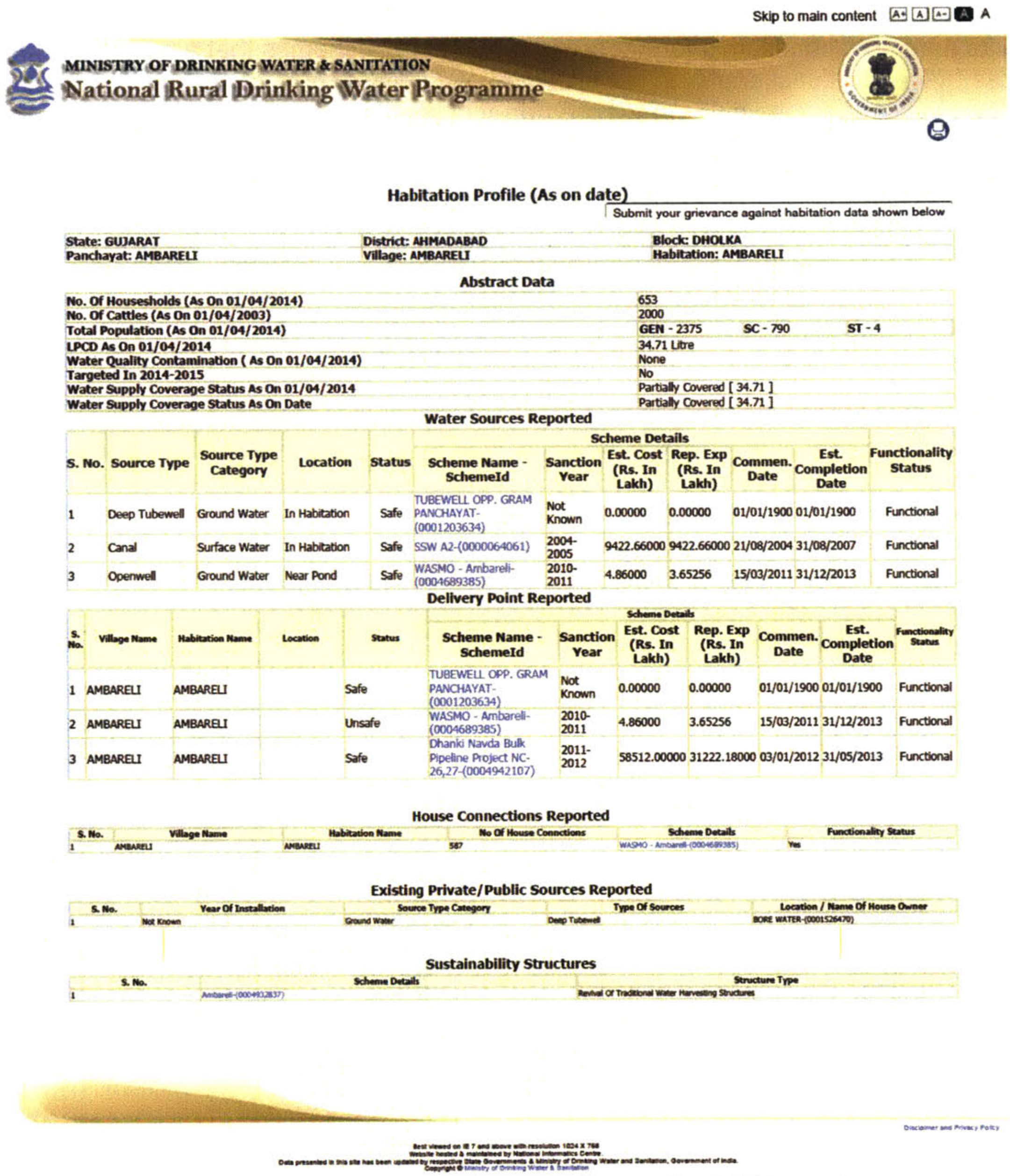
Format C17 - Partially Covered Habitation With Respect To Drinking Water Supply as per 40 LPCD

State:GUJARAT

Sl.No.	State	District	Block	Panchayat	Village	Habitation	Tot Pop	SC Pop	ST Pop	GEN Pop
1	GUJARAT	AHMADABAD	DASKROI	KUHA	KUHA	KUHA	950	200	250	500
2	GUJARAT	AHMADABAD	DASKROI	LAXMIPURA	LAXMIPURA	LAXMIPURA	704	0	0	704
3	GUJARAT	AHMADABAD	DHOLKA	AMBARELI	AMBARELI	AMBARELI	3169	790	4	2375
4	GUJARAT	AHMADABAD	DHOLKA	AMBETHI	AMBETHI	AMBETHI	1210	221	0	989
5	GUJARAT	AHMADABAD	DHOLKA	ANANDPURA	ANANDPURA	ANANDPURA	335	0	0	335
6	GUJARAT	AHMADABAD	DHOLKA	ARNEJ	ARNEJ	ARNEJ	1592	125	0	1467
7	GUJARAT	AHMADABAD	DHOLKA	BEGWA	BEGVA	BEGVA	1289	187	0	1102
8	GUJARAT	AHMADABAD	DHOLKA	BHOLAD	BHOLAD	BHOLAD	1893	110	0	1783
9	GUJARAT	AHMADABAD	DHOLKA	SHINDEREJ	SINDHRAJ	RANCHHODNAGAR	350	50	50	250
10	GUJARAT	AMRELI	AMRELI	Jasvantgadh	Jasvantgadh	Jasvantgadh	5994	453	12	5529
11	GUJARAT	AMRELI	AMRELI	Pratappara	Pratappura	Pratap Pura	200	0	0	200
12	GUJARAT	AMRELI	AMRELI	Timba	Timba	Timba	204	0	0	204
13	GUJARAT	AMRELI	KHAMBHA	Raningpara	Raningpara	Raningpara	443	25	0	418
14	GUJARAT	AMRELI	RAJULA	Agariya Dhudiya	Agariya Dhudiya	Agariya Dhudiya	2980	452	0	2528
15	GUJARAT	AMRELI	RAJULA	Agariya Mota	Agariya Mota	Agariya Mota	1934	116	0	1818
16	GUJARAT	AMRELI	RAJULA	CHANCH	CHANCH	Chancha	5833	1	2	5830
17	GUJARAT	AMRELI	RAJULA	CHANCH	CHANCH	RAJULA_CHANCH	300	0	0	300
18	GUJARAT	AMRELI	SAVERKUNDLA	Ghobapati	Ghobapati	Ghobapati	267	41	0	226
19	GUJARAT	ANAND	ANAND	VALASAN	VALASAN	Kaivalpura	400	0	0	400
20	GUJARAT	ANAND	BORSAD	BHADARANIYA	BHADRANIYA	Bhadran	3480	251	0	3229
21	GUJARAT	ANAND	BORSAD	JANTRAL	JANTRAL	Dadpura	1054	0	0	1054
22	GUJARAT	ANAND	KHAMBHAT	AKHOL	AKHOL	JUNI AKHOL	583	149	0	434
23	GUJARAT	ANAND	KHAMBHAT	BAJIPURA	BAJIPURA	Bajipura	1028	43	73	912
24	GUJARAT	ANAND	KHAMBHAT	DHUVARAN	DHUVARAN	ATHAMANAPURA	418	5	4	409
25	GUJARAT	ANAND	KHAMBHAT	DHUVARAN	DHUVARAN	RATNESHWAR	213	2	2	209
26	GUJARAT	ANAND	KHAMBHAT	DHUVARAN	DHUVARAN	UGAMANAPURA	418	5	4	409
27	GUJARAT	ANAND	KHAMBHAT	DHUVARAN	DHUVARAN	VALLABHPURA	293	3	3	287
28	GUJARAT	ANAND	KHAMBHAT	HARIPURA	HARIPURA	AMBEKHADA	226	0	0	226
29	GUJARAT	ANAND	KHAMBHAT	HARIPURA	HARIPURA	HARIPURA	965	2	1	962
30	GUJARAT	ANAND	KHAMBHAT	HARIPURA	HARIPURA	RAVPURA	3253	6	4	3243
31	GUJARAT	ANAND	KHAMBHAT	HARIPURA	HARIPURA	SEVRAPURA	1590	3	2	1585
32	GUJARAT	ANAND	KHAMBHAT	KANISA	KANISA	BABAR COLONY	212	14	1	197
33	GUJARAT	ANAND	KHAMBHAT	KANISA	KANISA	SOMAVAJAPURA	318	21	1	296
34	GUJARAT	ANAND	SOJITRA	KASOR - 23	KASOR	MAHUDIYAPURA	326	11	0	315
35	GUJARAT	ARAVALLI	BAYAD	AAMBLIYARA	AMBLIYARA	Abcd	300	50	50	200
36	GUJARAT	ARAVALLI	BAYAD	ALVA	ALVA	ALVA	789	43	132	614
37	GUJARAT	ARAVALLI	BAYAD	ALVA	ALVA	ALVA KAMPO	275	15	46	214
38	GUJARAT	ARAVALLI	BAYAD	CHANDREJ	CHANDAREJ	BADIYADEV	135	12	0	123
39	GUJARAT	ARAVALLI	BAYAD	DESAIPURA	DESAIPURA KAMPO	DESAIPURA	579	9	104	466
40	GUJARAT	ARAVALLI	BHILODA	DEVANIMORI	DEVNI MORI	Himatpur	166	150	1	15
41	GUJARAT	ARAVALLI	BHILODA	Jesingpur	Jesingpur	Motadodisara	1072	14	1052	6
42	GUJARAT	ARAVALLI	BHILODA	JESINGPUR	JESINGPUR	Motadodisara	1072	14	1052	6
43	GUJARAT	ARAVALLI	BHILODA	Jesingpur	Jesingpur	Nana Dodisara	669	0	669	0
44	GUJARAT	ARAVALLI	BHILODA	JESINGPUR	JESINGPUR	Nana Dodisara	669	0	669	0
45	GUJARAT	ARAVALLI	BHILODA	KHERANCHA	KHARI	KHARI	1221	0	1221	0
46	GUJARAT	ARAVALLI	BHILODA	VAGHPUR	VAGHPUR	VAGHPUR	555	515	15	25
47	GUJARAT	ARAVALLI	BHILODA	VANKANER	VANKANER	VANKANER CHHAPRA	431	40	240	151
48	GUJARAT	ARAVALLI	MEGHRAJ	Meghraj	Meghraj	Meghraj	10536	633	811	9092
49	GUJARAT	ARAVALLI	MODASA	BADODARA	BADODARA	PATEL NA MUVADA	132	23	1	108
50	GUJARAT	BANAS KANTHA	DANTA	AMBAJI	Ambaji (CT)	Ambaji (CT)	1000	0	0	1000

Figure 23 Format C17 snapshot of state level data

For details about the habitation schemes, it is necessary to click on the habitation name to access the Habitation Profile page. In the habitation profile it is possible to see the list of schemes, sources, and delivery points linked to the habitation.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MINISTRY OF DRINKING WATER & SANITATION
National Rural Drinking Water Programme

Habitation Profile (As on date)

Submit your grievance against habitation data shown below

State: GUJARAT	District: AHMADABAD	Block: DHOLKA
Panchayat: AMBARELI	Village: AMBARELI	Habitation: AMBARELI

Abstract Data

No. Of Households (As On 01/04/2014)	653		
No. Of Catties (As On 01/04/2003)	2000		
Total Population (As On 01/04/2014)	GEN - 2375	SC - 790	ST - 4
LPCD As On 01/04/2014	34.71 Litre		
Water Quality Contamination (As On 01/04/2014)	None		
Targeted In 2014-2015	No		
Water Supply Coverage Status As On 01/04/2014	Partially Covered [34.71]		
Water Supply Coverage Status As On Date	Partially Covered [34.71]		

Water Sources Reported

S. No.	Source Type	Source Type Category	Location	Status	Scheme Details: Scheme Name - SchemeId	Sanction Year	Est. Cost (Rs. In Lakh)	Rep. Exp (Rs. In Lakh)	Commen. Date	Est. Completion Date	Functionality Status
1	Deep Tubewell	Ground Water	In Habitation	Safe	TUBEWELL OPP. GRAM PANCHAYAT-(0001203634)	Not Known	0.00000	0.00000	01/01/1900	01/01/1900	Functional
2	Canal	Surface Water	In Habitation	Safe	SSW A2-(0000064061)	2004-2005	9422.66000	9422.66000	21/08/2004	31/08/2007	Functional
3	Openwell	Ground Water	Near Pond	Safe	WASMO - Ambareli-(0004689385)	2010-2011	4.86000	3.65256	15/03/2011	31/12/2013	Functional

Delivery Point Reported

S. No.	Village Name	Habitation Name	Location	Status	Scheme Details: Scheme Name - SchemeId	Sanction Year	Est. Cost (Rs. In Lakh)	Rep. Exp (Rs. In Lakh)	Commen. Date	Est. Completion Date	Functionality Status
1	AMBARELI	AMBARELI		Safe	TUBEWELL OPP. GRAM PANCHAYAT-(0001203634)	Not Known	0.00000	0.00000	01/01/1900	01/01/1900	Functional
2	AMBARELI	AMBARELI		Unsafe	WASMO - Ambareli-(0004689385)	2010-2011	4.86000	3.65256	15/03/2011	31/12/2013	Functional
3	AMBARELI	AMBARELI		Safe	Dhanki Navda Bulk Pipeline Project NC-26,27-(0004942107)	2011-2012	58512.00000	31222.18000	03/01/2012	31/05/2013	Functional

House Connections Reported

S. No.	Village Name	Habitation Name	No Of House Conenctions	Scheme Details	Functionality Status
1	AMBARELI	AMBARELI	587	WASMO - Ambareli-(0004689385)	Yes

Existing Private/Public Sources Reported

S. No.	Year Of Installation	Source Type Category	Type Of Sources	Location / Name Of House Owner
1	Not Known	Ground Water	Deep Tubewell	BORE WATER-(0001526470)

Sustainability Structures

S. No.	Scheme Details	Structure Type
1	Ambareli-(0004932837)	Revival Of Traditional Water Harvesting Structures

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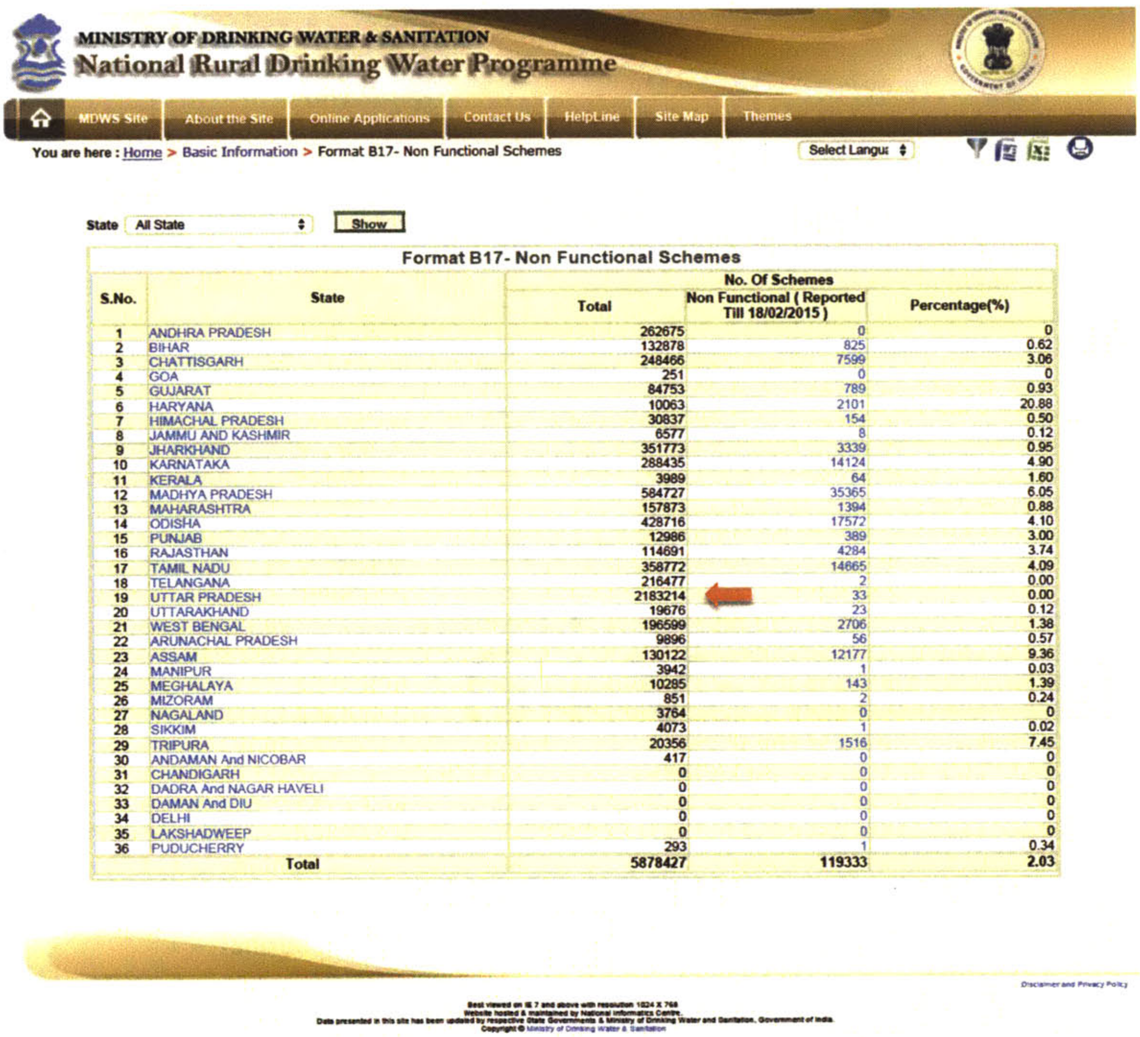
Figure 24 Habitation profile snapshot under C17 format

There was no specific use identified for this format or the habitation details during the data entry process by the people interviewed during this research.

For this analysis this format is used to identify water coverage status and location of "not covered" areas.

Format B17 – Non-functional Schemes

Like its name describes, this format lists the number of schemes that are not functioning across India. The functionality is not specified as quality or quantity at the national level, but the total of schemes built versus the non-functional schemes are shown per state in this format. It gives a good perspective about the failure of schemes per state versus the total number of schemes. Something interesting found during the interview process was that each state has a unique way to interpret schemes, i.e., hand pumps are entered as a scheme in some state while in others they are not, and this is why it is thought that Uttar Pradesh has more than 2 million schemes or 37% of all India.



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State: All State — Show

Format B17- Non Functional Schemes

S.No.	State	No. Of Schemes		Percentage(%)
		Total	Non Functional (Reported Till 18/02/2015)	
1	ANDHRA PRADESH	262675	0	0
2	BIHAR	132878	825	0.62
3	CHATTISGARH	248466	7599	3.06
4	GOA	251	0	0
5	GUJARAT	84753	789	0.93
6	HARYANA	10063	2101	20.88
7	HIMACHAL PRADESH	30837	154	0.50
8	JAMMU AND KASHMIR	6577	8	0.12
9	JHARKHAND	351773	3339	0.95
10	KARNATAKA	288435	14124	4.90
11	KERALA	3989	64	1.60
12	MADHYA PRADESH	584727	35365	6.05
13	MAHARASHTRA	157873	1394	0.88
14	ODISHA	428716	17572	4.10
15	PUNJAB	12986	389	3.00
16	RAJASTHAN	114691	4284	3.74
17	TAMIL NADU	358772	14665	4.09
18	TELANGANA	216477	2	0.00
19	UTTAR PRADESH	2183214	33	0.00
20	UTTARAKHAND	19676	23	0.12
21	WEST BENGAL	196599	2706	1.38
22	ARUNACHAL PRADESH	9896	56	0.57
23	ASSAM	130122	12177	9.36
24	MANIPUR	3942	1	0.03
25	MEGHALAYA	10285	143	1.39
26	MIZORAM	851	2	0.24
27	NAGALAND	3764	0	0
28	SIKKIM	4073	1	0.02
29	TRIPURA	20356	1516	7.45
30	ANDAMAN And NICOBAR	417	0	0
31	CHANDIGARH	0	0	0
32	DADRA And NAGAR HAVELI	0	0	0
33	DAMAN And DIU	0	0	0
34	DELHI	0	0	0
35	LAKSHADWEEP	0	0	0
36	PUDUCHERRY	293	1	0.34
	Total	5878427	119333	2.03

Figure 25 Format B17 snapshot at National Level

One of the biggest limitations for this format is that there is no historical data available, only what has been most recently updated during the annual survey. It is not possible to analyze any trends for this format at any spatial level.

When clicking the Non-Functional schemes number, one obtains more details available for each state and as low as the habitation level. This detailed information is shown in the following figure and specifies if the reason for non-functionality is due to quality and/or quantity reasons. This provides a good insight for most common causes of currently failed schemes for each state. The Sanction Year is the approval year for funding the project, giving a good reference of the age of failed schemes.

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Select Langu

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16

Format B17- Non Functional Schemes (Reported till 18/02/2015)

S. No.	State	District	Block	Panchayat	Village	Habitation	SchemeId	Scheme Name	Sanction Year	Non Functionality Reason	Is Parmanently defunct	Date of Non Functionality
1	GUJARAT	AHMADABAD	DASKROI	KATHWADA	KATHWADA	KATHWADA	0000002785	KATHAVADA	2004-2005	Quantity	NO	01/04/2014
2				SHILAJ	SHILAJ	SHILAJ	0000002784	SHILAJ	2003-2004	Quantity	NO	01/04/2014
3			DETROJ	RUDATAL	RUDATAL	GANESHPURA	0002387115	WELL WATER A C PATEL	Not Known	Due To Quality Problems	NO	01/04/2014
4			MANDAL	SOLGAM	SADRA	SADARA	0002386573	TUBEWELL GPB	Not Known	Quantity	NO	01/04/2014
5			SANAND	GORAJ	GORAJ	HIRAJINAPURA	0002383542	TUBEWELL GPB NR. PRIMARY SCHOOL	Not Known	Quantity	NO	01/04/2014
6			VIRAMGAM	GORAIYA	GORAIYA	GORAIYA	0000002811	GORAIYA	2004-2005	Quantity	NO	01/04/2014
7				KALIYANA	KALIYANA	KALIYANA	0002388524	BORE WATER	Not Known	Quantity	NO	01/04/2014
8				KAYALA	KAYLA	KAYALA	0002388191	WELLWATER VILLAGE	Not Known	Quantity	NO	01/04/2014
9		ANAND	ANKLAV	NARPURA -79	NARPURA	PAHADA VISTAR	0000424944	PAHADA VISTAR (NARPURA) W.S.S.	2005-2006	Quantity, Due To Quality Problems	NO	01/04/2014
10			KHAMBHAT	VATADRA	VATADRA	SADAVISTAR	0000419829	SADA VISTAR W.S.S.	2005-2006	Quantity, Due To Quality Problems	NO	01/04/2014
11			PETLAD	AGAS - 51	AGAS	AGAS	0006123825	Agas-Handpump	2013-2014	Quantity, Due To Quality Problems	NO	01/04/2014
12				LAKKADPURA - 67	LAKKADPURA	GOPALPURA	0000025963	GOPALPURA	2003-2004	Quantity, Due To Quality Problems	NO	01/04/2014
13				RAMOL - 7	RAMOL	AMRAPURA	0000489220	AMRAPURA WSS	2006-2007	Quantity, Due To Quality Problems	NO	01/04/2014
14			SOJITRA	DEVA TALPAD - 3	DEVA TALPAD	LAXMIPURA	0001119461	LAXMIPURA (DEVA-TALPAD) WSS	2008-2009	Quantity, Due To Quality Problems	NO	01/04/2014
15			UMRETH	LINGDA	LINGDA	HARIPURA	0000421510	HARIPURA W.S.S.	2005-2006	Quantity	NO	01/04/2014
16						LINGDA	0000002948	LINGDA	2004-2005	Quantity	NO	01/04/2014
17				MEGHVA-BADAPURA	MEGHVA-BADAPU	MEGHVA-BADAPURA	0006129658	Megva-Handpump	2013-2014	Quantity	NO	01/04/2014
18		ARAVALLI	BHILODA	ADHERA	GODH (KUSKI)	GODHKUSKI	0002548599	GODH KUSKT	2010-2011	Due To Quality Problems	NO	01/04/2014
19				BHILODA	BHILODA	BHILODA	0000746903	Bhiloda	2007-2008	Due To Quality Problems	NO	01/04/2014
20				BHUTAVAD	BHUTAVAD	BHUTVADA CHHAPRA	0002548693	BHUTAVADCHHAPARA	2010-2011	Due To Quality Problems	NO	01/04/2014
21				CHIBHADIYATA	CHIBHADIYATA	CHIBHADIYATA	0002548701	CHIBHADIYATA	2010-2011	Due To Quality Problems	NO	01/04/2014
22				KHUMAPUR	KHUMAPUR	KHUMAPUR	0000056329	Khumapur	2007-2008	Due To Quality Problems	NO	01/04/2014
23				MERU (BHETALI)	MERU (BHETALI)	MERU (BHETALI)	0005335751	MAHERU	2012-2013	Quantity	NO	01/04/2014
24						MERU (BHETALI)	0005332059	MEHRU	2012-2013	Quantity	NO	01/04/2014
25				NADOJ	MANDHARI	SHANKARAPURA CAMPO	0000026388	Gamtal	2006-2007	Due To Quality Problems	NO	01/04/2014
26				RAISINGPUR	RAISINGPUR	RAISINGPUR	0002556709	Raisingpur	2010-2011	Due To Quality Problems	NO	01/04/2014
27				SHAMALPUR	RAMPUR (MOTI)	RAMPURMORI	0002548585	RAMPURMORI	2010-2011	Due To Quality Problems	NO	01/04/2014
28				TAKATUKA	TAKATUKA	TAKATUKA	0005634130	SILASAN	2013-2014	Due To Quality Problems	NO	01/04/2014
29				TORDA (JETPUR)	BAVALIYA (TAKAPUR)	BAVALIYA (TAKA)	0002556619	BAVALIYA(TAKA)	2010-2011	Due To Quality Problems	NO	01/04/2014
30			DHANSURA	BUTAL	BUTAL	BUTALKAMPA	0000747202	ButalKampa	2007-2008	Due To Quality Problems	NO	01/04/2014
31				HIRAPUR G.G.P.	HIRAPUR	NAVA HIRAPUR	0000019820	Kesharpuea Kampa	2006-2007	Due To Quality Problems	NO	01/04/2014
32			MEGHRAJ	SANGAL	SANGAL	SANGAL	0005328990	SHANGAL	2012-2013	Due To Quality Problems	NO	01/04/2014
33			MODASA	DAVALI	DAVLI	CHHATRESWARI	0000622943	Chhatreswari WSS	2007-2008	Quantity	NO	01/04/2014

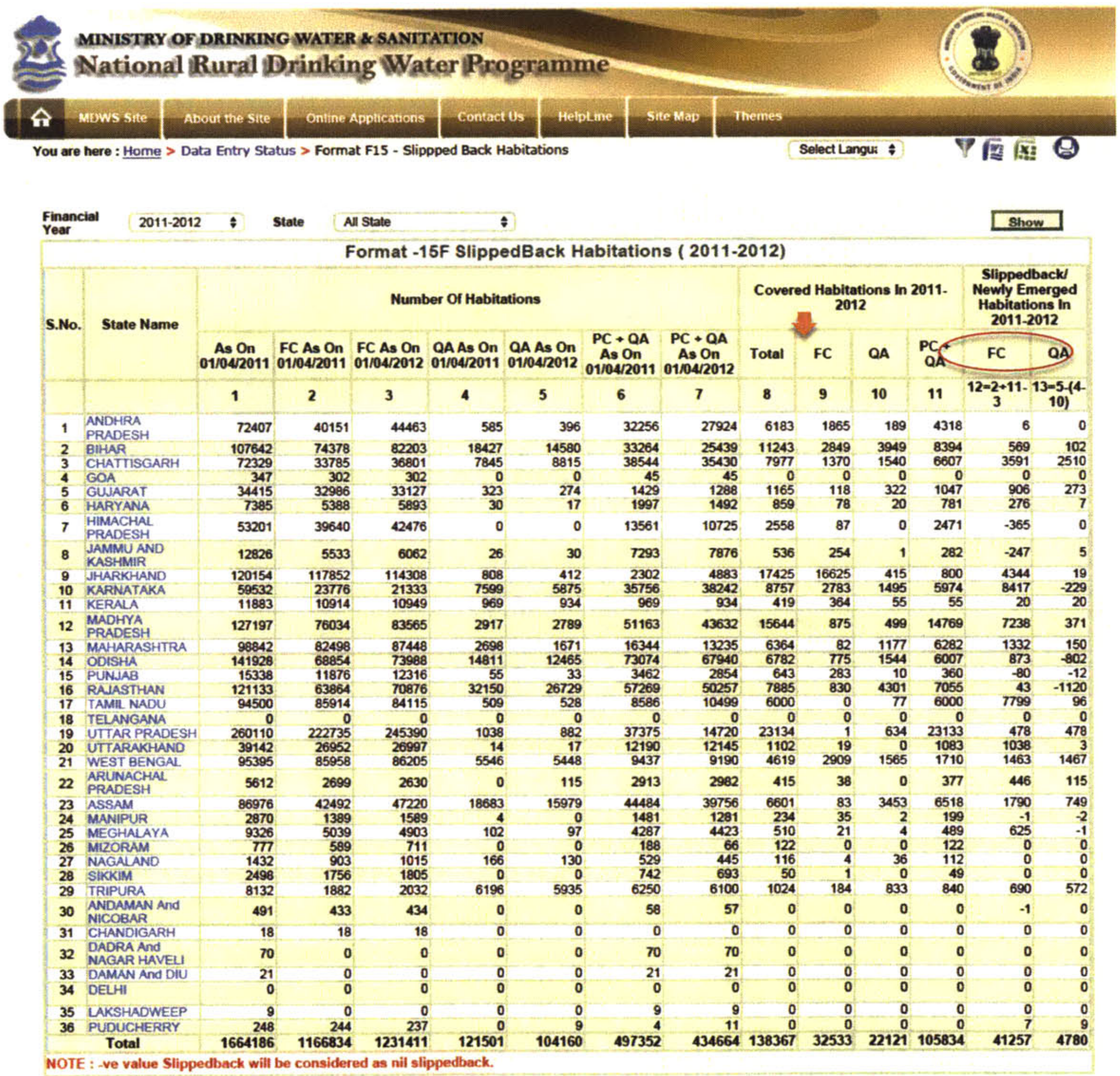
Figure 26 Format B17 details of Non-Functional schemes by state

Currently this format is not used by any of the organizations that enter data in IMIS at state or national level and that were interviewed during this research. For further analysis at the national level, the information for each state shall be separately downloaded and analyzed.

For this research this format is used for the Technology factor as in the FIETS evaluation of schemes failures, if it was a quality and/or quantity reason, and the relative age of the system.

Format F15 – Slipped Back Habitations

This is the most relevant format about slipback currently available in the IMIS. It shows the total habitations, FC habitations, PC+QA habitations, and QA habitations per financial year.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Financial Year: 2011-2012 State: All State Show

Format -15F SlippedBack Habitations (2011-2012)

S.No.	State Name	Number Of Habitations							Covered Habitations In 2011-2012				Slippedback/ Newly Emerged Habitations In 2011-2012	
		As On 01/04/2011	FC As On 01/04/2011	FC As On 01/04/2012	QA As On 01/04/2011	QA As On 01/04/2012	PC + QA As On 01/04/2011	PC + QA As On 01/04/2012	Total	FC	QA	PC + QA	FC	QA
		1	2	3	4	5	6	7	8	9	10	11	12=2+11-3	13=5-(4-10)
1	ANDHRA PRADESH	72407	40151	44463	585	396	32256	27924	6183	1865	189	4318	6	0
2	BIHAR	107642	74378	82203	18427	14580	33264	25439	11243	2849	3949	8394	569	102
3	CHATTISGARH	72329	33785	36801	7845	8815	38544	35430	7977	1370	1540	6607	3591	2510
4	GOA	347	302	302	0	0	45	45	0	0	0	0	0	0
5	GUJARAT	34415	32986	33127	323	274	1429	1288	1165	118	322	1047	906	273
6	HARYANA	7385	5388	5893	30	17	1997	1492	859	78	20	781	276	7
7	HIMACHAL PRADESH	53201	39640	42476	0	0	13561	10725	2558	87	0	2471	-365	0
8	JAMMU AND KASHMIR	12826	5533	6062	26	30	7293	7876	536	254	1	282	-247	5
9	JHARKHAND	120154	117852	114308	808	412	2302	4883	17425	16625	415	800	4344	19
10	KARNATAKA	59532	23776	21333	7599	5875	35756	38242	8757	2783	1495	5974	8417	-229
11	KERALA	11883	10914	10949	969	934	969	934	419	364	55	55	20	20
12	MADHYA PRADESH	127197	76034	83565	2917	2789	51163	43632	15644	875	499	14769	7238	371
13	MAHARASHTRA	98842	82498	87448	2698	1671	16344	13235	6364	82	1177	6282	1332	150
14	ODISHA	141928	68854	73988	14811	12465	73074	67940	6782	775	1544	6007	873	-802
15	PUNJAB	15338	11876	12316	55	33	3462	2854	643	283	10	360	-80	-12
16	RAJASTHAN	121133	63864	70876	32150	26729	57269	50257	7885	830	4301	7055	43	-1120
17	TAMIL NADU	94500	85914	84115	509	528	8586	10499	6000	0	77	6000	7799	96
18	TELANGANA	0	0	0	0	0	0	0	0	0	0	0	0	0
19	UTTAR PRADESH	260110	222735	245390	1038	882	37375	14720	23134	1	634	23133	478	478
20	UTTARAKHAND	39142	26952	26997	14	17	12190	12145	1102	19	0	1083	1038	3
21	WEST BENGAL	95395	85958	86205	5546	5448	9437	9190	4619	2909	1565	1710	1463	1467
22	ARUNACHAL PRADESH	5612	2699	2630	0	115	2913	2982	415	38	0	377	446	115
23	ASSAM	86976	42492	47220	18683	15979	44484	39756	6601	83	3453	6518	1790	749
24	MANIPUR	2870	1389	1589	4	0	1481	1281	234	35	2	199	-1	-2
25	MEGHALAYA	9326	5039	4903	102	97	4287	4423	510	21	4	489	625	-1
26	MIZORAM	777	589	711	0	0	188	66	122	0	0	122	0	0
27	NAGALAND	1432	903	1015	166	130	529	445	116	4	36	112	0	0
28	SIKKIM	2498	1756	1805	0	0	742	693	50	1	0	49	0	0
29	TRIPURA	8132	1882	2032	6196	5935	6250	6100	1024	184	833	840	690	572
30	ANDAMAN And NICOBAR	491	433	434	0	0	58	57	0	0	0	0	-1	0
31	CHANDIGARH	18	18	18	0	0	0	0	0	0	0	0	0	0
32	DADRA And NAGAR HAVELI	70	0	0	0	0	70	70	0	0	0	0	0	0
33	DAMAN And DIU	21	0	0	0	0	21	21	0	0	0	0	0	0
34	DELHI	0	0	0	0	0	0	0	0	0	0	0	0	0
35	LAKSHADWEEP	9	0	0	0	0	9	9	0	0	0	0	0	0
36	PUDUCHERRY	248	244	237	0	9	4	11	0	0	0	0	7	9
	Total	1664186	1166834	1231411	121501	104160	497352	434664	138367	32533	22121	105834	41257	4780

NOTE : -ve value Slippedback will be considered as nil slippedback.

Figure 27 Format F15 snapshot at National level

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Financial Year: 2011-2012 State: GUJARAT Show

Format -15F SlippedBack Habitations (2011-2012)

S.No.	District Name	Number Of Habitations							Covered Habitations In 2011-2012				Slippedback/ Newly Emerged Habitations In 2011-2012	
		As On 01/04/2011	FC As On 01/04/2011	FC As On 01/04/2012	QA As On 01/04/2011	QA As On 01/04/2012	PC + QA As On 01/04/2011	PC + QA As On 01/04/2012	Total	FC	QA	PC + QA	FC	QA
		1	2	3	4	5	6	7	8	9	10	11	12=2+11-3	13=5-(4-10)
1	AHMADABAD	703	665	688	0	0	38	15	23	2	0	21	-2	0
2	AMRELI	646	645	643	1	3	1	3	0	0	0	0	2	2
3	ANAND	909	871	879	30	12	38	30	61	25	30	36	28	12
4	BANAS KANTHA	1730	1594	1483	86	99	136	247	118	0	86	118	229	99
5	BHARUCH	787	739	768	29	0	48	19	29	0	29	29	0	0
6	BHAVNAGAR	795	795	795	0	0	0	0	0	0	0	0	0	0
7	DANG	326	280	290	0	0	46	36	29	3	0	26	16	0
8	DOHAD	3144	3143	3144	1	0	1	0	1	0	1	1	0	0
9	GANDHINAGAR	412	412	412	0	0	0	0	0	0	0	0	0	0
10	JAMNAGAR	748	747	748	1	0	1	0	1	0	1	1	0	0
11	JUNAGADH	900	899	853	0	5	1	47	8	7	0	1	47	5
12	KACHCHH	1070	961	1070	0	0	109	0	108	2	0	106	-3	0
13	KHEDA	2052	1937	1960	35	8	115	92	136	35	35	101	78	8
14	MAHESANA	830	762	830	0	0	68	0	68	0	0	68	0	0
15	NARMADA	720	545	619	32	5	175	101	90	9	32	81	7	5
16	NAVSARI	2035	1758	1841	13	38	277	194	194	4	13	190	107	38
17	PANCH MAHALS	2526	2526	2505	0	0	0	21	0	0	0	0	21	0
18	PATAN	649	649	649	0	0	0	0	0	0	0	0	0	0
19	PORBANDAR	182	181	182	1	0	1	0	1	0	1	1	0	0
20	RAJKOT	861	861	861	0	0	0	0	0	0	0	0	0	0
21	SABAR KANTHA	2444	2423	2355	17	56	21	89	20	2	17	18	86	56
22	SURAT	1543	1451	1475	0	0	92	68	24	0	0	24	0	0
23	SURENDRANAGAR	696	671	674	1	0	25	22	24	0	1	24	21	0
24	TAPI	1663	1546	1641	20	0	117	22	100	5	20	95	0	0
25	VADODARA	2149	2089	2051	56	48	60	98	74	16	56	58	96	48
26	VALSAD	3895	3836	3711	0	0	59	184	56	8	0	48	173	0
	Total	**34415**	**32986**	**33127**	**323**	**274**	**1429**	**1288**	**1165**	**118**	**322**	**1047**	**906**	**273**

NOTE : -ve value Slippedback will be considered as nil slippedback.

Figure 28 Format F15 snapshot for Gujarat

The slipback is calculated in the report with the next formula:

Slipback = FC previous year+(PC+QA covered in current year)– FC current year

Based on this formula, slipback is defined as the difference of FC habitations between the beginning and the end of the financial year. This calculation detects the annual change of status of FC habitations to QA and combines PC+QA.

This format tracks the change of status of habitations within a financial year as a bulk number. This format combines quantity and quality (PC+QA) habitations. To know the PC separate from QA habitations additional calculation is needed, subtracting QA from PC+QA. Also to be able to compare more than one financial year slipback requires downloading the report for each financial year to create a trend, which is only available for the past four (4) financial years starting in 2011. The habitations that have been affected are not available in this format, which is something that could help identify further problems related to schemes by habitations. The lowest spatial data available is district level.

One important item to be clarified is that there are more projects done at FC habitations versus QA habitations according to columns 9 and 10. Since there is no detail on completed projects it is not possible to understand why these FC habitations are labeled under covered projects.

During the field interviews there was neither direct reference to this format to calculate slipback nor a reference for users entering data in the IMIS.

For this research this format will not be used, as more detailed coverage data is taken from format C17.

Current reports used from IMIS
There are standards established by the NRDWP guidelines, and the information for specific sections that are of interest for the central government should follow this standard format. These reports are posted within the IMIS data entry forms, so no additional data is required for reporting.

However, since each state has autonomy on water resources management, they are also able to customize their institutional organization. Based on this the reports can vary among states, as different organizations create them. The data for the IMIS is kept in separate excel documents that are used for internal reporting. This double data record helps as a backup but it also adds to the complexity of data entry records for the IMIS users, which could be avoided with a better interface with IMIS. It was observed that the use of additional data repositories increases at the lower spatial levels, being larger at district and smaller at central government.

Regarding slipback reporting, it was not found in the Monthly Progress Reports (MPR) but only on the annual survey data. It is assumed that the slipback formats in the public display are generated as a query within the database. This annual reporting reduces visibility on seasonal or temporary failures.

Chapter 6. IMIS Data Analysis at the State and District Levels

This research wants to answer the questions: what are the reasons for slipback, and which of these reasons can be measured using existing IMIS data and the FIETS framework. This analysis will help determine current capabilities of IMIS to assess slipback using a holistic approach from the FIETS categorization. During this joint analysis of FIETS and IMIS, gaps in information will be identified and targeted for recommendations to improve data collection within the IMIS platform.

The first step is to determine where habitations with poor water coverage are located. Then the factors categorized under FIETS as listed below are considered. These factors have been collected from current documentation as well as field interviews performed during this research.

Financial Factors:

a. Resources for Operation and Maintenance (O&M)
b. Compliance of water tariff payment by the community
c. Adequacy of water tariff amount for community income levels
d. Financial resources being transferred to Gram Panchayat (GP) instead of Village Water and Sanitation Committee (VWSC)

Institutional Factors:

a. Presence of local governance for water and sanitation, in India these are called the Village Water and Sanitation Committees (VWSC)
b. Autonomy and authority of VWSC
c. Ratio of schemes transferred to local governance: VWSC or Gram Panchayat

Environmental Factors:

a. Ground water sources depletion
b. Quality degradation of water sources
c. Variation of water provided during rainy season
d. Climate change events causing unexpected droughts and/or catastrophic events

Technological Factors:

a. Type of technology that fails frequently. Hand-pumps are perceived as the technology with highest failures. Traditional technologies are perceived as more sustainable.
b. Type of sources of failed system and uncovered habitations. Ground water is perceived as the least reliable.
c. Operation and maintenance (O&M) complexity increases failures.
d. Power supply reliability has a direct impact on system failures.
e. Age of systems is perceived as a reason of failure.

Social Factors:

a. Population growth leads to increase of slipback.

b. Community awareness on water and sanitation problems reduces de occurrence of slipback. This requires education and information programs.
c. Community participation in local governance decisions. Active communities reduce the number of slipback.
d. Inequality of water distribution lead to slipback.

FIETS Factors and IMIS Data Gap Analysis

The data gap analysis is done after a thorough analysis of data available in IMIS database, described above. The data gap considers if data is available, (Y) or no (N), in IMIS and the geographical and time scopes for that variable.

Table 11 FIETS categorization of IMIS formats

Financial data from IMIS:	State	District	Block	Panchayat	Village	Habitation	Since
Format C16 - Financial and physical progress	Y	Y	N	N	N	N	2010
Format 10 - Financial report for O&M expenditure	Y	N	N	N	N	N	2010
Format C29 - Progressive expenditure status	Y	N	N	N	N	N	2012
Format E16- NRWQMSP Financial Progress Report	Y	N	N	N	N	N	2005
Format D8 - Component wise expenditure by State	Y	N	N	N	N	N	2010
Format D8A - Component wise expenditure by State	Y	N	N	N	N	N	2010
Format C28 - Progress Report on drinking water mitigation activities	Y	N	N	N	N	N	2012
Format C28A - Progress Report of Drinking Water Mitigation Activities	Y	N	N	N	N	N	2014
Format C31- Physical/Financial Achievement Through Tanker	Y	Y	N	N	N	N	2012
Institutional data from IMIS:							
Format 8 - Community Involvement In NRDWP	Y	Y	N	N	N	N	2011
Format 9 - Schemes Handed Over To Community	Y	Y	Y	Y	Y	Y	2009
Environmental data IMIS:							
Format B8- Surface Water Bodies	Y	Y	Y	Y	Y	Y	2014
Format B6- List of sources in Habitations	Y	Y	Y	Y	Y	Y	2014
Format B13- List of Quality affected Habs	Y	Y	Y	Y	Y	Y	2009
Format B19- GPS Co-Ord of Sources/ Delivery point	Y	Y	Y	Y	Y	Y	2009
Format B23-List of DPAP (Drought Prone Areas Program) Blocks State	Y	Y	Y	N	N	N	2014
Format C28 - Progress Report on drinking water mitigation activities	Y	N	N	N	N	N	2012
Format C28A - Progress Report of Drinking Water Mitigation Activities	Y	N	N	N	N	N	2014
Format C31- Physical/Financial Achievement Through Tanker	Y	Y	N	N	N	N	2012
Format E1 - Contamination wise report	Y	Y	Y	Y	Y	Y	2010
Format E1A - Newly emerged contamination report	Y	Y	Y	Y	Y	Y	2010
Format E 30- Month wise Chemical/Bacteriological Contaminated Sources	Y	Y	Y	Y	Y	Y	2010
Format E32 - Status of Sources Tested during Pre & Post Monsoon periods	Y	Y	Y	Y	Y	Y	2010
Format E29 - Contaminated habitations as per lab testing	Y	Y	Y	Y	Y	Y	2012
Format E28 - Habitation Status based on testing	Y	Y	Y	Y	Y	Y	2006

Format F15-Slippedback Habitations	Y	Y	N	N	N	N	2011
Technology data from IMIS:							
Format B17- Non Functional Schemes	Y	Y	Y	Y	Y	Y	2014
Format B18- Category Wise Scheme Report	Y	Y	N	N	N	N	2014
Format B 21- Hand Pump details	N	N	N	N	N	N	N/A
Format B15- Complete List Of Schemes (Sanction Year Wise)	Y	Y	N	N	N	N	1974
Format B22 - Complete List of Schemes (Fiscal Year)	N	Y	Y	Y	Y	Y	2009
Format C28 - Progress Report on drinking water mitigation activities	Y	N	N	N	N	N	2012
Format C28A - Progress Report of Drinking Water Mitigation Activities (New Format)	Y	N	N	N	N	N	2014
Format C31- Physical/Financial Achievement Through Tanker	Y	Y	N	N	N	N	2012
Format C 37 - State wise Total Number Of Sustainability Structures	Y	Y	Y	Y	Y	Y	2009
Format 7 - Details Of Sustainability Structures	Y	Y	Y	Y	Y	Y	2009
Social data from IMIS:							
Format B11- Rural Population	Y	Y	Y	Y	N	N	2009
Format B9 - Private and public sources	Y	Y	Y	Y	Y	Y	2014
Format B1- Basic Habitation Information	Y	Y	Y	Y	Y	Y	2014
Format B2- List of LWE Districts	Y	Y	N	N	N	N	2014
Format B3- List of DDP Blocks	Y	Y	Y	N	N	N	2014
Format B4- List of Minority Districts/Blocks	Y	Y	Y	N	N	N	2014
Format B5- List of SC/ST Concentrated Habs	Y	Y	Y	Y	Y	Y	2009
Format C38 - Progressive Coverage Program wise	Y	Y	Y	Y	Y	Y	2009
Format C17- Coverage of Habitation (PC,FC,QA)	Y	Y	Y	Y	Y	Y	2011
Format C18- Coverage of Habitation (0-25%, 25-50%...)	Y	Y	Y	Y	Y	Y	2009
Format B7- List of Habs Cov with PWS	Y	Y	Y	Y	Y	Y	2014
Format C30- Population Coverage by PWS (piped water supply)	Y	Y	N	N	N	N	2012
Format B10- List Of Schools with Drinking Water	Y	Y	N	N	N	N	2014

FIETS categorization and expected correlations of IMIS variables

After the data gap analysis it is possible to identify which factors that cause slipback and are listed in the first section of this chapter can be found in the IMIS database. A logical or perceived correlation analysis was also considered during this process. A positive correlation means that slipback and the factor are directly proportional; if the factor increases, slipback increases as well. A negative correlation means the opposite, one decrease as the other increases.

For identification of slipback, the IMIS provides details on the number of habitations that change status from FC since 2009, but there is no direct number that represents slipback. Location of "partial coverage" is given by the name of habitation, village, panchayat, block, district, and state. Identification of the reason of slipback can be found as quantity, quality, and specific pollution agent. Solutions to solve slipback are not tracked, so data on actions taken are not currently available. Also, the cost of slipback is not being tracked as of 2014. The cost to repair infrastructure is under the O&M costs and until 2014 these are only tracked as low as the district level. Other financial allocation details are provided and shown in the financial factors table.

The following tables list the FIETS factors, their correlation with slipback occurrence, and whether the data are currently available in IMIS database. New factors were added under each category since they were found to be related to slipback and available at IMIS.

Financial Factors:	**Correlation**	**In IMIS**
a. Resources for Operation and Maintenance (O&M)	Negative	Yes
b. Compliance of water tariff payment by the community	Positive	No
c. Adequacy of water tariff for community income levels	Positive	No
d. Financial resources being transferred to Gram Panchayat (GP) instead of Village Water and Sanitation Committee (VWSC)	Positive	No
e. Cost of tankers for water supply	*Positive*	*Partial*
f. Allocation of funds by type per district	*Positive*	*Yes*

Capabilities and limitations of financial data: As mentioned above, financial resources for slipback are categorized by type, such as O&M and are available for each state and each district from 2009 until 2014 financial years. From 2015 O&M expenditures will be recorded for specific schemes enabling to calculate the cost to repair failed schemes. Since water schemes are handed over the community and they have 100% responsibility for O&M, the tariff collection and compliance is not currently tracked or measured. Cost for water tankers are recorded at state level only without details of which habitations require this service and not frequently, hence this variable is not used for this study.

Institutional Factors:	**Correlation**	**In IMIS**
a. Presence of local governance for water and sanitation	Negative	Yes

(VWSC)		
b. Autonomy and authority of VWSC	Negative	No
c. # Trainings given to VWSC	*Negative*	*Yes*
d. Schemes handed over to the community	*Negative*	*Yes*

Data Capabilities and limitations of institutional factors: For institutional factors there are several metrics that can be used. The presence of local governance can be related to the establishment of Village Water and Sanitation Committee (VWSC). The correlation between slipback projects and the establishment of VWSC can be evaluated from this data. However, the fact that a VWSC was established does not mean that it is an active group. The activities and performance of VWSC are not measured or recorded in the IMIS. The number of trainings given at each habitation is also recorded in the IMIS, giving visibility of how these are related with poor water coverage. The number of schemes handed over to the community is also recorded in the IMIS system and they can also be correlated to a slipback habitation. The limitations with the trainings records are that the same people can be trained more than once and they can move to other villages. So, the number of trained people indicates the education given to the community but may not increase the number of skilled people or the skill level if members have already been trained.

Environmental Factors:	**Correlation**	**In IMIS**
a. Ground water sources depletion or drying	Positive	Partial
c. Quality degradation of water sources	Positive	Yes
d. Variation of water provided during rainy season	Negative	No
e. Climate change, unexpected droughts, catastrophic events	Positive	No

Capabilities and limitations of environmental factors: For environmental factors there is a good amount of data for water sources. The IMIS water quality monitoring system allows the analysis of water quality trends at habitations where slipback occurs. However, there are no records for rain levels that could increase the quantity and quality of sources. Due to climate change, rain levels can be relevant for rural water supply as well as droughts or natural disasters. So the only source of IMIS data for environmental factors is the quality of sources.

Technological Factors:	**Correlation**	**In IMIS**
a. Type of technology that fails more frequently	Positive	Partial
b. Type of source of failed systems or habitations	Positive	Partial
c. Operation and maintenance (O&M) complexity.	Positive	No
d. Power supply reliability.	Negative	No
e. Age of systems is perceived a reason of failure.	Positive	Yes
f. Number of schemes built per financial year	Positive	Yes
g. Non-functional schemes	*Positive*	*Yes*

Capabilities and limitations of technological factors: The age of the system offers a good perspective on early failure trends, and provides data to establish preventive maintenance for schemes. The schemes are currently categorized by type and the source used, this allows analysis of which types of scheme and source are more frequent at slipback habitations. However this data is not readily available on the current formats and requires additional data mining, so it would not be used for this study. Another important factor that impacts slipback is power supply. Currently a scheme's information displays if there is an alternative source of power, but systems connected to a grid are not recorded. Having the details of grid connections can help link power failures to lack of water supply by habitations. Finally, *one major limitation of monitoring technologies is the lack of real time data.* Water meters or quality sensors are not available in the rural sector, so the annual survey is the only time when data is collected. This leaves a year to identify major variability of water supply services to the community.

Social Factors:	**Correlation**	**In IMIS**
a. Population growth leads to increase of slipback.	Positive	Yes
b. Community awareness on water and sanitation problems.	Negative	Partial
c. Community participation in local governance decisions.	Negative	No
d. Inequality of water distribution.	Positive	Yes
e. # Gram Sabah meetings held	*Negative*	*Yes*

Data Capabilities and limitations of social factors: Thanks to the annual habitation survey it is possible to measure population changes. This survey also evaluates minority population to correlate slipback with increases of population as well as population by caste or tribe. The granularity of survey does not measure the actual water being given to sectors within habitations, which reduces visibility of possible inequalities of water distribution within the habitation. General public could access the IMIS to submit complaints, however this is not currently tracked within an IMIS format. The only type of community participation measure is the number of meetings held by the local government called Gram Sabah meetings. It can be assumed that the more community meeting the more community participation, and the lower the slipback.

FIETS Analysis for Gujarat and its Districts

This section provides data analysis to locate and quantify slipback, identify possible causes, and best ways to display this data. Data analysis for slipback status will be represented in three (3) graphic illustrations: histograms, historical trends, and tabular form. These three formats were found to be used and appealing to government personnel currently generating and reading reports from the IMIS (Government of Gujarat interviews, 2014).

Histograms and historical trends will be represented with a bar graph, showing change over time of different values in the same graphic. Looking at frequency and historical trends, governments at state and district level can identify the progress of factors and take actions against trends that affect negatively water supply systems.

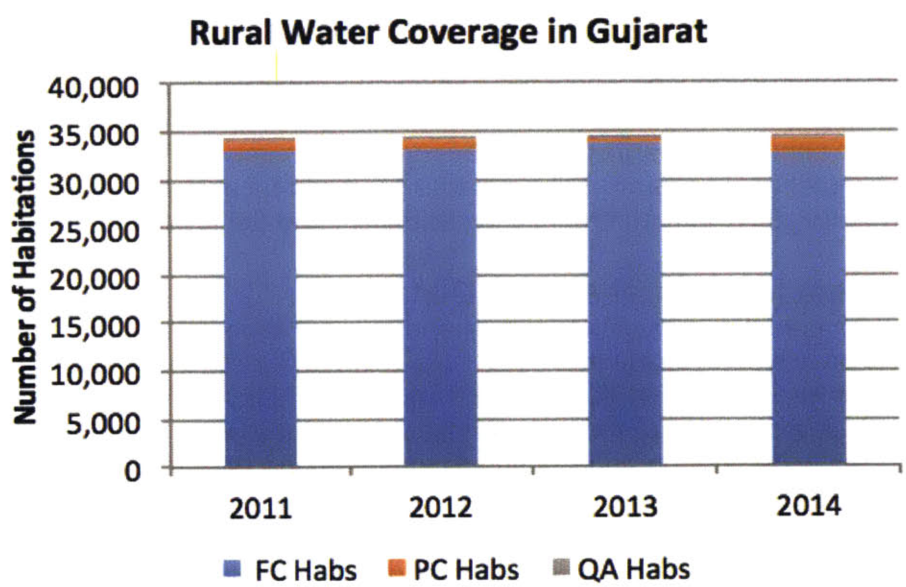
The tabular format is currently used which makes it easier to adapt to current users. This format will be used to provide rankings of problem areas for specific variables.

Mapping of data is desired but not included in the scope of this study. Geographic representation identifies where the slipback projects are located, and spatial clusters of issues that can lead to further analysis to take strategic action in specific geographic areas.

From the findings of this study it will be possible to create a dashboard where these visual representations are linked, giving a dynamic and holistic perspective of location, trend, and numerical situation of slipback, as well as variables causing the failure.

FIETS Analysis of Gujarat
This analysis will provide an analysis across the state of Gujarat using districts and the subdivision unit that are called "blocks" in India. An important consideration is that Gujarat changed its political territory in 2013 adding 7 new districts for a total of 33 districts. Data will use the 26 previous districts in most cases, unless there is data available for all 33. All FIETS factors are analyzed and presented as follows.

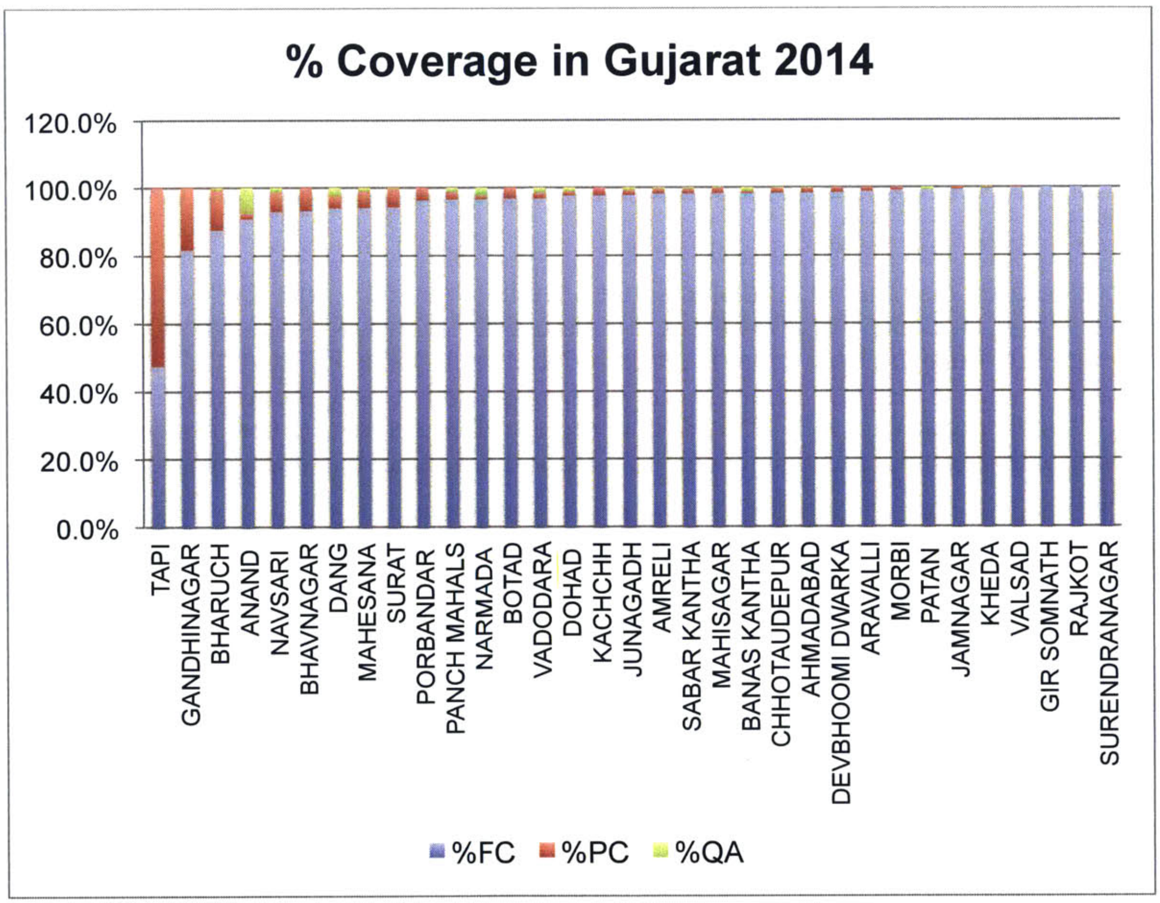
Coverage Status
For this analysis the status of habitations is evaluated to identify where problems are located and how they have changed over time. Fully Covered (FC) and Partially Covered (PC), and Quality Affected (QA) habitations are evaluated. The following chart shows the coverage status in the state from 2011 to 2014.



The coverage graph and table show there was a slipback of 1,212 habitations or 3.5% of total habitations in the state between 2013 and 2014. QA habitations are less than 1%. The relationship between habitation status is mutually exclusive and total inclusive as the Total Number habitations = FC habitations + PC habitations + QA habitations.

Financial Year	FC Habs	PC Habs	QA Habs	Total Habs
2011	32,986	1,106	323	34,415
2012	33,127	1,014	274	34,415
2013	33,805	403	207	34,415
2014	32,726	1,567	255	34,548

The following graphic shows percent coverage by district for 2014 and proves that data values have total inclusive relationship.



Based on this graphic, the QA is small compared to PC and FC. The districts with least water coverage in 2014 are Tapi, Gandhinagar, Baruch, Anand, and Navsari.

The low level of QA habitations leaves most of the problems as quantity affected or PC habitations and it also raise questions about data reflecting ground reality. This helps with the analysis, as PC status will not be studied separate as they are represented from the FC analysis. QA habitations will be evaluated to understand better the dimensions of this coverage problem. The small variation of coverage among districts makes it difficult to correlate factors to performance of coverage. More focus on FIETS factor relationship could provide more information.

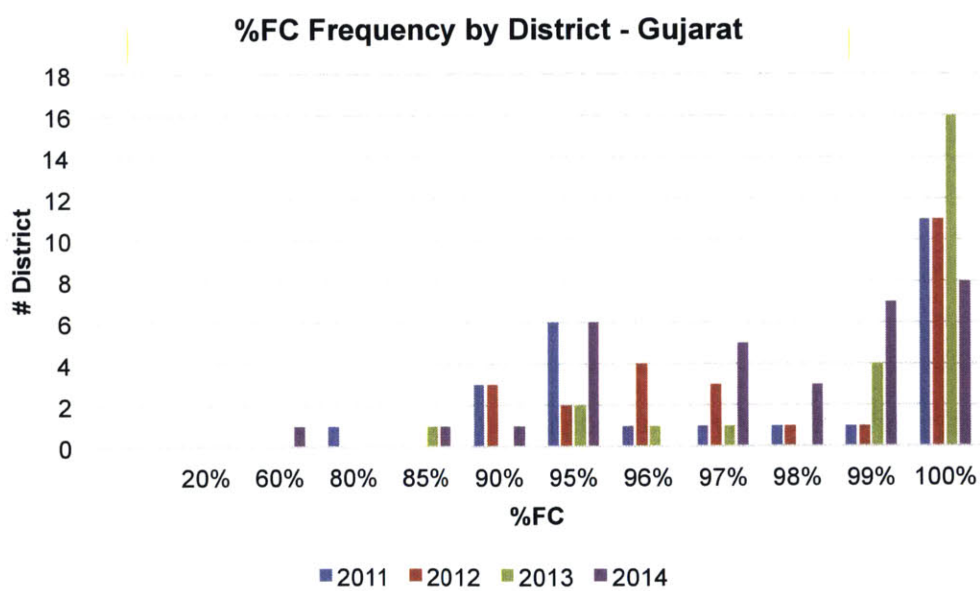
Full Coverage Status

The lowest values of FC will indicate areas with poor coverage hence indicating high PC. This helps understand historical trends and which districts have most problems.

After removing the seven (7) new districts the distribution of Fully Covered districts in Gujarat has very good coverage, ranging from 80 to 100% in the past 3 years. There has been progress of 100% covered districts from 15 in 2011 to 24 in 2014 financial year but there are more PC habitations than previous years.

Since habitation status is collected during the annual survey, the status of one year reflects the results of previous year efforts. For example, the status of 2014 will remain the same as these were collected as April 2014. The next annual survey will reflect status for habitations as of 2015. Based on this the district that shows coverage between 0-70% FC represents slipback since the previous year the lowest coverage was 90%.

A more detailed distribution for districts that have between 80% and 100% coverage is shown in this bar chart. For 2014 there are more districts between 95 and 100% coverage but there are only 8 districts from 16 that were 100% FC in 2013, this shows slipback in several districts. There is one district that has coverage between 20 and 60%. This district is Tapi with 47% FC coverage in 2014 survey. Further analysis on status of habitations in this district can help learn more about this relevant negative change.



The creation of new districts should not decrease the coverage of districts since the water supply systems and habitations remain in the same location. So these changes are not related to the new district allocation in Gujarat.

- In 2011 there were 6 districts with 95% coverage and only one with 80% coverage. In 2012 there were no districts with less than 90% coverage but the total number of districts with 100% remained the same as 2011.
- In 2013 there is great progress to reach the 100% coverage in 5 districts more, reaching a total of 16 districts. However there is a drop in coverage for one district to 85%. This indicates slipback of habitations. It is expected to see an increase of PC or QA percentages for 2013.
- In 2014 there is a 50% drop of fully covered districts from 16 to 8. The covered only dropped by 0.01% but within the water supply context this indicates an important change of access for users.

%FC	2014	2013	2012	2011
Mean	0.950	0.980	0.966	0.953
Standard Error	0.016	0.008	0.008	0.011
Median	0.977	0.997	0.977	0.968
Mode	1	1	1	1
Standard Deviation	0.094	0.040	0.043	0.059
Sample Variance	0.009	0.002	0.002	0.003
Kurtosis	21.722	8.405	1.436	3.867
Skewness	-4.394	-2.807	-1.476	-1.781
Range	0.526	0.171	0.143	0.243
Minimum	0.474	0.829	0.857	0.757
Maximum	1	1	1	1
Sum	31.361	25.485	25.105	24.777
Count	33	26	26	26

Looking at general statistics from 2011 to 2013, the average of fully covered districts has a positive trend going from 95% in 2011 to 98% in 2013. In 2014 we see a 95%. The mode is 1 indicating majority of districts are 100% covered. The minimum values indicate the lowest coverage in the state. In 2011 the least covered district had 76% FC. This value has increased in the next years to 86% in 2012 and 83% in 2013. The drop in coverage indicates a decrease of covered habitations, hence representing 3% slipback from already covered habitations within districts.
The 47% of 2014 indicates a major slipback of coverage in one district. Further analysis in this case is needed. The maximum is expected to remain at 1 indicating the maximum coverage of 100%. Sum indicator displays the additional seven (7) districts taking them from 26 to 33.

The following list shows the 10 districts with the lowest %FC coverage from

District	Total No of Habitation	FC No of Habitation	PC No of Habitation	QA No of Habitation	Financial Year	%FC	%PC	%QA
TAPI	1505	714	791	0	2014	47.4%	52.6%	0.0%
NARMADA	720	545	143	32	2011	75.7%	19.9%	4.4%
GANDHINAGAR	496	405	91	0	2014	81.7%	18.3%	0.0%
NARMADA	720	597	108	15	2013	82.9%	15.0%	2.1%
BANAS KANTHA	1730	1483	148	99	2012	85.7%	8.6%	5.7%
DANG	326	280	46	0	2011	85.9%	14.1%	0.0%
NARMADA	720	619	96	5	2012	86.0%	13.3%	0.7%
NAVSARI	2035	1758	264	13	2011	86.4%	13.0%	0.6%
BHARUCH	886	775	105	6	2014	87.5%	11.9%	0.7%
DANG	326	290	36	0	2012	89.0%	11.0%	0.0%

2011 to 2014. In 2014 the District of Tapi has the minimum %FC with 47.4%. There are no quality problems recorded in this district. The second lowest coverage was reported in 2011 and then in 2014 the third lowest coverage of 81.7% in Gandhinagar district. The fact the lowest coverage for the past four years is from the current financial year indicates failure of water supply systems.

More details on Tapi are shown in the next table. Data shows the drop on coverage from 99.6% to 47.4%, which is a major slipback of 52.2% within one year. Coverage from 2011 to 2013 showed incremental progress from 93% to 99.6% indicating no previous problem on coverage at this district. The total number of habitations decrease by 158 and still there are 785 new partially covered habitations. This major change indicates further analysis for this district coverage status.

District	Total No of Habitation	FC No of Habitation	PC No of Habitation	QA No of Habitation	Financial Year	%FC	%PC	%QA
TAPI	1663	1546	97	20	2011	93.0%	5.8%	1.2%
TAPI	1663	1641	22	0	2012	98.7%	1.3%	0.0%
TAPI	1663	1657	6	0	2013	99.6%	0.4%	0.0%
TAPI	1505	714	791	0	2014	47.4%	52.6%	0.0%

Gandhinagar is the third lowest coverage district in the past four years, reaching 81.7% in 2014. This district was 100% covered in 2011 and 2012 and slipback started in 2013 with 1.7% and 16.6% in 2014. The total number of habitation increase in 2014 and the number of FC habitations remained the same. This indicates that the drop of coverage is due to creation of habitations. Further analysis on population of these habitations can indicate if it due to population increase or relocation of people where there is no infrastructure for water supply. There are no quality problems in this district.

District	Total No of Habitation	FC No of Habitation	PC No of Habitation	QA No of Habitation	Financial Year	%FC	%PC	%QA
GANDHINAGAR	412	412	0	0	2011	100.0%	0.0%	0.0%
GANDHINAGAR	412	412	0	0	2012	100.0%	0.0%	0.0%
GANDHINAGAR	412	405	7	0	2013	98.3%	1.7%	0.0%
GANDHINAGAR	496	405	91	0	2014	81.7%	18.3%	0.0%

Narmada shows continuous progress on quantity coverage from 2011 and 2014. No slipback on this quantity is shown but there are problem with quality-affected habitations, which is discussed in the next section.

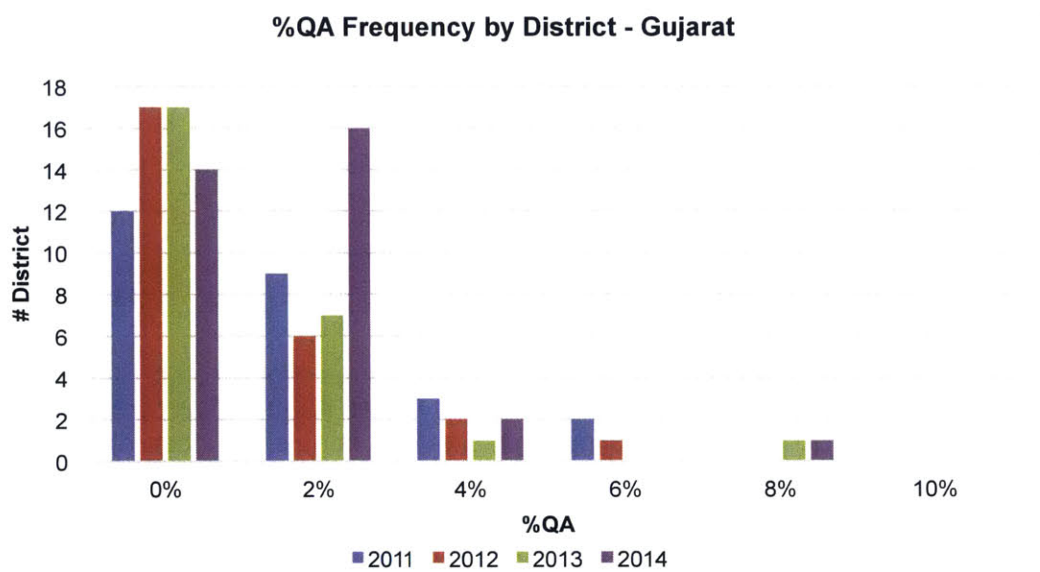
Baruch is a district that did not have any coverage problems until 2014, indicating slipback. Looking at historical data, in 2013 Bharuch was 99.5% covered but in 2014 it shows 11.9% of partially coverage and 0.2% more quality affected for an overall slipback of 12.1% in 2014.

District	Total No of Habitation	FC No of Habitation	PC No of Habitation	QA No of Habitation	Financial Year	%FC	%PC	%QA
BHARUCH	787	739	19	29	2011	93.9%	2.4%	3.7%
BHARUCH	787	768	19	0	2012	97.6%	2.4%	0.0%
BHARUCH	787	783	0	4	2013	99.5%	0.0%	0.5%
BHARUCH	886	775	105	6	2014	87.5%	11.9%	0.7%

Quality Affected

Based on the overall status graphic, quality affected habitations is not as relevant as the quantity problem in Gujarat. However, further detailed analysis would help understand which districts are most affected and help determine further review and actions.

For QA status there is also progress between 2011 and 2013, with a drop of performance in 2014. The number of districts with no QA status decreased from 17 in 2013 to 14 in 2014. Also, there are one more districts with 2% QA habitations than previous years. Percentages remain low across the years but there is a decrease on performance that indicates failures of water supply systems.



The graphic above helps compare the percentage of QA habitations per district since 2011 to 2014. The purple bar indicates the performance for 2014 and how there are more districts with 2 % QA habitations compared to previous 3 years.

There is one district value for 8% QA range and increase of 4% QA range. Further details should be found on these districts.

Bin	Frequency			
%QA	2011	2012	2013	2014
0	12	17	17	14
2%	9	6	7	16
4%	3	2	1	2
6%	2	1	0	0
8%	0	0	1	1
10%	0	0	0	0
More	0	0	0	0
	26	26	26	33

Based on the most quality-affected districts in from 2011 to 2014 there are repetitive districts.

Banas Khanta and Anand show the highest quality problems with 8% in 2013 and 7.5% in 2014. Banas Kantha also shows high ranked in 2012 and 2011, confirming continuous quality problems in this district. However in 2014, Banas Khanta does not rank on top 10 indicating that it has less than 2.4% of habitations affected by quality problems.

In 2014 the highest quality problems show in Dang and Narmada with 2 and 3% respectively. Narmada shows on the list in 2011 with 4.4% QA habitations and then shows up again in 2014 with 2.4%. This indicates the quality improved for 2012 and 2013 and declined again in 2014.

On the other hand, Anand shows worse quality problems going from 3% in 2011 to 8% in 2014.

	District	Total No of Habitation	FC No of Habitation	PC No of Habitation	QA No of Habitation	Financial Year	%FC	%PC	%QA
1	BANAS KANTHA	1730	1586	6	138	2013	91.7%	0.3%	8.0%
2	ANAND	946	859	16	71	2014	90.8%	1.7%	7.5%
3	BANAS KANTHA	1730	1483	148	99	2012	85.7%	8.6%	5.7%
4	BANAS KANTHA	1730	1594	50	86	2011	92.1%	2.9%	5.0%
5	NARMADA	720	545	143	32	2011	75.7%	19.9%	4.4%
6	BHARUCH	787	739	19	29	2011	93.9%	2.4%	3.7%
7	ANAND	909	871	8	30	2011	95.8%	0.9%	3.3%
8	VADODARA	2149	2089	4	56	2011	97.2%	0.2%	2.6%
9	DANG	318	299	11	8	2014	94.0%	3.5%	2.5%
10	NARMADA	717	693	7	17	2014	96.7%	1.0%	2.4%

The two highest percentages of water quality problems are registered in 2013 and 2014, indicating a slipback for the districts of Anand and Banas Kantha. Narmada and Dang show as new districts in 2014.The following tables look in detail at these districts.

District	Total No of Habitation	FC No of Habitation	PC No of Habitation	QA No of Habitation	Financial Year	%FC	%PC	%QA
BANAS KANTHA	1730	1594	50	86	2011	92.1%	2.9%	5.0%
BANAS KANTHA	1730	1483	148	99	2012	85.7%	8.6%	5.7%
BANAS KANTHA	1730	1586	6	138	2013	91.7%	0.3%	8.0%
BANAS KANTHA	1727	1696	11	20	2014	98.2%	0.6%	1.2%

District	Total No of Habitation	FC No of Habitation	PC No of Habitation	QA No of Habitation	Financial Year	%FC	%PC	%QA
ANAND	909	871	8	30	2011	95.8%	0.9%	3.3%
ANAND	909	879	18	12	2012	96.7%	2.0%	1.3%
ANAND	909	896	3	10	2013	98.6%	0.3%	1.1%
ANAND	946	859	16	71	2014	90.8%	1.7%	7.5%

District	Total No of Habitation	FC No of Habitation	PC No of Habitation	QA No of Habitation	Financial Year	%FC	%PC	%QA
NARMADA	720	545	143	32	2011	75.7%	19.9%	4.4%
NARMADA	720	619	96	5	2012	86.0%	13.3%	0.7%
NARMADA	720	597	108	15	2013	82.9%	15.0%	2.1%
NARMADA	717	693	7	17	2014	96.7%	1.0%	2.4%

District	Total No of Habitation	FC No of Habitation	PC No of Habitation	QA No of Habitation	Financial Year	%FC	%PC	%QA
DANG	326	280	46	0	2011	85.9%	14.1%	0.0%
DANG	326	290	36	0	2012	89.0%	11.0%	0.0%
DANG	326	310	16	0	2013	95.1%	4.9%	0.0%
DANG	318	299	11	8	2014	94.0%	3.5%	2.5%

Looking at historical data for these districts affected by quality issues, the next findings are noted: the highest slipback is in Anand at 6.4% for QA and 1.4% for coverage in 2014. For Narmada there is a slipback of 0.3% and for Dang 2.5%. slipback of 2.3% is found in 2013 for Banas Kantha with great improvement, reaching 1.2% QA habitations in 2014.

Interestingly the districts of Valsad, Baruch, Vadodara, and Surat that were mentioned in the background research for Gujarat, as highly polluted districts, are not showing water quality affected habitations which again raises questions about reliability of water quality data.

Summary of Slipback:

- 1,212 habitations of 3.5% reported slipback in 2014.
- 133 new habitations reported in national survey data.
- 1164 or 3.4% habitations reported PC slipback and 48 or 0.1% habitations reported QA slipback.
- Largest slipback from 2011 until 2014 is found between 2013 and 2014.

The slipback between 2013 and 2014 is summarized for the top 10 districts as follows:

District	%PC Slipback	%QA Slipback	%Total Slipback
TAPI	52.2%	0.0%	52.2%
GANDHINAGAR	16.6%	0.0%	16.6%
BHARUCH	11.9%	0.2%	12.1%
ANAND	1.4%	7.4%	8.8%
DANG	0.0%	2.5%	2.5%
NARMADA	0.0%	0.3%	0.3%
BANASKANTHA	0.3%	0.0%	0.3%
NAVSARI	2.2%	0.0%	2.2%
BHAVNAGAR	6.9%	0.0%	6.9%
SURAT	4.3%	0.0%	4.3%
PORBANDAR	3.8%	0.0%	3.8%

The next step is to identify the FIETS factors that help explain these patterns.

Financial Factors

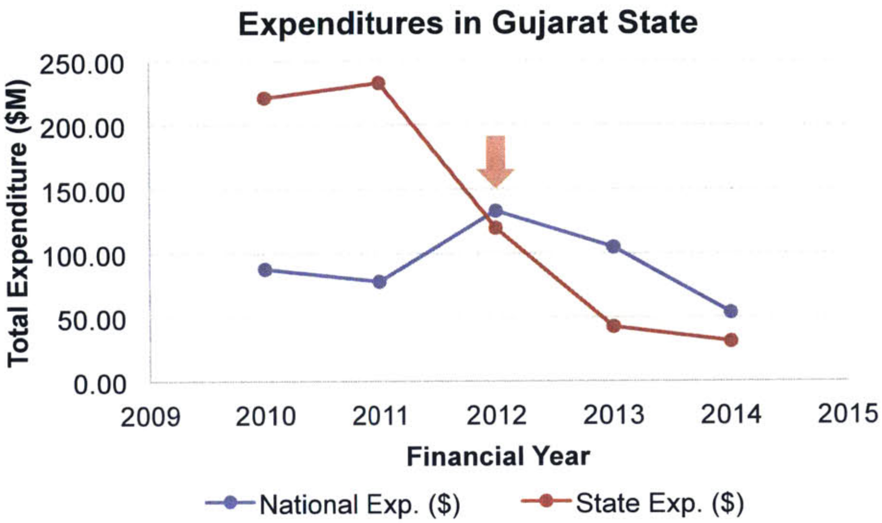
It is important to understand the overall expenditures in Gujarat for the past 5 years. The tables below are based on IMIS data until Feb 2015, with amounts in lakhs of Indian Rupees (1 lakh = 100,000). The total spent is 662,582 lakhs in the past 5 years. For general understanding these numbers are also shown in US dollars, using currency exchange of 60 rupees per dollar.

Fin. Year	National Exp. (lakhs)	State Exp.(Lakhs)	Total (lakhs)	% of Total
2010	52729.33	132703.8	185433.13	28%
2011	46,770	139,715	186484.65	28%
2012	79,791	71,727	151517.42	23%
2013	62,795	25680.85	88476.07	13%
2014	32,185	18756.23	50940.76	8%
Grand Total	274269.75	388582.28	662852.03	

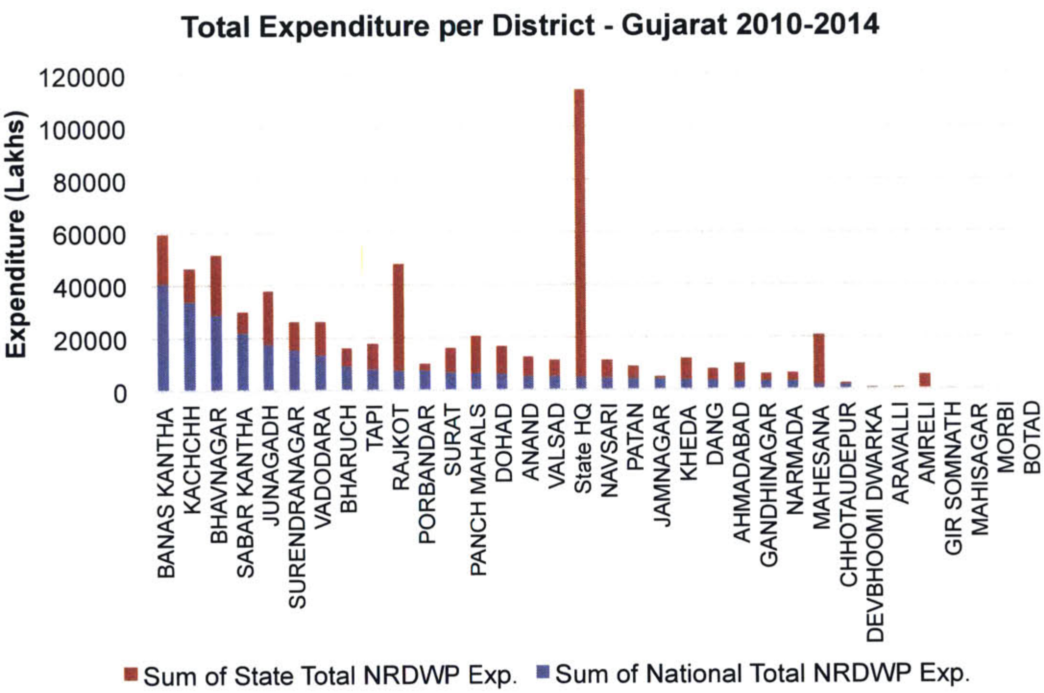
Fin. Year	National Exp. ($)	State Exp. ($)	Total ($)
2010	87.88	221.17	309.06
2011	77.95	232.86	310.81
2012	132.98	119.54	252.53
2013	104.66	42.80	147.46
2014	53.64	31.26	84.90
Grand Total	457.12	647.64	1104.75

The total expenditure from 2010 until Feb 2015 is $1.1M USD. The amounts have greatly decreased by 73% from $310M to $85M. The annual average of expenditure is $200M between 2010 to 2014 financial years. If we divide this average per 26 districts would be $7.7M USD per year per district. It will be interesting to see the progress made in water supply projects in the past 2 years as expenses were greatly reduced.

Also, as shown in the following graph, from 2012 the national contribution became larger than the state, which would be an indication of a relevant change of regulations or focus of projects. Since the state has 100% covered habitations, the expenses are expected to remain constant for maintenance and emergencies expenses. This data will be interesting to analyze expenditure versus water coverage progress.



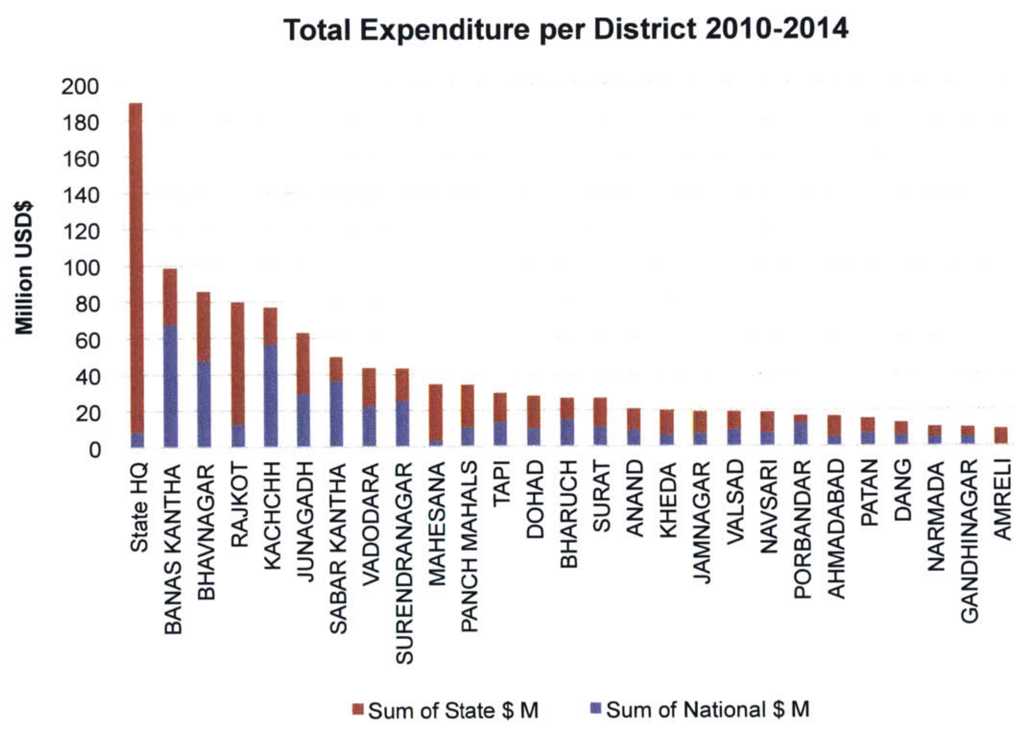
After looking at the overall state expenditure, the following graphic shows the total expenditures from 2010 to 2014 per district differentiating National and State funding.



Districts are ranked based on National Expenditure. The top 3 districts are the focus for national expenditure using 38% of total costs. Banas Kantha district has the highest expenditure of $67.5M USD national and $31.2M USD state funding. Based on coverage evaluation Banas Kantha was found to be the most quality affected district in the state. The second district is Kachchh, which is the driest district in Gujarat and it is expected to see it in the top for national funding allocations. Kachchh only showed problems of quantity in 2011 and biological pollution in 2010 and 2012. Bhavnagar has the third highest expenditure and it was not found to have coverage problems from 2011 to 2014.

The State Head Quarters gets the highest ratio of state funding with 14% of total state expenditures; this entity has no real performance to track. The second largest allocation for state funds is Rajkot with 12% followed by Bhavnagar with 7% and Junagadh with 6%. These districts are not identify as having coverage problems and further analysis may show why these are focus for state allocations.

For general reference the following graphic shows the total expenditures per district in Million USD.

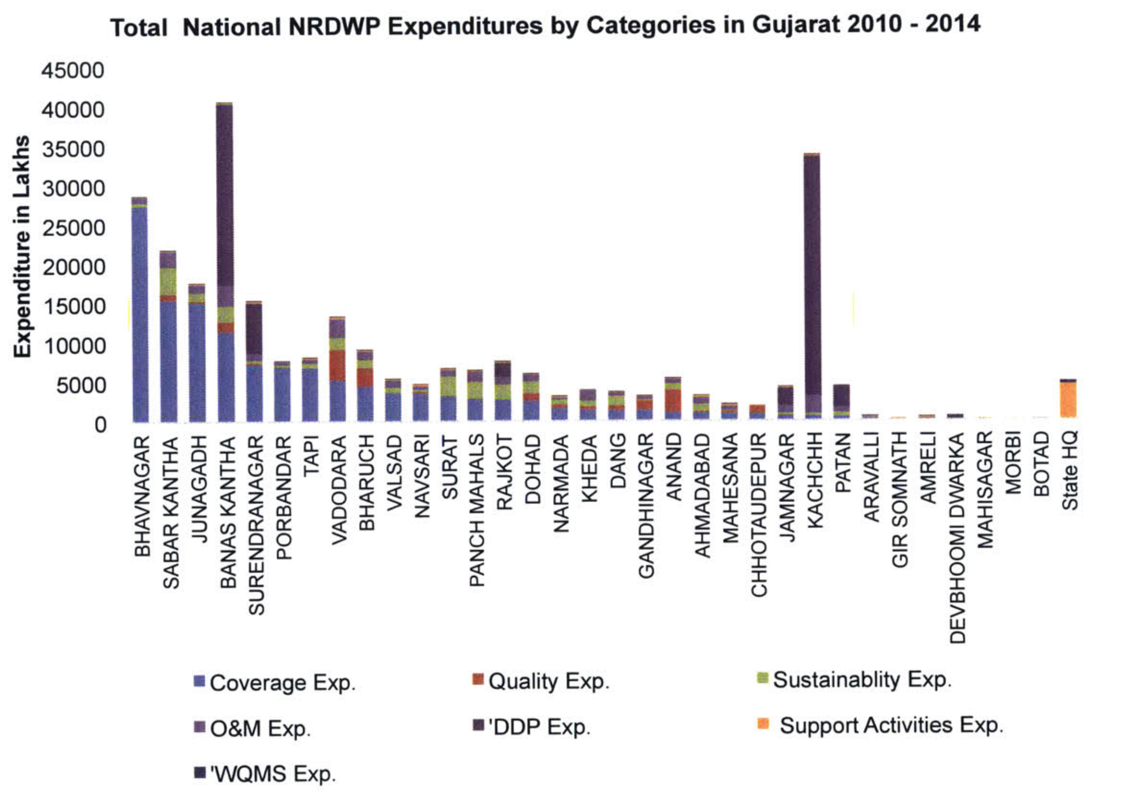


Looking at the districts with least expenditures Amreli has only state funding. Gandhinagar, Narmada, and Dang are the lowest investment districts and they also have high rankings on quantity and quality affected habitations.

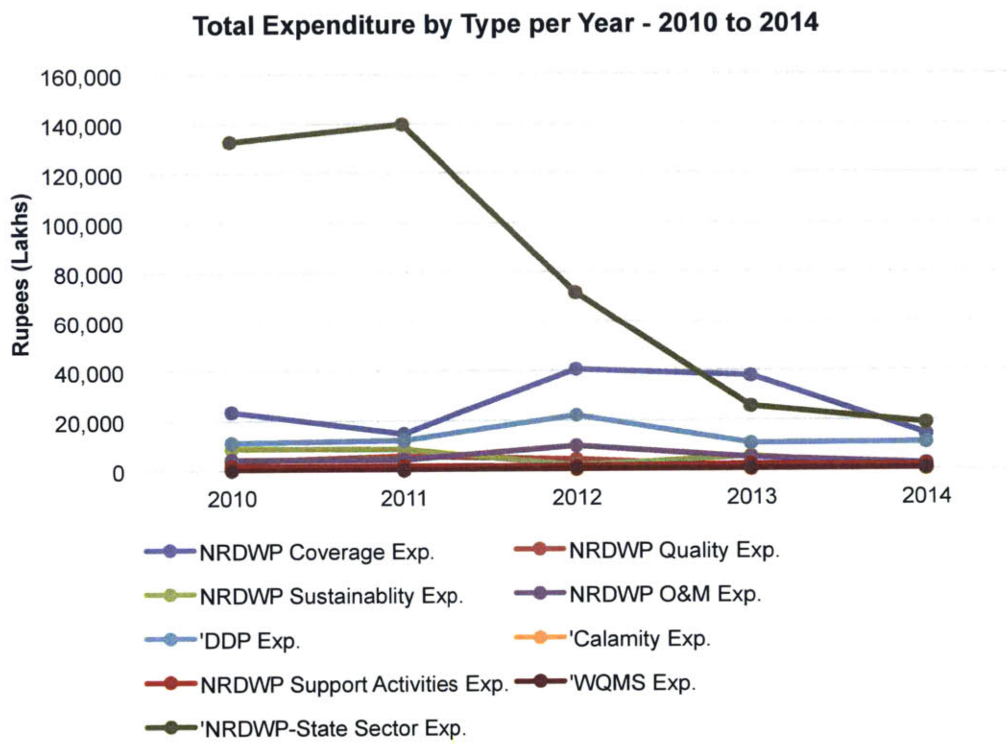
Expenditure by Allocation
This analysis is only available for central funds in the IMIS since there is no visibility for these types of expenditures at district level for each state. This analysis indicates if funds are being allocated adequately in each of the strategies, and which one has required most funding.

By comparing the type of expenditure by district with the key problems per district it helps estimate how effective funds have been allocated. If a state has a high percent of expenditure and issues remain over time, then actions taken are not being as effective as expected and require additional evaluation.

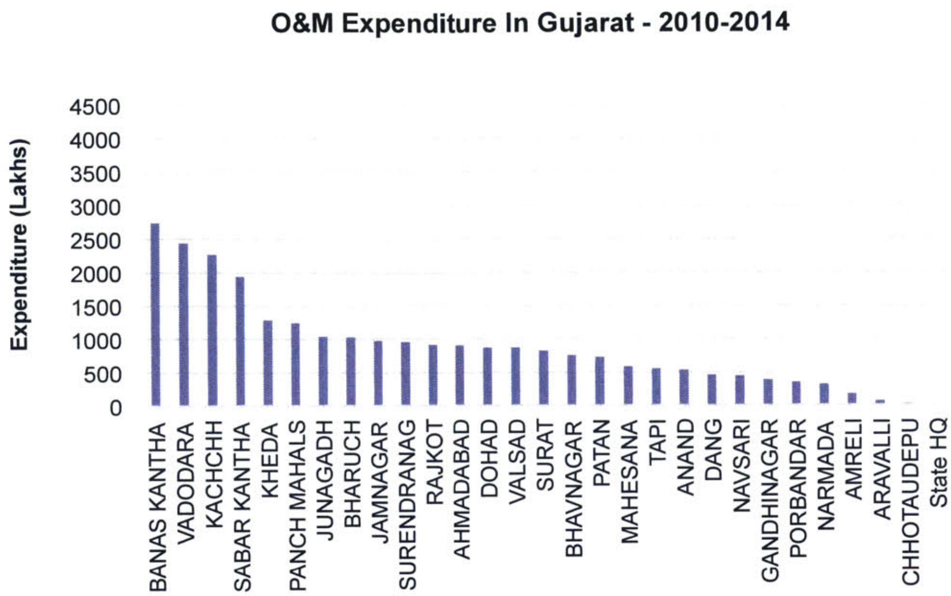
The next graphic is in descending order for coverage expenditure; this type of allocation should indicate investment on of FC habitations. The second largest funding comes from DDP or desertification affected areas. More than half of the national funding for Banas Kantha comes from this type of allocation. Kachchh district has 90% of national funds allocated from DDP funds. Surendranagar is the third district with high DDP representing 42% of its national funds.
From the graphic other funding allocations from national government are small compared with Coverage and DDP. The Support Activities expenditure only shows at the State HQ, which indicates that these activities are centralized in the state office.



In the next graph, looking at the type of expenditure over years, allows understanding if there are specific funds that have shifted over time. Based on the lines graphic, the change is driven by state allocation, which has no details on type of expenditure. From the national level the Coverage funding is declining, which could be possible considering that 100% of villages in Gujarat are covered.
It will be interesting to observe if the reduction of state fund will be able to sustain the existing infrastructure.



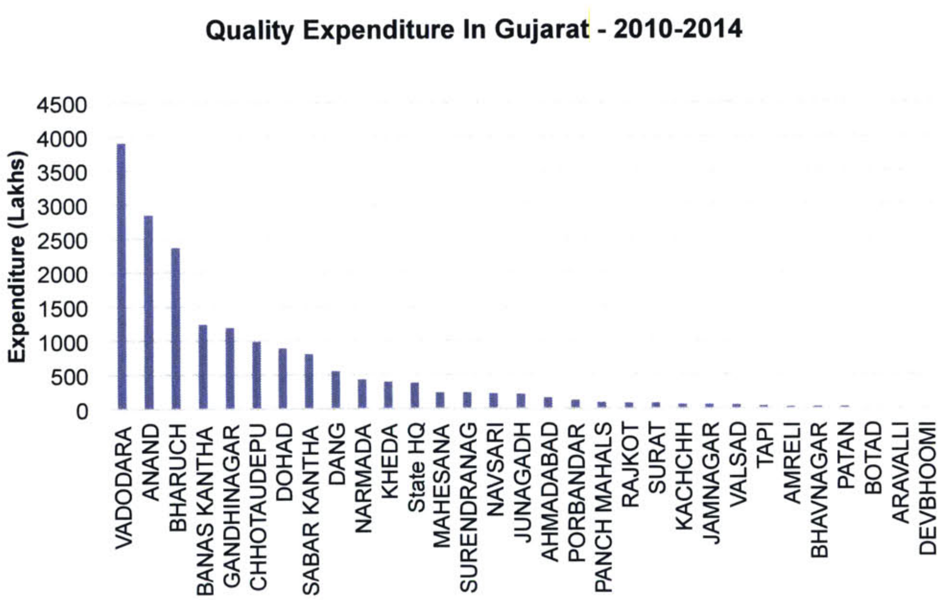
Since we are looking at identifying reasons for slipback or failure of water supply to communities, the following graphics show the O&M, Quality, Sustainability, and Support Activities funds that are related to other FIETS factors.



The cumulative O&M costs from 2010 to 2014 shows as top 5 districts:

- Banas Kantha
- Vadodara
- Kachchh
- Sabar Khanta
- Kheda

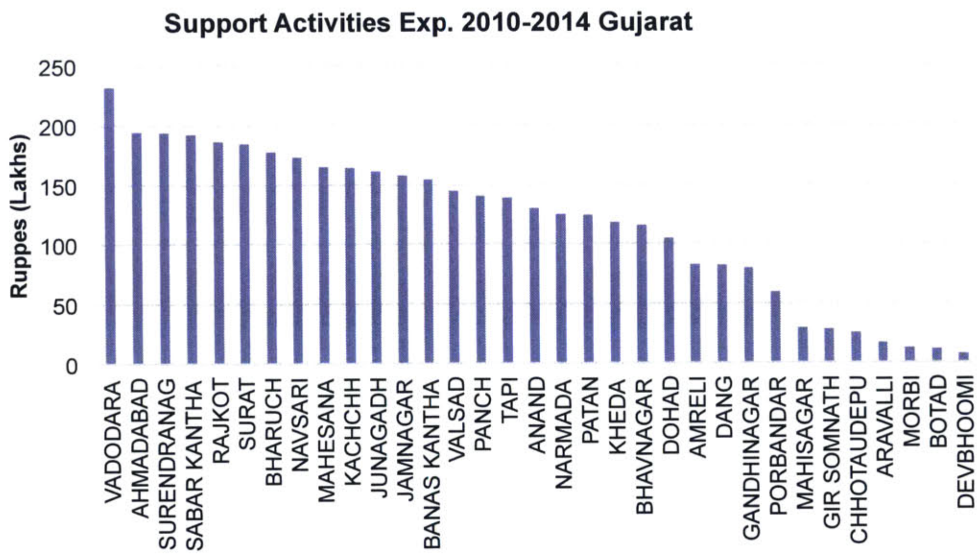
These districts range from 2800 to 1300 lakhs rupees.
The O&M should be associated with more failures, such as non-functional schemes.



For quality we combined the quality affected and the costs of laboratory and testing materials. Top 5 districts are:

- Vadodara
- Anand
- Bharuch
- Banas Kantha
- Gandhinagar

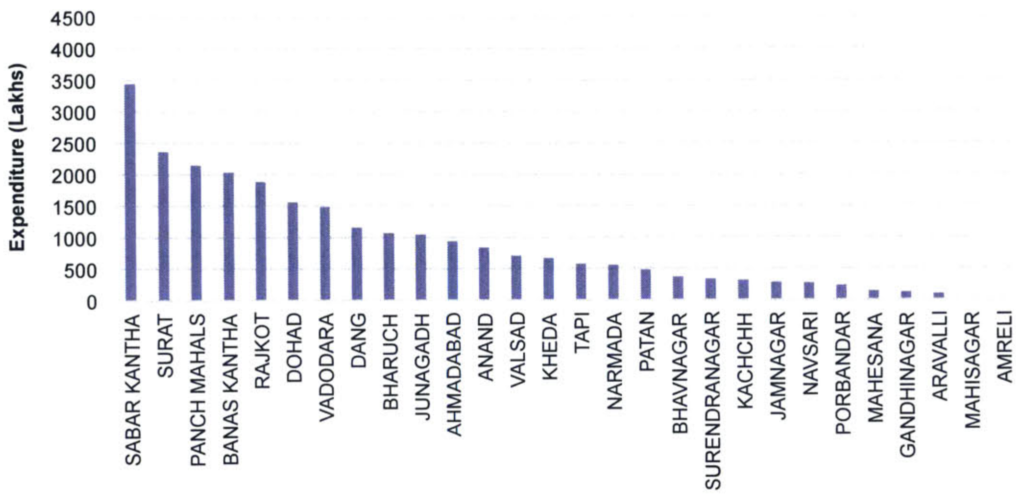
These range from 3900 to 1200 lakhs rupees from 2010 to 2014. These districts should be expected to have high QA habitations and pollution problems.



These support activities help communities with training, workshops, and materials building skills and organization to solve water and sanitation issues. Data shows funds are allocated mostly to State HQ with a total of 4500 lakhs rupees between 2010 and 2014. Districts with most funding are expected to have more training and community activities from the Institutional analysis. The last seven districts are the newly created, which explains their low funding.

- Vadodara
- Ahmadabad
- Surendranagar
- Rajkot
- Surat

Sustainability Expenditure In Gujarat - 2010-2014



Sustainability structure shows as top 5 districts:

- Sabar Kantha
- Surat
- Panch Mahals
- Banas Kantha
- Rajkot

These range from 3,500 to 2,000 lakhs rupees. These districts should have quality and quantity problems during that time frame that required additional infrastructure, especially at source level.

Institutional Factors

The IMIS has relevant data to indicate the institutional structure and participation within a village from 2010 and 2014. The data details in IMIS go as low as district level; hence there are no details at village or habitation level.

A few important institutions concepts need to be defined:

- GPs or Gran Panchayats are the local governments at village or group of villages (Block).
- VWSC or Village Water and Sanitation Committee is selected by the community and formalized within the village(s) with a Gram Sabah
- Gram Sabah is a community meeting led by the GPs to get community's approval and vote for issues that impact their village.

The seven districts established in 2013 are included in cases where data is available.

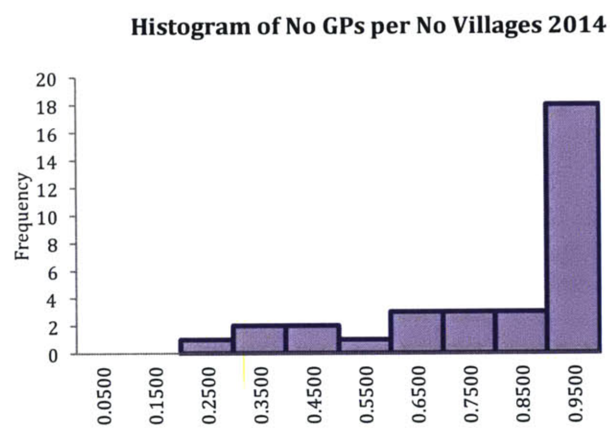
Based on NRDWP guidelines, schemes within village limits should be approved by the community's and participation. If the community will provide operation and maintenance of the system, then it requires their participation and approval to ensure the scheme is locally sustained.

In the institutional analysis from IMIS data it is expected to find the following:

- An increase of VWSC formed from 2010 to 2014 that shows improved focused on sustainability based on community participation.
- At least one (1) training per VWSC formed as adequate support and skills needed for water systems management.
- At least one Gram Sabah per VWSC formed to ensure community approves their responsibilities as managers of water and sanitation systems.
- Find low training, Gram Sabahs, and VWSC formed in district with high water supply problems.
- A positive correlation between numbers of schemes handed over to the community and the number of trainings provided to the VWSC as well as Gram Sabahs.

Number of Gram Panchayat per Village

Number of GP per Villages that gives us an estimate of how many local governments exists per village. Values closer to 1 indicate a local government for a single village that has a stronger institutional structure. For values closer to zero there are more villages per GP that adds complexity in the decision-making process hence a weaker institutional structure.



The data for GP per village remain the same from 2010 until 2014, so only data from 2014 is shown in this histogram.

The histogram shows that in 28 or 93% of districts GPs have 1 or 2 villages under their governance, which indicates a strong local governance presence in Gujarat. The remaining 7% represents 5 districts with 2-5 villages per Gram Panchayat.

A list of 10 districts with the lowest ratio of GP per villages is shown in the following table. The lower the ratio the higher number of villages under the GP authority.

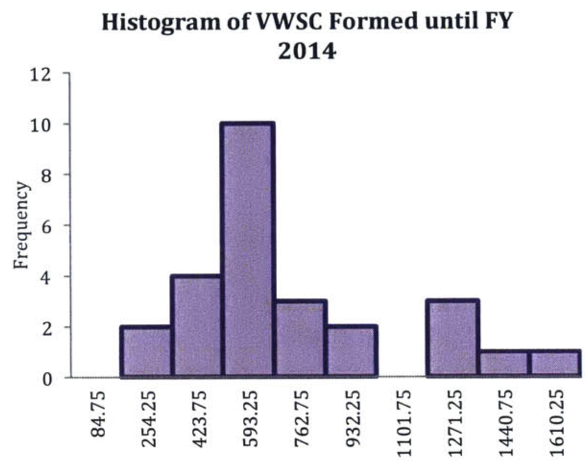
District	GPs per Villages	Villages per GP
DANG	0.224	4.46
CHHOTAUDEPUR	0.372	2.69
NARMADA	0.397	2.52
MAHISAGAR	0.414	2.41
ARAVALLI	0.439	2.28
SABAR KANTHA	0.594	1.68
TAPI	0.615	1.63
BANAS KANTHA	0.625	1.60
DOHAD	0.650	1.54
PANCH MAHALS	0.708	1.41

Dang has the lowest ratio with 4-5

villages per GP.
Chhotaudepur, Narmada, Mahisagar, and Aravali range between 2-3 villages per GP. The remaining on the list has between 1.4-2 villages per GP. There are 6 districts with 1 GP per village and these are: Junagadh, Jamnagar, Devbhoomi Dwarka, Botad, Bhavnagar, and Rajkot.

Number of Village Water and Sanitation Committees (VWSC) per Village

The number of VWSC per district represents institutional presence at the village level. Taking the 26 districts established until 2013, there are 20 districts with more than 500-formed VWSC. Details are shown in the following histogram.



There are a total of 19,024 VWSC established as of 2014 and there are a total of 18,091 villages. This indicates that there are more than one VWSC per village.

Summary	No VWSC per Total Villages
Mean	1.31
Variance	0.28
Std. Dev.	0.53
Mode	1
Minimum	0.91
Maximum	3.23
Range	2.33
Count	26
Sum	34.26
1st Quartile	1.0
3rd Quartile	1.55
Interquartile Range	0.55

The next table shows the number of VWSC per total number of villages per district.

Looking at descriptive statistic data the average is 1.31 VWSC per village, which is a good indicator of strong formation of VWSCs in the state.

The minimum shows that there is at least 1 VWSC per village indicating strong institutional presence in districts with lower number of VWSC. There is a maximum of 3.24 indicating more than 3 VWSC per village For villages with more than 1 VWSC requires further study to understand why these districts have more than one VWSC than total of villages.

The ranking of 10 districts with most numbers of VWSCs show that it may bring more complexity to the problems, and it was an unexpected finding during this analysis.

The first district is Gandhinagar with 3.23 VWSC per village and this has remained the same since 2012. Porbandar, Anand, and Navsari have 2 VWSC per village. And the other districts range between 1 and 2 VWSC per village. Looking at changes in the past 4 years, Valsad changed from 0.82 to 1.64 in 2014. The last change was seen in Tapi from 1.03 to 1.52. It will be interesting to compare if there were changes in reported problem with changes in the number of VWSC per districts.

District	VWSC Formed per No villages			
	2011	2012	2013	2014
GANDHINAGAR	1.61	3.23	3.23	3.23
PORBANDAR	2.03	2.03	2.03	2.03
ANAND	2.02	2.02	2.02	2.02
NAVSARI	1.81	2.00	2.00	2.00
VALSAD	0.82	0.82	0.82	1.64
DANG	1.59	1.59	1.59	1.59
PATAN	1.46	1.46	1.46	1.55
TAPI	1.03	1.03	1.03	1.52
AHMADABAD	1.24	1.24	1.24	1.24
NARMADA	1.22	1.22	1.22	1.22

Training per VWSC

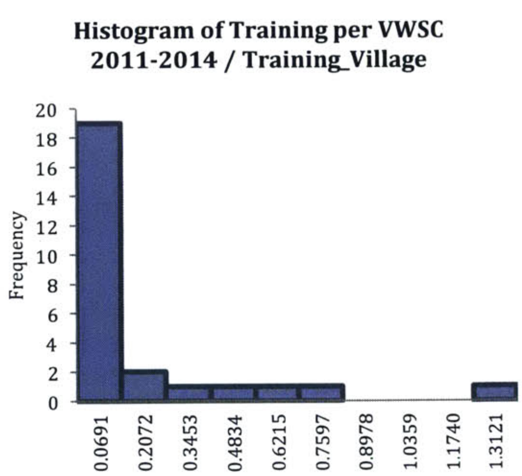
First look at the statistical data we see that averages are closer to zero, indicating poor training of VWSCs. It is expected to see values closer to one (1) that indicates one (1) training session per VWSC. This data shows uniquely low indicating poor data entry or actual poor training for VWSC.

The maximum number shows in 2013 with 0.98 indicating district(s) with one training session per VWSC formed.

Next analysis will look at the histogram of cumulative training from 2011 to 2014, expecting an ideal four (4), representing one (1) training session per VWSC across all districts for all four years. There is only one (1) district that has had training session for all VWSC in the past four (4) years.

Since the training data has so many low districts, a list for all is included below for reference and further analysis.

This low numbers for training indicate an important gap between the community engagement goal and the data shown in IMIS. An important change on state strategy would be to increase training projects and ensure district offices maintain data entry updated for this important indicator. If data is not correct, then it indicates an important gap between field and IMIS data that would require state attention.



No Training per VWSC	2011	2012	2013	2014
Mean	0.00	0.03	0.068	0.078
Variance	0.00	0.016	0.0386	0.026
Median	0.00	0.00	0.00	0.011
Mean Abs. Dev.	0.00	0.053	0.097	0.098
Mode	0.00	0.00	0.00	0.00
Minimum	0.00	0.00	0.00	0.00
Maximum	0.00	0.651	0.99	0.71
Range	0.00	0.651	0.99	0.71
Count	26	26	26	26
1st Quartile	0.00	0.00	0.00	0.00
3rd Quartile	0.00	0.00	0.06	0.074
Interquartile Range	0.00	0.00	0.06	0.074

District	Training per VWSC 2011-2014	2011	2012	2013	2014
NAVSARI	1.38	0.00	0.00	0.99	0.39
AHMADABAD	0.80	0.00	0.00	0.09	0.71
GANDHINAGAR	0.68	0.00	0.65	0.00	0.03
DANG	0.49	0.00	0.00	0.17	0.32
KACHCHH	0.29	0.00	0.00	0.19	0.09
TAPI	0.26	0.00	0.00	0.15	0.12
BHARUCH	0.23	0.00	0.08	0.03	0.12
PATAN	0.10	0.00	0.00	0.07	0.02
SURENDRANAGAR	0.07	0.00	0.00	0.00	0.07
PORBANDAR	0.07	0.00	0.00	0.06	0.01
RAJKOT	0.06	0.00	0.00	0.00	0.06
BANAS KANTHA	0.05	0.00	0.05	0.00	0.00
VADODARA	0.04	0.00	0.00	0.00	0.04
VALSAD	0.02	0.00	0.00	0.00	0.01
ANAND	0.02	0.00	0.00	0.01	0.01
SABAR KANTHA	0.02	0.00	0.00	0.00	0.02
BHAVNAGAR	0.01	0.00	0.00	0.01	0.00
NARMADA	0.00	0.00	0.00	0.00	0.00
KHEDA	0.00	0.00	0.00	0.00	0.00
AMRELI	0.00	0.00	0.00	0.00	0.00
DOHAD	0.00	0.00	0.00	0.00	0.00
JAMNAGAR	0.00	0.00	0.00	0.00	0.00
JUNAGADH	0.00	0.00	0.00	0.00	0.00
MAHESANA	0.00	0.00	0.00	0.00	0.00
PANCH MAHALS	0.00	0.00	0.00	0.00	0.00
SURAT	0.00	0.00	0.00	0.00	0.00

Gram Sabah meetings per WSC

This analysis looks at the number of community meetings or Gram Sabah per VWSC. It is expected to see at least one Gram Sabah per VWSC, as they should be established after a Gram Sabah.

Higher ratios of Gram Sabah per VWSC would indicate projects coordinated by VWSC with involvement of the community. Villages with high projects per year should also have high activity from VWSC. This data can be compared with number of schemes built per district per year.

The next table shows cumulative Gram Sabah meetings from 2011 and 2014 as well as for each year data. These are sorted by descendent order of cumulative meetings.

Based on this, Tapi has the highest community participation in meetings, reaching 0.85 per village in 2012 and 0.5 in 2014. The second highest is Porbandar with a cumulative 1 and close to 0.5 in 2011 and 2012.

It is expected to see more projects in Tapi and other high-ranking districts since these meeting indicate approval of projects implementation.

District	Gram Sabah per VWSC 2011-2014	2011	2012	2013	2014
TAPI	1.556	0.223	0.852	0	0.481
PORBANDAR	1.073	0.44	0.46	0	0.173
GANDHINAGAR	1.027	0.38	0.478	0	0.17
SURAT	0.968	0.17	0.09	0	0.71
VALSAD	0.829	0.15	0.525	0	0.15
RAJKOT	0.775	0.13	0.236	0	0.41
AHMADABAD	0.687	0.2	0.231	0	0.26
ANAND	0.645	0.27	0.377	0	0
PATAN	0.614	0.2	0.189	0	0.22
DANG	0.496	0	0.386	0	0.11
VADODARA	0.493	0.11	0.177	0	0.20
MAHESANA	0.487	0.22	0.188	0	0.08
AMRELI	0.439	0.18	0.26	0	0
KHEDA	0.406	0.19	0.22	0	0
NAVSARI	0.391	0.31	0.078	0	0
PANCH MAHALS	0.390	0.06	0.045	0.206	0.08
SURENDRANAGAR	0.349	0.18	0.167	0	0
BHARUCH	0.342	0	0.19	0	0.15
NARMADA	0.312	0	0.312	0	0
BANAS KANTHA	0.303	0	0.183	0	0.12
KACHCHH	0.237	0	0.091	0	0.15
BHAVNAGAR	0.232	0	0.109	0	0.12
JUNAGADH	0.221	0.15	0.075	0	0
JAMNAGAR	0.220	0.17	0.049	0	0
DOHAD	0.218	0	0.218	0	0
SABAR KANTHA	0.214	0.096	0.118	0	0

Similarly to training, this data indicates great need to improve community participation as well as following closely on data entry for this data set.
The least active districts are Sabar Kantha, Dohad, Jamnagar, Junagadh, and Bhavnagar.

Schemes handed over to GP

This data set combines few formats from IMIS to look at how many schemes are handed over the community compared with the total built per financial year from 2009 to 2014.

Current data displayed in IMIS shows the percent of schemes handed over versus those included in that target for that year, however this is not a good representation of work done in the field. There are more schemes built than the target, and it is important to account the GP participation from the total projects instead of only the target.

Also, as mentioned before the institution that has ownership of water and sanitation issues is the VWSC but there are no records of schemes handed over to VWSC only to GP. This transfer of schemes to GP instead of VWSC can lead to confusion of institutional ownership.

The variables to analyze are:

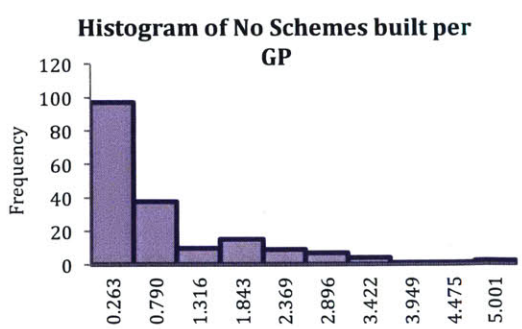
- Percentage of schemes handed over to GP versus total built per district per year measures ownership transferred to local governance.
- Number of schemes built by GP per district per year indicates if there are too many projects that could be overwhelming for the GP management.

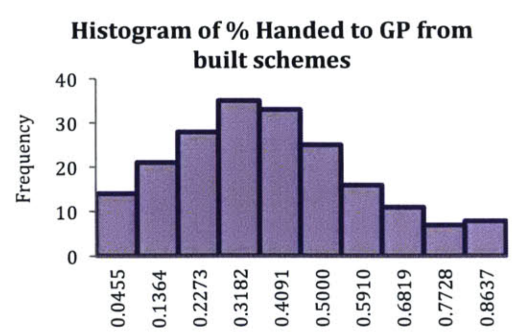
Data about number of GP for the 7 new districts is not available for 2009 to 2010, hence the difference of counts by 14 records. On the other hand, records of schemes handed over to the GP for all 7 new districts from 2009 to 2014 are available.

Summary	% Schemes Handed to GP	No of Schemes per GP
Mean	0.3855	0.911
Variance	0.0424	1.058
Std. Dev.	0.2058	1.029
Median	0.3650	0.478
Mean Abs. Dev.	0.1659	0.770
Mode	0.2220	0.523
Minimum	0.0033	0.048
Maximum	0.9092	5.265
Range	0.9058	5.216
1st Quartile	0.2182	0.197
3rd Quartile	0.5155	1.124
Interquartile Range	0.2973	0.927

Looking at descriptive statistics, the average shows that 40% of built schemes are handed over to GP and there is almost 1 scheme built per GP per district per year. This indicates good activity per Gram Panchayat. However, it also indicates that there are several schemes built per village, which should not be the case after a village has built two (2) water supply schemes.

The maximum and minimum show that there are districts where 90% of schemes built are handed over to the community, which increases their social sustainability. The minimum is zero percent of schemes handed over to GP, which will require further analysis of how many schemes were built. The maximum number of schemes per GP is 5 per year, which would be difficult to manage for the GP and may jeopardize the management of the projects. The minimum is 0.05, which indicates a very low number of schemes built per GP in those district(s).





Per the histograms, 60% of the time districts give ownership to the GP of 45% or less of built schemes. Only 16 of 198 times districts handed over 70-90% of built schemes. This percentage should increase as part of the community focus programs on water systems in Gujarat and India.

For the number of schemes built per GP, 100 times there was less than 1 scheme per GP every two years. This indicates a possibility to promote more transfers of schemes to GP or VWSC, since there are more VWSC than GP (19,039 VWSC and 13,888 GPs in 2014). The main point from this variable is that GPs rely on more than one scheme, which on the one hand can guard against overall slipback, but on the other hand can mask slipback of individual schemes (if new schemes are making up for failures in existing ones).

Environmental Factors

Pollution of sources is the environmental factor that is available in IMIS, has direct impact on functionality of schemes, and potentially affects habitations.

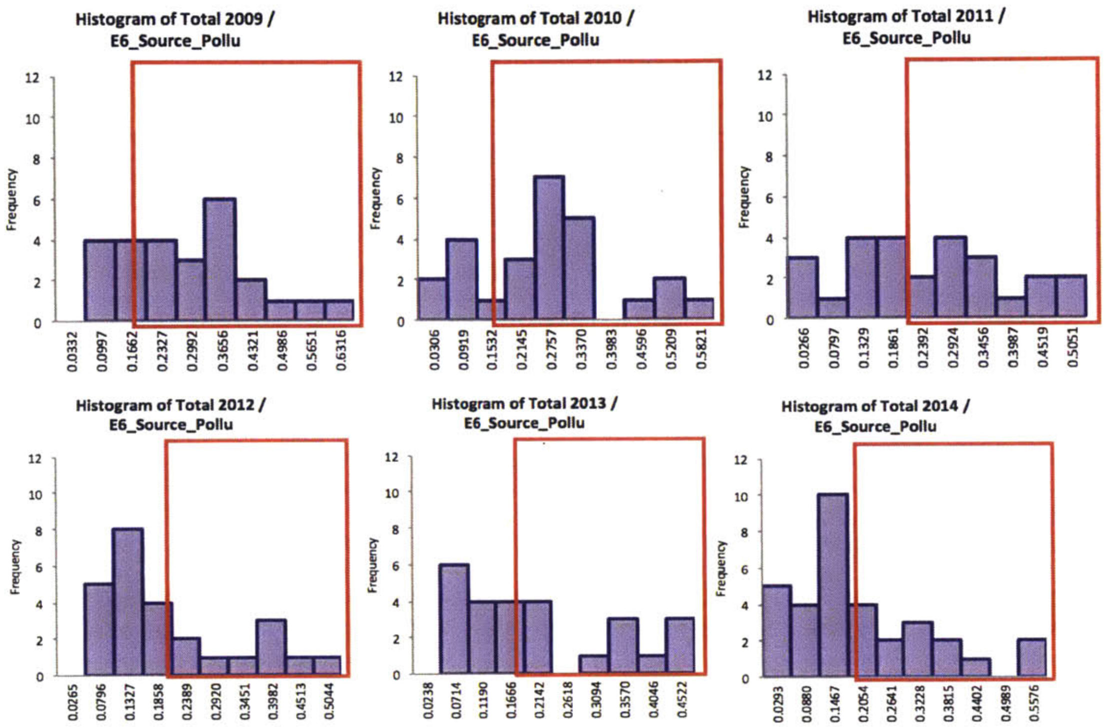
The sources are tested by the GJTI, and data is entered on regular basis, more frequently than the annual survey of habitation status.

Due to resources availability and time, not all sources are tested. GJTI samples a set number of sources and it is assumed that these are randomly selected. The information available consists of total tested sources and the number of polluted sources from the samples taken. The amount of samples taken per district varies.

Total pollution consists of two categories, chemical and biological pollution. The chemical analysis has the minimum five parameters mentioned in the NRDWP guidelines, which are: Arsenic, Fluoride, Iron, Nitrate, and Salinity and other contaminants. For biological analysis the tests include e-coli and fecal coliform. GJTI collects samples and analyzes them at district level. Each laboratory enters this data, as results are available.

In this research the percentage of polluted samples from the tested sources is used to analyze the level of pollution per district. This percentage is not fully representative of the district sources but provides the current approach. Regarding the types of sources, this information is not included in this data set. There are three types of sources listed on IMIS as habitations sources: scheme sources, public and private sources, and delivery points. At state level analysis, details on the type of source are not readily accessible.

Total Pollution at Sources



Looking at total pollution histograms from format E6 provides the best assessment of contaminated sources. Looking at histograms of total pollution from 2009 to 2014, it is possible to assess increase or decrease of polluted sources per district. Looking at cases with more than 20% pollution, the red square area shows a considerable reduction of number of districts falling in this range of pollution. Going from 18 districts in 2009 to 12 in 2014.

Looking at the average, there are improvements in water quality from 29% in 2009 to 20% in 2014. The minimum percentage of pollution is only 0.5% in 2014 versus 7% in 2009. Maximum values have also reduced from 66.5% to 58.7% in 2014. There was a lower maximum level of pollution in 2013 with 47.6%, which indicates a lower performance in 2014 compare to the previous year.

The top rankings for total polluted sources from the tested sample are listed in the next tables for each year from 2009 to 2014. It is interesting to see how long a district stays as a top ranking and determine if there are quality improvements compared to other top ranking districts. Districts that appear in the top raking for all 6 years it will indicate a problem where current strategies may not work as effectively and the source of pollution has being resilient, requiring further evaluation.

Newly listed districts would indicate a dramatic change of source, indicating a new activity that is affecting quality of sources. This can also be associated to the sources selected for sampling, which is something that should be evaluated further.

Total Polluted Sources from Sample Tested 2009-2014

District	Total 2009
KHEDA	66.5%
PATAN	55.4%
JAMNAGAR	50.7%
AMRELI	44.2%
KACHCHH	43.3%
SABAR KANTHA	39.6%
MAHESANA	37.9%
BANAS KANTHA	37.3%
RAJKOT	36.1%
VADODARA	34.5%

District	Total 2010
KHEDA	61.3%
BANAS KANTHA	53.5%
VADODARA	50.3%
SABAR KANTHA	45.0%
GANDHINAGAR	36.4%
ANAND	36.1%
SURENDRANAGAR	35.7%
MAHESANA	34.5%
NARMADA	31.9%
RAJKOT	30.0%

District	Total 2011
BANAS KANTHA	53.2%
RAJKOT	49.3%
VADODARA	47.6%
KHEDA	45.4%
MAHESANA	41.1%
SURENDRANAGAR	36.6%
ANAND	33.7%
JAMNAGAR	32.7%
PORBANDAR	29.3%
PATAN	29.2%

District	Total 2012
BANAS KANTHA	53.1%
AMRELI	44.4%
SURENDRANAGAR	39.7%
KHEDA	38.3%
VADODARA	37.2%
JAMNAGAR	34.7%
PANCH MAHALS	29.8%
SURAT	24.7%
MAHESANA	22.0%
PATAN	19.6%

District	Total 2013
JAMNAGAR	47.6%
BANAS KANTHA	46.1%
VADODARA	43.7%
PANCH MAHALS	40.4%
MAHESANA	37.4%
KHEDA	35.3%
SURAT	34.1%
AMRELI	32.7%
JUNAGADH	23.1%
RAJKOT	22.7%

District	Total 2014
JAMNAGAR	58.7%
AMRELI	55.7%
KACHCHH	46.0%
BANAS KANTHA	37.8%
JUNAGADH	35.3%
CHHOTAUDEPUR	33.6%
PORBANDAR	31.7%
VADODARA	29.4%
DEVBHOOMI DWARKA	26.9%
BHAVNAGAR	24.6%

Looking at the top ranking in 2014 and their trends. Jamnagar, Amreli, Vadodara, and Banas Kantha appear as top ranking in more than four years, indicating a wide and resilient source of pollution in their respective areas of the state. Evaluation of strategies for these districts would indicate the source of problems and how to better address the problem.

Kheda ranks high in all years from 2009 until 2013, showing great improvement on a continuous polluted area. Further analysis of what made this change could help improve other districts that have been highly polluted for several years.

Porbandar and Junagadh only rank highly in two years, and Bhavnagar is a new high-ranking district in2014, indicating that pollution sources are reaching high levels of pollution in the Saurashtra region. Further analysis of which sources are tested can help identify source and strategies for improving quality of these sources.

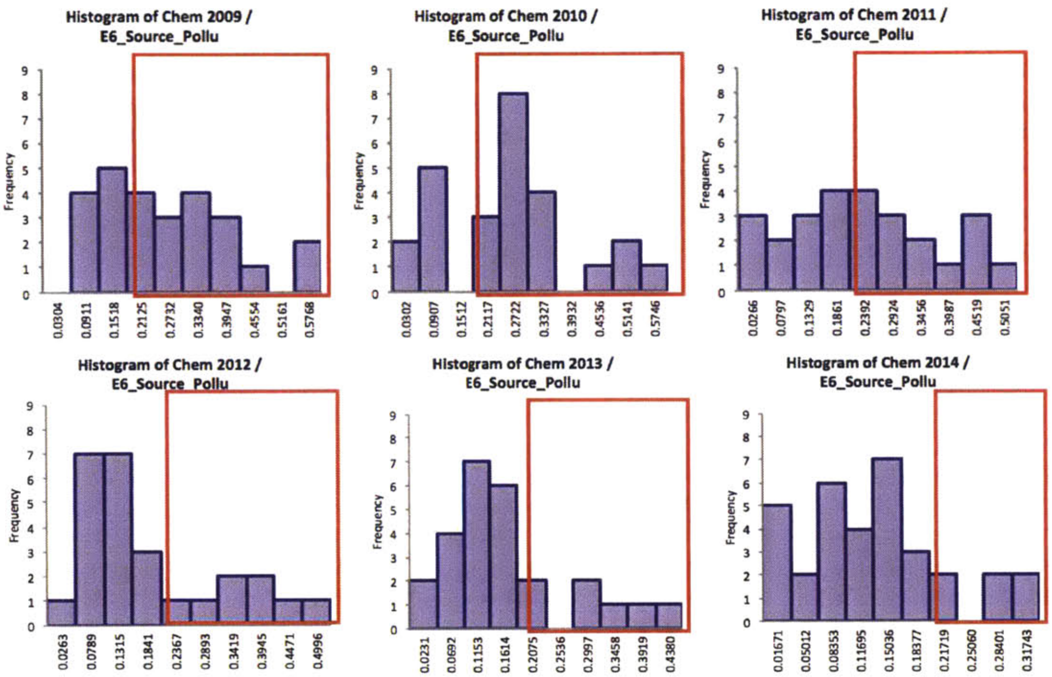
Chhotaudepur Chhotaudepur and Devbhoomi Dwarka are new districts and these do not require further analysis but further observation.

Chemical Pollution at Sources

These histograms show chemical polluted sources from 2009 to 2014. As a way to measure improvement of quality of tested sources the red rectangles show number of districts with more than 20% contaminated sources.

Based on this data there was great improvement on chemical pollution across Gujarat. In 2009 there were 15 districts with more than 20% pollution and in 2014 there are only

5 districts. The peak of worse chemical pollution at tested sources was in 2010 with 17 districts.



The mean values for chemical pollution at tested sources indicates an improvement in performance, from 26% in 2009 to 13% in 2014. Minimum pollution is also closer to zero in 2014 with 0.5% versus 6.5% in 2009. The lowest percent of pollution was in 2011 with 0.13%. So compared to this year there was a decrease of quality of 0.4% until 2014. Maximum values of chemical contamination show a continuous improvement from 60% min 2009 to 33% in 2014.

Summary	2009	2010	2011	2012	2013	2014
Mean	0.26	0.26	0.24	0.19	0.16	0.13
Variance	0.02	0.02	0.02	0.018	0.01	0.01
Std. Dev.	0.14	0.15	0.15	0.13	0.11	0.09
Mode	0.27	0.07	0.30	0.05	0.12	0.16
Minimum	0.066	0.02	0.00	0.05	0.03	0.005
Maximum	0.61	0.61	0.53	0.53	0.46	0.33
Range	0.54	0.58	0.53	0.48	0.43	0.33
Count	26	26	26	26	26	33

Top ranking districts for chemical and biological pollution will help identify specific quality problems by district.

Chemically Polluted Sources from Sample Tested 2009-2014

District	Chem 2009
KHEDA	60.7%
PATAN	55.4%
KACHCHH	43.3%
SABAR KANTHA	39.6%
MAHESANA	37.9%
BANAS KANTHA	37.3%
BHAVNAGAR	34.4%
RAJKOT	34.1%
SURENDRANAGAR	32.6%
VADODARA	31.2%

District	Chem 2010
KHEDA	60.5%
BANAS KANTHA	53.5%
VADODARA	49.5%
SABAR KANTHA	45.0%
ANAND	36.1%
SURENDRANAGAR	35.7%
MAHESANA	34.5%
NARMADA	31.9%
KACHCHH	29.3%
PATAN	29.1%

District	Chem 2011
BANAS KANTHA	53.2%
VADODARA	47.5%
RAJKOT	46.1%
KHEDA	44.7%
MAHESANA	40.8%
SURENDRANAGAR	36.3%
ANAND	32.6%
JAMNAGAR	30.5%
PORBANDAR	29.3%
PATAN	29.2%

District	Chem 2012
BANAS KANTHA	52.6%
AMRELI	43.9%
SURENDRANAGAR	38.2%
KHEDA	38.0%
VADODARA	36.5%
JAMNAGAR	32.7%
PANCH MAHALS	28.0%
MAHESANA	21.7%
PATAN	19.3%
RAJKOT	18.1%

District	Chem 2013
BANAS KANTHA	46.1%
MAHESANA	37.4%
VADODARA	35.6%
JAMNAGAR	28.7%
AMRELI	27.7%
PANCH MAHALS	22.7%
KHEDA	19.7%
SURAT	18.0%
ANAND	17.3%
RAJKOT	16.4%

District	Chem 2014
CHHOTAUDEPUR	33.4%
BANAS KANTHA	30.8%
VADODARA	28.6%
AMRELI	27.7%
PANCH MAHALS	21.5%
MAHESANA	20.0%
KHEDA	19.7%
MAHISAGAR	18.7%
JAMNAGAR	17.0%
KACHCHH	15.8%

For chemical pollution Banas Kantha, Vadodara, Kheda, and Mahesana appear in the highest chemically polluted districts every year from 2009 to 2014. This indicates there are persistent sources of pollution for these districts where further analysis of site characteristics as well as strategies that need to be implemented is necessary.

Amreli, Panch Mahals, and Jamnagar have had high pollution for the past 3-4 years. This indicates a change on the sources that have persisted for the past few years.

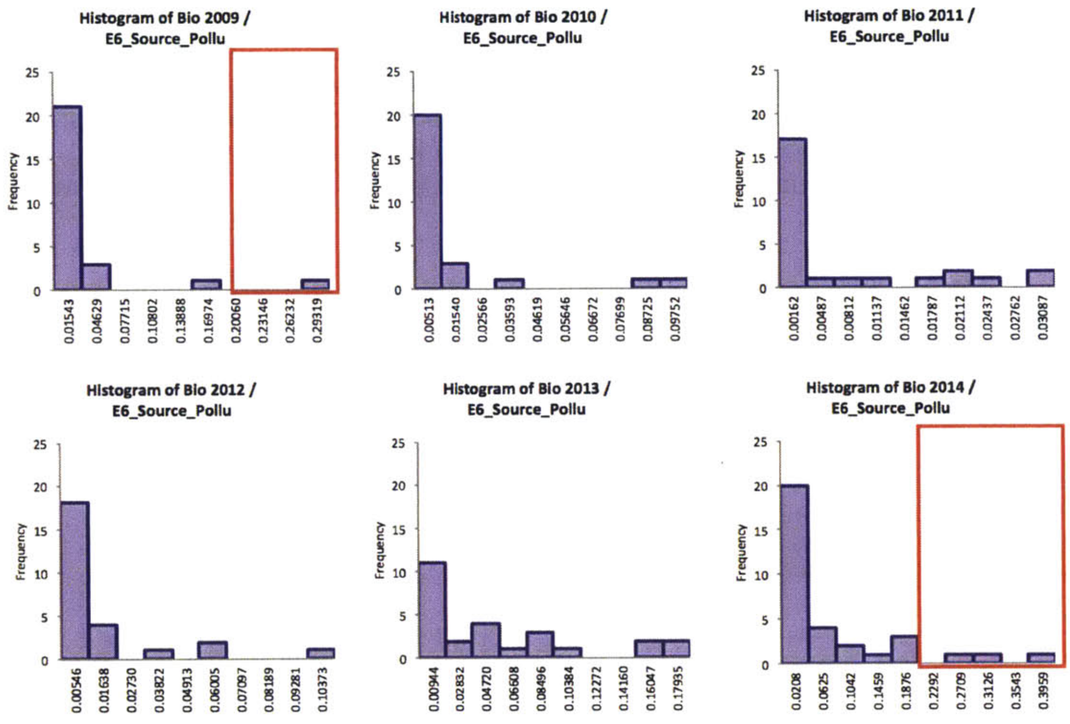
Mahisagar and Chhotaudepur are new districts hence no historical data available.

Kachchh district shows in the 2014 top ranking but the last time that appears with high problems was in 2010 and with much higher percentage of pollution. In this case the high ranking does not indicate a new issue but perhaps that the overall pollution in the state has improved and lower levels of chemical pollution have been reached.

Biological Pollution at Sources

These histograms show the evolution of biological pollution at tested sources across Gujarat from 2009 to 2014.

Following the same methodology to look at districts with more than 20% pollution, there is a considerable decrease of quality of water. The number of contaminated samples is low. If data are correct, it suggests that water sources have surprisingly little biological contamination and that water-related diarrheal disease in the state is more attributable to sanitation and hygiene than contaminated water, at least in rural areas. However, the numbers are so low that sampling and laboratory testing and reporting should be evaluated.



In 2009 there was only one district with more than 20% and zero districts from 2010 to 2013. However, in 2014 there are 3 districts with biological pollution reaching the highest percentage of 40%.

Based on the average there is a decrease of biological quality of tested sources. In 2009 this is 2.8% and in 2014 the average increases, by a factor of more than 2, to 7%. The minimum values are zero in all years, indicating that at least one district has no biological pollution problems, which should be checked. The maximum values show high fluctuation over time, ranging between 31% in 2009, to 10% in 2010 and 2012, and 3% in 2011, and then reaching its peak in 2014 at 42%. This is aligned with the decrease of quality shown by the histograms and the mean values.

Summary	2009	2010	2011	2012	2013	2014
Mean	0.03	0.01	0.01	0.02	0.05	0.07
Variance	0.01	0.00	0.00	0.00	0.00	0.01
Std. Dev.	0.07	0.03	0.01	0.03	0.06	0.10
Median	0.00	0.00	0.00	0.01	0.03	0.02
Mode	0.00	0.00	0.00	0.00	0.00	0.0
Minimum	0.00	0.00	0.00	0.00	0.00	0.0
Maximum	0.31	0.10	0.03	0.11	0.19	0.42
Range	0.31	0.10	0.03	0.11	0.19	0.42
Count	26	26	26	26	26	33

Comparing data from chemical and biological pollution, it is seen that most pollution at sources are chemical agents instead of biological. However, the biological pollution seems to be increasing in 2014 while chemical pollution seems to be decreasing with fewer sources found over time.
As seen in the statistical data from previous table, the range of highest pollution at sources goes from 31% in 2009 to 3.2% in 2011 and back to 41.7% in 2014. This wide variation of concentration of biological pollution compared to chemical may correspond to channels of biological pollution that can be site specific based on many environmental agents around the source, such as rainfall and human and animal waste contact.

Biologically Polluted Sources from Sample Tested 2009-2014

District	Bio 2009	District	Bio 2010	District	Bio 2011
JAMNAGAR	30.9%	DOHAD	10.3%	BHAVNAGAR	3.2%
AMRELI	16.8%	GANDHINAGAR	8.2%	RAJKOT	3.2%
KHEDA	5.8%	JUNAGADH	4.0%	DOHAD	2.6%
JUNAGADH	5.7%	RAJKOT	2.0%	JAMNAGAR	2.3%
VADODARA	3.3%	AMRELI	1.4%	AMRELI	2.1%
AHMADABAD	2.5%	JAMNAGAR	1.3%	GANDHINAGAR	1.9%
DOHAD	2.2%	KHEDA	0.8%	ANAND	1.1%
ANAND	2.2%	VADODARA	0.8%	KHEDA	0.7%
RAJKOT	2.0%	KACHCHH	0.2%	KACHCHH	0.5%
TAPI	1.4%	TAPI	0.1%	JUNAGADH	0.3%

District	Bio 2012	District	Bio 2013	District	Bio 2014
SURAT	10.9%	JAMNAGAR	18.9%	JAMNAGAR	41.7%
GANDHINAGAR	6.3%	PANCH MAHALS	17.7%	KACHCHH	30.1%
VALSAD	6.1%	SURAT	16.1%	AMRELI	28.0%
DANG	3.4%	KHEDA	15.7%	JUNAGADH	20.8%
JAMNAGAR	2.0%	PORBANDAR	9.6%	PORBANDAR	19.5%
PANCH MAHALS	1.8%	BHAVNAGAR	9.4%	BHAVNAGAR	16.9%
BHARUCH	1.7%	JUNAGADH	8.1%	DEVBHOOMI DWARKA	13.1%
SURENDRANAGAR	1.5%	VADODARA	8.1%	GANDHINAGAR	9.2%
NAVSARI	1.0%	RAJKOT	6.3%	SURENDRANAGAR	8.8%
KACHCHH	0.7%	AMRELI	5.1%	BANAS KANTHA	7.0%

Looking at biological pollution at sources, districts of Jamnagar, Amreli, and Junagadh appear in the high-ranking districts every year from 2009 to 2014.
Kachchh appears in 4 years, however the first three years it shows minimal pollution at less than 1% ramping up to 30% in 2014.

Gandhinagar also appears 4 years but it maintains a narrower concentration of pollution between 2 and 10%.

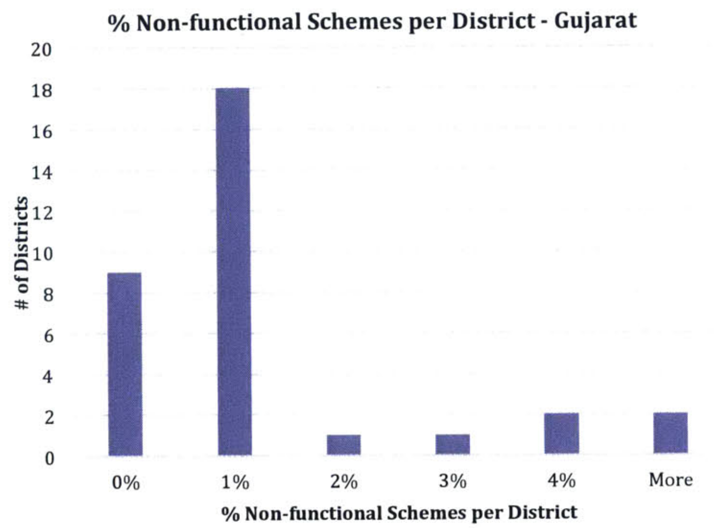
Surendranagar and Banas Kantha are new to the list in 2014 with 9 and 7% respectively, indicating new sources of pollution in these districts.

Technology Factors

Functionality of Schemes

This dataset displays the failure of schemes based on quality and quantity issues. This data is only shown in IMIS for the current year, no historical trends are available on the website.

This histogram shows the non-functional schemes reported as of 28/2/2015. The non-functional percentage goes from 0 to 5% and 18 districts have between 0 and 1% failures. According to these data, schemes do not have a high failure rate in the state. Data from previous years would help match the status changes with schemes failures. For 2014 it is possible to compare these data for habitations with PC and QA problems.



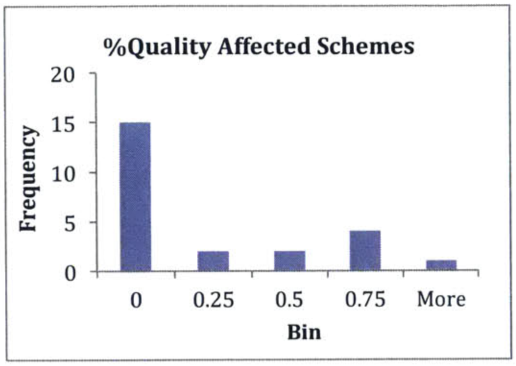
The top 10 districts for failed schemes are shown in the next table.

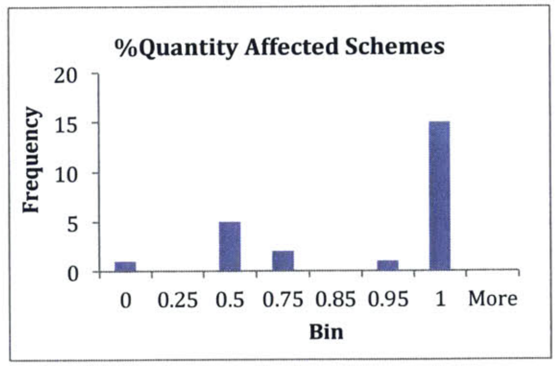
Banas Kantha ranks first with 5.1% or 233 failed schemes. This district is also ranked in top 10 since for QA. However, these problems were reported before 2014.

	District	Percentage(%)	Total # Schemes	Non Functional
1	BANAS KANTHA	5.12	4549	233
2	BHAVNAGAR	4.11	3794	156
3	MORBI	3.76	1490	56
4	KHEDA	3.27	2413	79
5	RAJKOT	2.30	3170	73
6	BOTAD	1.81	1216	22
7	VADODARA	0.73	2997	22
8	CHHOTAUDEPUR	0.70	3016	21
9	SURENDRANAGAR	0.70	3021	21
10	ARAVALLI	0.68	2801	19

The other districts showing higher failure of schemes in the state are not ranked on the habitation water coverage status analysis. This indicates there is no correlation between failed schemes and not covered habitations, as it was initially thought that failed schemes were related and a cause of slipback habitations. A correlation analysis will be done further among several variables to determine relational and causal relationships.

Non-Functional schemes data shows the reason of failure due to quantity or quality. Based on this, it is possible to correlate quality-affected sources and quality-affected habitations with non-functional scheme.



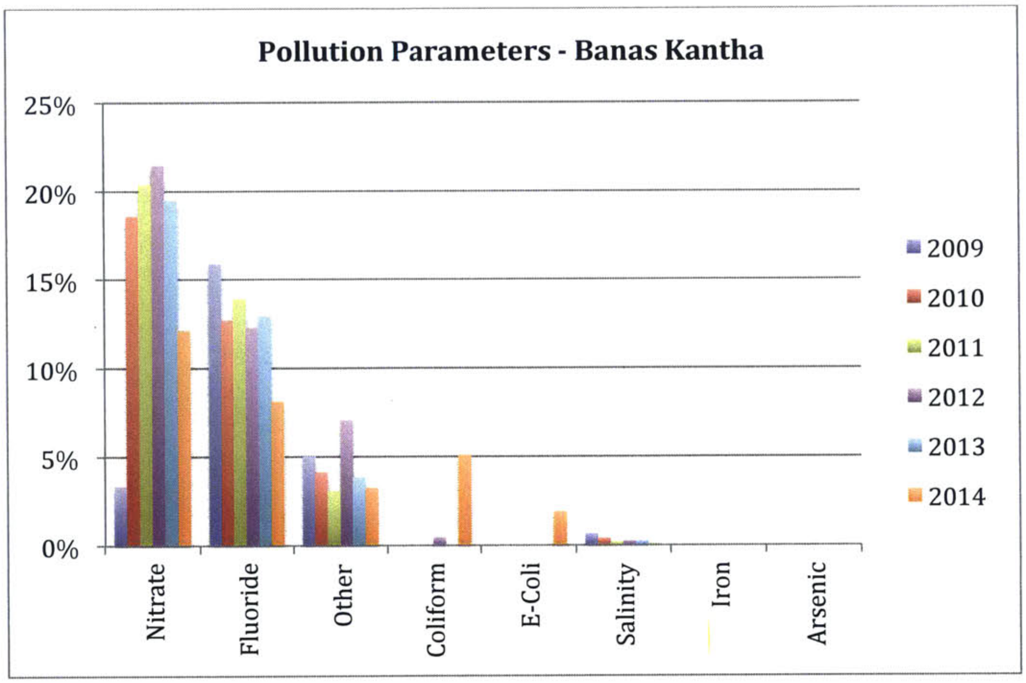


Quantity problems dominate with 15 districts presenting only this type of challenge. There is only one district where all schemes only have quality problems. The other eight (8) quality affected districts have both quality and quantity affected schemes. The next table shows the number of schemes and percentage affected by district.

District	Quality	Quantity	Non Functional Schemes	%Quality	%Quantity	Total # Schemes	% NFS
BANAS KANTHA	170	70	240	71%	29%	4549	5.1%
BHAVNAGAR	0	156	156	0%	100%	3794	4.1%
MORBI	0	56	56	0%	100%	1490	3.8%
KHEDA	0	79	79	0%	100%	2413	3.3%
RAJKOT	0	73	73	0%	100%	3170	2.3%
BOTAD	0	22	22	0%	100%	1216	1.8%
VADODARA	0	22	22	0%	100%	2997	0.7%
CHHOTAUDEPUR	19	10	29	66%	34%	3016	0.7%
SURENDRANAGAR	0	21	21	0%	100%	3021	0.7%
ARAVALLI	14	5	19	74%	26%	2801	0.7%
SABAR KANTHA	12	5	17	71%	29%	2372	0.7%
MAHISAGAR	0	15	15	0%	100%	2548	0.6%
BHARUCH	0	6	6	0%	100%	1335	0.4%
ANAND	7	10	17	41%	59%	2469	0.4%
NARMADA	0	4	4	0%	100%	1426	0.3%
AHMADABAD	1	7	8	13%	88%	3007	0.3%
PANCH MAHALS	0	6	6	0%	100%	2573	0.2%
DEVBHOOMI DWARKA	4	0	4	100%	0%	1780	0.2%
PATAN	0	4	4	0%	100%	2103	0.2%
JAMNAGAR	2	2	4	50%	50%	2889	0.1%
SURAT	1	3	4	25%	75%	2932	0.1%
DOHAD	0	3	3	0%	100%	3084	0.1%
KACHCHH	0	2	2	0%	100%	2232	0.1%
TAPI	0	2	2	0%	100%	2422	0.1%
Grand Total	**230**	**583**	**814**	**28%**	**72%**	**61,639**	

There are 9 districts that have zero non-functional schemes. These are: Amreli, Dang, Gandhinagar, Gir Somnath, Junagadh, Mahesana, Navsari, Porbandar, and Valsad. Only 2 of these districts were formed in 2013.

Banas Kantha district leads the number of non-functional schemes ranking with 240 schemes or 5.1%. This district is also has the highest number of schemes (170) affected by quality. This indicates a major need to target quality issues in Banas Kantha. Based on data from quality-affected sources, the specific quality problem is due to chemical pollution. The key parameters of pollution for Banas Khanta are nitrate, fluoride, and other parameters. Details are shown in the following graphic.



The second district with highest number of quality problems has only 20 schemes that represent 66% of all non-functional schemes. However, this district only has 0.7% of the schemes as non-functional.

Bhavnagar has the largest number of schemes affected by quantity with 156 schemes that represents 4.1% of all the schemes in the district. Morbi and Kheda follow with 3.8% and 3.3% of affected schemes respectively. Two out of three are in the Saurashtra hard rock aquifer region. All these three districts only have quantity-affected schemes.

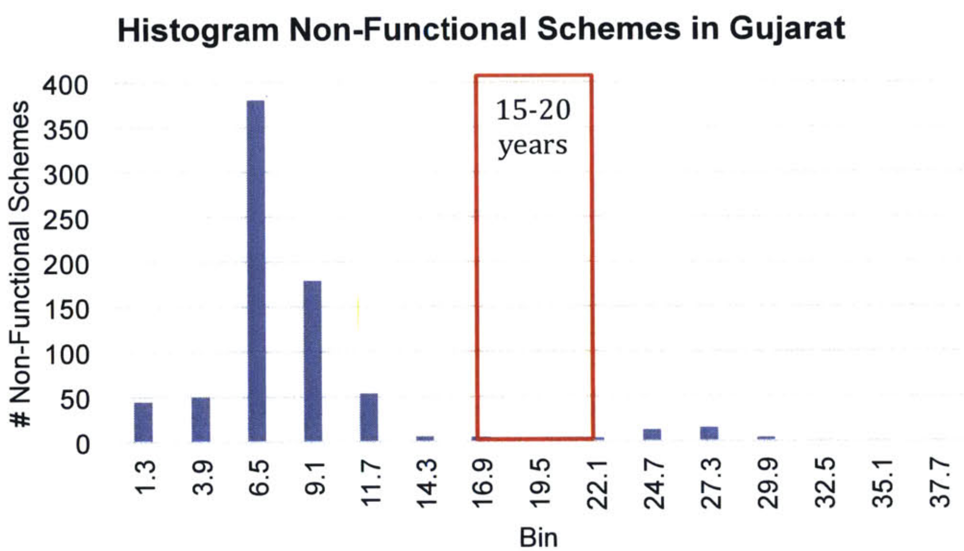
Looking at districts with high partially coverage, these do not appear on the top of quantity affected non-functional schemes as it was expected. Tapi only has 2 schemes affected; Gandhinagar has zero schemes affected, and Baruch only 6 schemes. These three (3) districts appear in the FC and QA from 2014 and non-functional scheme data also from 2014.

Age of Non-Functional Schemes
The expected life of a scheme is 15-20 years per design estimates. However, looking at non-functional schemes reported in April 2014 the average age is 8 years, which is half of expected life.

This average life applies only for schemes reported as of April 2014; this data does no include schemes reported in previous years. From the total 814 schemes 55 were removed since they have "Unknown" sanction years. It is important to mention that 21 of these are from Surendranagar district, indicating a need to improve data entry in this office.

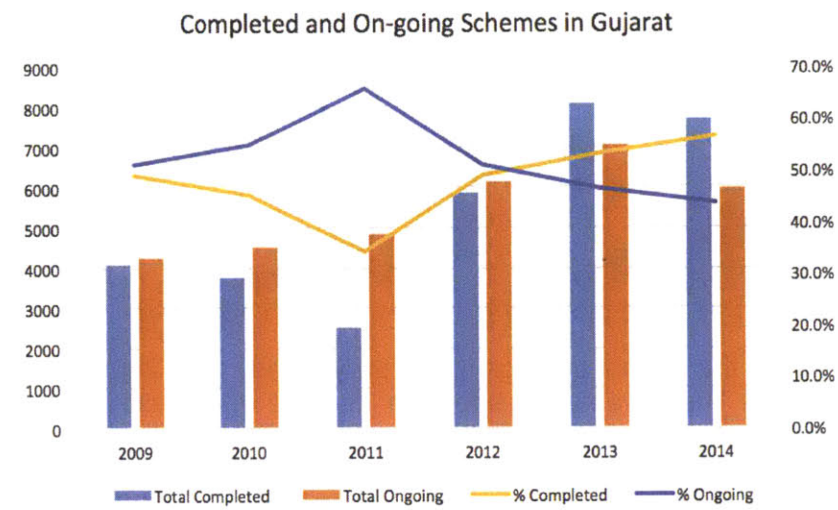
This age calculation is conservative since the data only shows the sanction year, which is the year the project was approved. The completion year assumed to be one year after approval date. 80% of failed schemes in 2014 are less than 8 years old.

The age of schemes that failed is 50% of the expected life, and it has no visibility in the IMIS database today. This is a parameter that could help create strategies to reach the 15-20 years target.



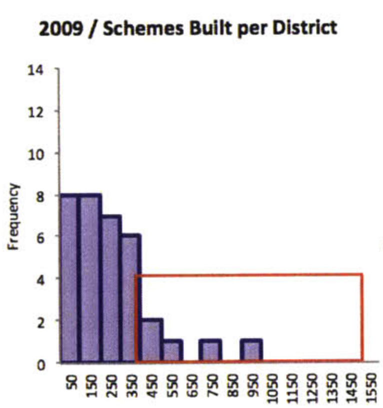
Schemes Built per Year
In order to better understand the magnitude of failed schemes, we should look at the total schemes completed per district per year. IMIS provides data from 2009 to 2014.

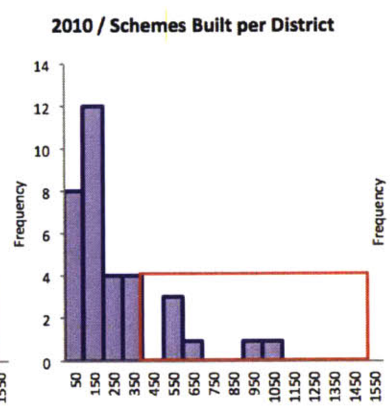
Each year the total schemes listed includes two categories: completed and ongoing. In Gujarat the number and percentage of each of these categories is shown in the following graphic. In 2009 to 2011 there were more schemes ongoing than completed, indicating a high rollover trend in those years. In 2012 the trend switched and more schemes were completed versus those that continue to the following year. These trends will be a good indicator of activity in the state on developing new schemes and the actual progress of their construction.

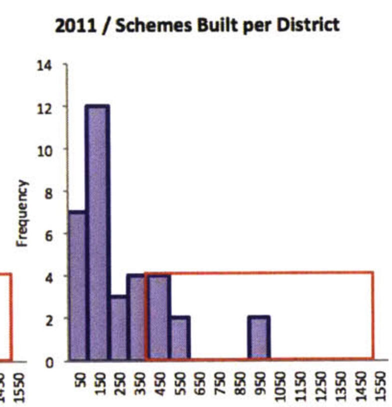


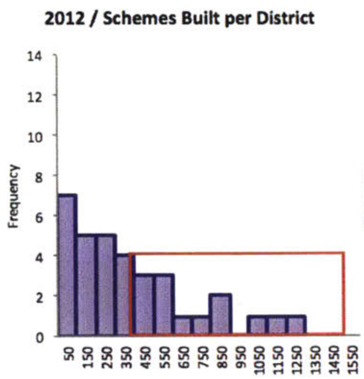
The following histograms show ranges or bins of 100, and the middle of the means is shown in the horizontal axis in the graphs shown here.

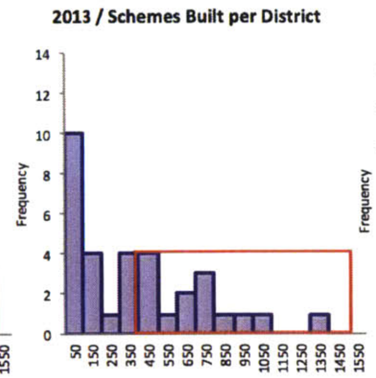
Since 2009 there has been an increase in the numbers of districts building more than 400 schemes per year. In 2009 there were only 5 districts with this level of construction, 14 districts in 2013, and 10 in 2014. This phenomenon indicates intense building of schemes in selected districts; for example, in 2014 one district built 1450 schemes.

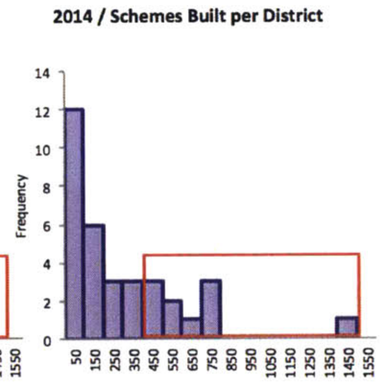












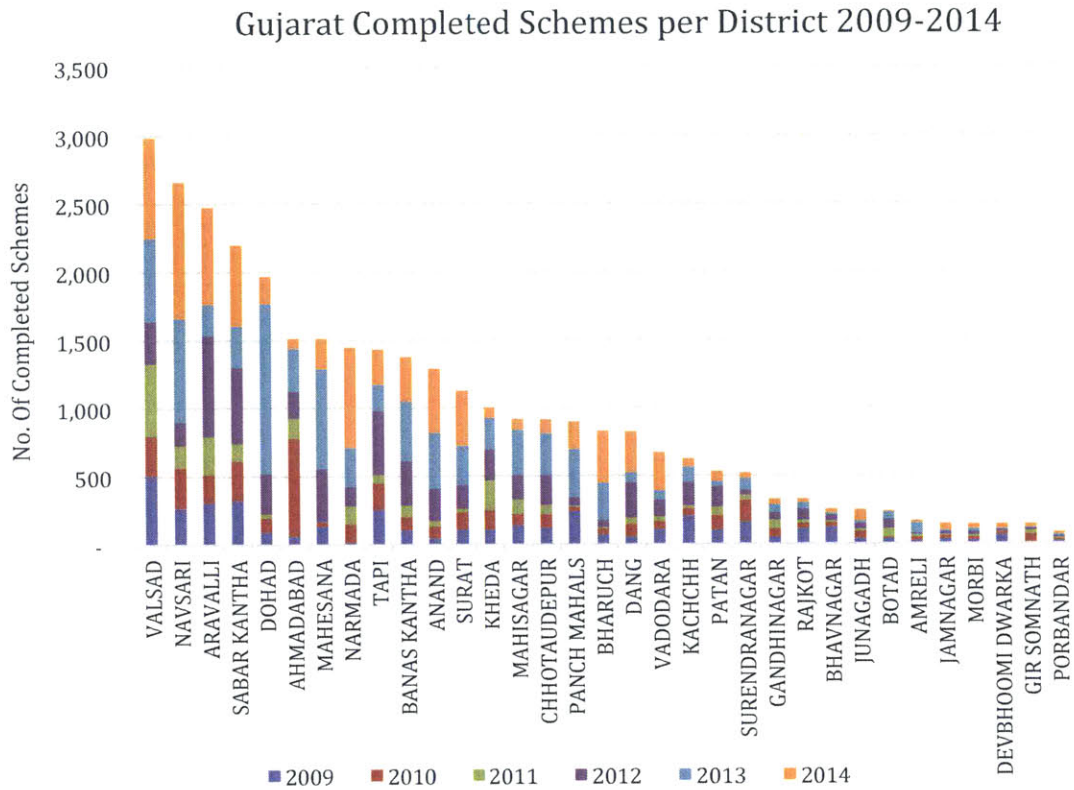
Looking at the annual average it was very steady from 2009 to 2011 at 260 schemes per district. There was a considerable increase of projects in 2012 and 2013, with 390 and 425 respectively. In 2014 the average is 295 but it may increase as more schemes get completed and entered before April 2015.
The minimum number of schemes dropped from 44 in 2009 to 26 in 2013. The 9 schemes built in 2014 may change as the financial year closes.

The maximum number of schemes per district increased 150% from 927 in 2009 to 1654 in 2013. Numbers in 2014 may be similar 2013 as they are 1418 just 2 months before the financial year ends. All districts were included in this analysis since there is data of built schemes for all 33 districts, even though 7 districts were created in 2013.

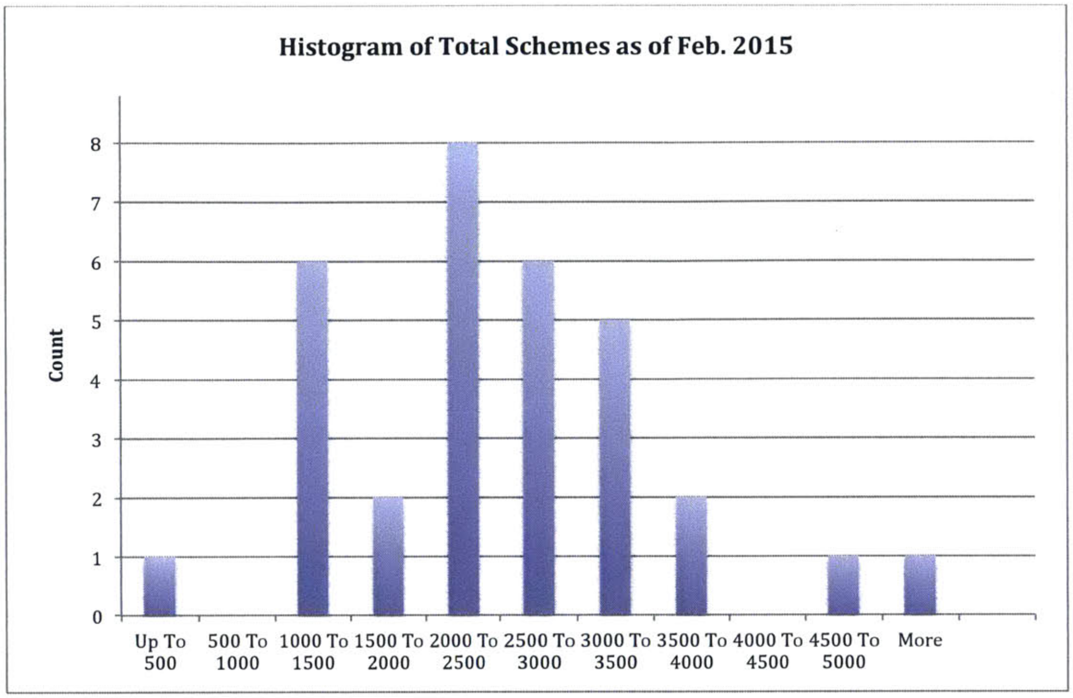
	2009	2010	2011	2012	2013	2014
Mean	261.33	260.55	261.85	390.24	424.42	294.61
Variance	40573.17	58401.63	55608.07	111030.25	172787.69	96135.31
Std. Dev.	201.43	241.66	235.81	333.21	415.68	310.06
Median	203.00	178.00	170.00	288.00	311.00	160.00
Mode	46.33	121.00	48.67	288.00	31.00	49.00
Minimum	44.00	41.00	27.00	33.00	26.00	9.00
Maximum	927.00	1052.00	977.00	1244.00	1654.00	1418.00
Range	883.00	1011.00	950.00	1211.00	1628.00	1409.00
Count	33.00	33.00	33.00	33.00	33.00	33.00
Sum	8624.00	8598.00	8641.00	12878.00	14006.00	9722.00

The average number of schemes built from 2009 to 2014 is 316 schemes per district per year. Comparing this to 814 total of non-functional schemes in 2014 it represents a failure of almost 3 districts. Considering that1418 schemes built in 2014, 60% of the schemes were non-functional at the beginning of the year. Based on this calculation the number of non-functional schemes represents a high portion of new schemes built per year. Even though the percent of failures over total schemes built is low, it is shown that visibility of failures can be improved by comparing non-functional schemes with total built per year.

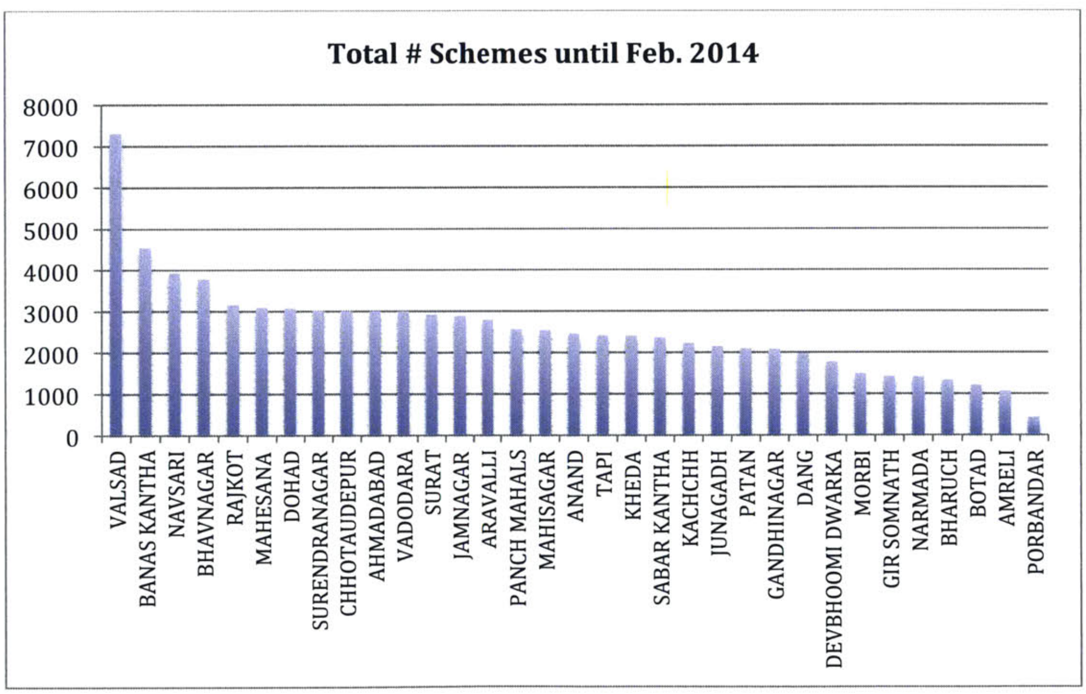
The following diagram shows the total number of schemes built per district from 2009 until 2014. This graphic can help identify which district have been actively building water supply schemes, hence reducing PC and QA habitations, increasing institutional activities, having larger expenditure, and possibly an increase on demand.



There are 11 districts with less than 500 schemes completed from 2009, indicating very low activity for water coverage. From these 11 districts, four (4) are newly established in 2013: Botad, Morbi, Devbhoomi Dwarka, and Gir Somath. Looking at the total number of schemes per district, the following histogram shows that only Porbandar has less than 500 schemes in total.



Most of districts have between 1000 and 3500 schemes built. Details on the total number of completed schemes are shown in the following graphic.



Social Factors

In this section the IMIS data that will be used is population growth, and minority casts per district.

The expectations are:

- Districts with population growth leads to higher failures of water supply and schemes
- It is perceived that minority casts have lower water supply services, so high minority population would indicate more water supply problems

In the IMIS data about population per caste is available as: General Population, Scheduled Caste, and Scheduled Tribal. The last two groups are considered minority and are recognized by the constitution of India as disadvantaged populations, hence additional support from national government is given to habitations with more than 40% of either or both minority populations.

General and Minority Population Density

The social analysis is done using population density per district since water needs are directly related to this variable. Districts with high population density as percentage of state population indicates that these are likely to have more water supply problems. Also, the type of social groups is evaluated within this section. By understanding the distribution of minority population it is possible to understand if water problems are more frequent in minority dominated districts. This will help identify inequality problems.

Data from 2009 to 2014 are evaluated at the state level first to see how much the total population has changed. Based on this data the only change is from 2011 to 2012, this is attributed to the national census survey from 2011. There was a registered 1% increase in rural population in Gujarat.

	2009	2010	2011	2012	2013	2014
Total Pop	36,071,891	36,071,891	36,071,891	36,071,891	36,549,283	36,549,283
Pop Change	0	0	0	477,392	0	-
%Pop Change	-	-	-	1%	-	-

Since population has not changed considerably from 2009 to 2014, only data from 2014 will be analyzed for population density as percent of total state population and the density of minorities within each district.

The following four (4) tables show data for population density, minority, scheduled caste, and tribe for all districts from 2011 until 2014. The changes between 2011 and 2012 are attributed to the census data, and the changes from 2012 to 2013 are due to the establishment of 7 new districts.

District	% State Population			
	2011	2012	2013	2014
BANAS KANTHA	7.0%	7.0%	7.6%	7.6%
DOHAD	4.6%	4.6%	5.3%	5.3%
KHEDA	5.1%	5.1%	4.5%	4.5%
MAHESANA	4.5%	4.5%	4.5%	4.5%
ANAND	4.2%	4.2%	4.1%	4.1%
KACHCHH	3.6%	3.6%	4.0%	4.0%
SURAT	4.3%	4.3%	3.9%	3.9%
BHAVNAGAR	4.7%	4.7%	3.9%	3.9%
PANCH MAHALS	5.6%	5.6%	3.8%	3.8%
AMRELI	3.4%	3.4%	3.3%	3.3%
VADODARA	6.3%	6.3%	3.3%	3.3%
BHARUCH	3.2%	3.2%	3.3%	3.3%
SABAR KANTHA	5.9%	5.9%	3.3%	3.3%
VALSAD	3.2%	3.2%	3.2%	3.2%
RAJKOT	4.9%	4.9%	3.2%	3.2%
AHMADABAD	3.6%	3.6%	3.1%	3.1%
SURENDRANAGAR	3.5%	3.5%	3.0%	3.0%
PATAN	3.0%	3.0%	2.9%	2.9%
NAVSARI	2.8%	2.8%	2.9%	2.9%
GANDHINAGAR	2.8%	2.8%	2.8%	2.8%
CHHOTAUDEPUR			2.7%	2.7%
JUNAGADH	5.4%	5.4%	2.6%	2.6%
ARAVALLI			2.6%	2.6%
GIR SOMNATH			2.5%	2.5%
MAHISAGAR			2.4%	2.4%
TAPI	2.1%	2.1%	1.9%	1.9%
MORBI			1.8%	1.8%
JAMNAGAR	3.3%	3.3%	1.8%	1.8%
DEVBHOOMI DWARKA			1.5%	1.5%
NARMADA	1.6%	1.6%	1.5%	1.5%
BOTAD			1.2%	1.2%
PORBANDAR	0.9%	0.9%	0.9%	0.9%
DANG	0.6%	0.6%	0.6%	0.6%

District	% Minority Population			
	2011	2012	2013	2014
DANG	97%	97%	100%	100%
TAPI	91%	91%	91%	91%
NARMADA	86%	86%	87%	87%
CHHOTAUDEPUR			84%	84%
DOHAD	79%	79%	80%	80%
VALSAD	73%	73%	73%	73%
NAVSARI	64%	64%	58%	58%
SURAT	55%	55%	54%	54%
BHARUCH	44%	44%	47%	47%
MAHISAGAR			43%	43%
SABAR KANTHA	30%	30%	36%	36%
PANCH MAHALS	35%	35%	30%	30%
ARAVALLI			28%	28%
VADODARA	49%	49%	23%	23%
BANAS KANTHA	20%	20%	20%	20%
JUNAGADH	12%	12%	14%	14%
KACHCHH	21%	21%	14%	14%
PORBANDAR	12%	12%	13%	13%
SURENDRANAGAR	12%	12%	12%	12%
AHMADABAD	12%	12%	12%	12%
GIR SOMNATH			12%	12%
JAMNAGAR	8%	8%	11%	11%
RAJKOT	9%	9%	10%	10%
PATAN	11%	11%	10%	10%
AMRELI	9%	9%	9%	9%
MAHESANA	8%	8%	8%	8%
GANDHINAGAR	6%	6%	7%	7%
DEVBHOOMI DWARKA			7%	7%
BOTAD			7%	7%
MORBI			7%	7%
KHEDA	7%	7%	6%	6%
ANAND	6%	6%	6%	6%
BHAVNAGAR	6%	6%	5%	5%

Percent of State Minority Population: Banas Kantha has the highest minority population with 7.6% of state population, followed by Dohad with 5.3% and Kheda with 4.5%. On the least populated districts we have Dang with 0.6% and Porbandar with 0.9%. It is expected to see more quantity problems in minority-populated districts.

Percent of Minority Population: Dang has the highest density of minority population with 100%, followed by Tapi with 91% and Narmada with 87%. For the least minority-populated districts we have Bhavnagar with 6% and Anand with 6%.

Considerable changes in minority populations due in part to redistricting are seen at:

- Vadodara from 49% to 23%
- Kachchh from 21% to 14%
- Navsari from 64% to 58%
- Panch Mahals from 35% to 30%

- Jamnagar from 8% to 11%
- Sabar Kantha from 30% to 36% has the only significant increase.

	%SC Population			
District	2011	2012	2013	2014
KACHCHH	12%	12%	12%	12%
JUNAGADH	11%	11%	12%	12%
AHMADABAD	11%	11%	11%	11%
SURENDRANAGAR	11%	11%	11%	11%
GIR SOMNATH			11%	11%
BANAS KANTHA	11%	11%	11%	11%
RAJKOT	9%	9%	10%	10%
JAMNAGAR	8%	8%	10%	10%
PORBANDAR	10%	10%	10%	10%
SABAR KANTHA	8%	8%	9%	9%
PATAN	10%	10%	9%	9%
AMRELI	9%	9%	9%	9%
MAHESANA	8%	8%	8%	8%
BOTAD			7%	7%
MORBI			6%	6%
ARAVALLI			6%	6%
GANDHINAGAR	6%	6%	6%	6%
DEVBHOOMI DWARKA			6%	6%
VADODARA	5%	5%	6%	6%
ANAND	5%	5%	5%	5%
MAHISAGAR			5%	5%
BHAVNAGAR	6%	6%	5%	5%
KHEDA	5%	5%	5%	5%
PANCH MAHALS	4%	4%	4%	4%
SURAT	4%	4%	3%	3%
BHARUCH	4%	4%	3%	3%
VALSAD	3%	3%	2%	2%
CHHOTAUDEPUR			2%	2%
NAVSARI	2%	2%	2%	2%
DOHAD	2%	2%	2%	2%
NARMADA	1%	1%	1%	1%
TAPI	1%	1%	1%	1%
DANG	1%	1%	0%	0%

	% ST Population			
District	2011	2012	2013	2014
DANG	97%	97%	100%	100%
TAPI	90%	90%	90%	90%
NARMADA	85%	85%	86%	86%
CHHOTAUDEPUR			82%	82%
DOHAD	77%	77%	78%	78%
VALSAD	70%	70%	70%	70%
NAVSARI	61%	61%	57%	57%
SURAT	50%	50%	51%	51%
BHARUCH	40%	40%	43%	43%
MAHISAGAR			38%	38%
SABAR KANTHA	22%	22%	26%	26%
PANCH MAHALS	31%	31%	26%	26%
ARAVALLI			22%	22%
VADODARA	45%	45%	17%	17%
BANAS KANTHA	9%	9%	10%	10%
PORBANDAR	2%	2%	3%	3%
JUNAGADH	1%	1%	3%	3%
SURENDRANAGAR	1%	1%	2%	2%
AHMADABAD	1%	1%	2%	2%
KHEDA	2%	2%	2%	2%
GIR SOMNATH			1%	1%
KACHCHH	10%	10%	1%	1%
DEVBHOOMI DWARKA			1%	1%
JAMNAGAR	0%	0%	1%	1%
GANDHINAGAR	0%	0%	1%	1%
ANAND	1%	1%	1%	1%
PATAN	1%	1%	1%	1%
MORBI			1%	1%
RAJKOT	0%	0%	0%	0%
AMRELI	0%	0%	0%	0%
MAHESANA	0%	0%	0%	0%
BHAVNAGAR	0%	0%	0%	0%
BOTAD			0%	0%

Percent of Scheduled Caste: Kachchh and Junagadh have the highest Scheduled Caste populations with 12%, followed by Ahmadabad and other 3 districts with 11%. On the least populated districts we have Dang with 0% and Tapi with 1%. There are no considerable changes in this population after the creation of the 7 new districts in 2013.

Percent of Scheduled Tribes: This type of population follows the same ranking as minority population. Dang has the highest ST population density with 100%, followed by Tapi with 90% and Narmada with 86%. On the least populated districts we have other districts compared to the minority raking, Botad, which is a new district, with 0% as other 4 districts.

The largest differences between old and new districts established in 2013 are:

- Vadodara from 45% to 17%

- Panch Mahals from 31% to 26%
- Navsari from 61% to 57%
- Sabar Kantha from 22% to 26%
- Baruch from 40% to 43%

Correlation Analysis:

After analyzing each FIETS factor using the IMIS data, a statistical correlation is used to identify quantitative relationships between the variables. The number of samples used is the number of districts (33) for the most recent year with full data. The significance tests for correlations are based on a 95% confidence level. Values equal or higher than 0.349 are considered relevant correlations.

The correlation analysis is done in two steps. First a correlation analysis is done between coverage of habitations and each of the FIETS factors. This first analysis identifies which factors have significant correlations with habitations status. For example, it may be assumed that areas with poor water coverage will have more focus from investment, projects, and community support. Or alternatively, those with poor coverage receive lower levels of investment. Secondly, a correlation analysis between FIETS factors is done to identify how the variables that can cause slipback are interconnected.

Coverage and Financial Factors:

Variable	%FC	%PC	%QA	National NRDWP Exp.	State NRDWP Exp.	Total Expenditure
%FC	1.					
%PC	-0.989	1.				
%QA	-0.042	-0.106	1.			
National NRDWP Exp.	0.095	-0.096	0.004	1.		
State NRDWP Exp.	0.027	-0.031	0.026	0.754	1.	
Total Expenditure	0.073	-0.074	0.013	0.961	0.906	1.

There is no statistical correlation between the status of coverage of habitations and financial resources spent. This is aligned with the perception that the failure to provide water is not directly related with the amount of investments.

Coverage and Institutional Factors

Variable	%FC	%PC	%QA	GPs per Villages	VWSC Formed until FY	VWSC formed per villages	Training for VWSC per VWSC	Gram Sabha per VWSC Formed
%FC	1.							
%PC	-0.989	1.						
%QA	-0.042	-0.106	1.					
GPs per Villages	0.102	-0.085	-0.113	1.				
VWSC Formed until FY	0.026	-0.01	-0.104	-0.075	1.			
VWSC formed per total villages	-0.036	0.032	0.023	0.187	-0.153	1.		
Training for VWSC per VWSC	0.075	-0.052	-0.158	0.201	-0.427	-0.013	1.	
Gram Sabha per VWSC Formed	0.062	-0.045	-0.112	0.16	-0.368	-0.01	0.916	1.

There is no correlation between habitation water coverage and institutional factors. However, there is a correlation between the number of training sessions and the number of VWSC formed. This should be a positive correlation, as more training is needed with more VWSC formed. However the calculated correlation is negative indicating there is not enough training sessions per formed VWSC. The number of Gram Sabah meetings is also correlated with the number of VWSC and the training for VWSC. There is a negative correlation with VWSC formed and positive correlation with training per VWSC. The correlation with training indicates that Gram Sabah meetings are a good factor to measure activities within the VWSC.

Coverage and Environmental Factors

Variable	%FC	%PC	%QA	% Contaminated Sources	%Chem Pollution	% Bio Pollution
%FC	1.					
%PC	-0.989	1.				
%QA	-0.042	-0.106	1.			
% Contaminated Sources	0.294	-0.277	-0.099	1.		
%Chem Pollution	0.306	-0.323	0.12	0.705	1.	
% Bio Pollution	0.156	-0.12	-0.238	0.81	0.155	1.

For environmental factors, there is no statistical correlation between habitation coverage and polluted sources. It was expected to see a strong correlation between polluted sources and quality affected habitations, but data shows no relevant correlation values.

Coverage and Technology Factors

Variable	%FC	%PC	%QA	%Quality Failures	%Quantity Failures	Total # Schemes	% NFS	Age of NFS	Schemes Built per FY
%FC	1.								
%PC	-0.989	1.							
%QA	-0.042	-0.106	1.						
%Quality Failures	0.156	-0.165	0.066	1.					
%Quantity Failures	-0.095	0.098	-0.023	-0.311	1.				
Total # Schemes	0.082	-0.078	-0.026	0.101	-0.082	1.			
% NFS	0.155	-0.137	-0.12	0.113	0.308	0.176	1.		
Age of NFS	0.129	-0.089	-0.267	0.067	0.09	0.111	0.183	1.	
Schemes Built per FY	-0.133	0.084	0.328	0.132	-0.188	0.447	-0.115	-0.124	1.

There is no statistical correlation between schemes failed, built, of age of failed schemes with coverage numbers. The highest correlation number is for schemes built per year and quality affected habitations at a nearly significant level of 0.328.

Coverage and Social Factors

Variable	%FC	%PC	%QA	SC Pop.	ST Pop.	GEN Pop.	TOTAL Pop.	% State Pop	%Minority Pop	% SC Pop	% ST Pop
%FC	1.										
%PC	-0.989	1.									
%QA	-0.042	-0.106	1.								
SC Population	0.272	-0.265	-0.039	1.							
ST Population	-0.18	0.176	0.018	-0.365	1.						
GEN Population	0.228	-0.247	0.135	0.841	-0.443	1.					
TOTAL Population	0.13	-0.15	0.141	0.688	0.227	0.771	1.				
% State Pop	0.13	-0.15	0.141	0.688	0.227	0.771	1.	1.			
%Minority Pop	-0.341	0.324	0.107	-0.518	0.793	-0.671	-0.162	-0.162	1.		
% SC Pop	0.389	-0.35	-0.253	0.739	-0.655	0.537	0.153	0.153	-0.771	1.	
% ST Pop	-0.354	0.334	0.125	-0.554	0.796	-0.672	-0.165	-0.165	0.998	-0.813	1.

Based on this data there is a significant correlation between coverage and %SC and %ST populations. Scheduled caste population has a positive correlation with FC habitations indicating that this minority is present in Fully Covered communities. When combined with the observation that expenditures have been higher in communities with a high SC population, it appears that the expenditures are correlated with high levels of coverage. This is an important positive finding of the research.

However, for Scheduled Tribal communities there is a negative correlation between FC and the percentage of this minority population. This indicates that habitations with more percentages of tribal communities have less coverage of water supply, especially for quantity. This is one of the most important negative finding of the research.

FIETS Factors Correlations

In the next set of tables all FIETS variables are compared with one another for correlation analysis. The variables for each FIETS factor are delimited with a black line since these should have high correlations and were evaluated in previous tables. Values equal or higher than 0.349 are considered relevant correlations.

Financial variables are highly correlated with total and general population, since it is expected to have allocations based on total population. The Scheduled Caste has the highest correlation of 0.588 of national expenditure, indicating a focus on this minority. There is also a strong correlation between total expenditure and the percent of non-functional schemes. This could indicate funds allocated for areas affected by failed schemes, or a threshold of capacity to build functional schemes.

Institutional factors show a correlation between the number of Gram Sabha meeting per VWSC and contaminated sources, especially chemically polluted sources. This is can indicate that in active communities there are more samples tested and identified as polluted. Also, more meetings may be required to implement solutions since chemically polluted sources can affect human health for long term and sometimes with irreversible effects.

Variable	National Exp.	State Exp.	Total Exp.	% National Exp.	% State Exp.	% Total Exp.	Gram Sabha per VWSC	Gram Sabha per GP	% Contaminated Sources	%Chem Pollution	% Bio Pollution
National Exp.	1.										
State Exp.	0.754	1.									
Total Exp.	0.961	0.906	1.								
% National Exp.	1.	0.754	0.961	1.							
% State Exp.	0.754	1.	0.906	0.754	1.						
% Total Exp.	0.961	0.906	1.	0.961	0.906	1.					
Training per VWSC	0.09	-0.04	0.041	0.09	-0.04	0.041					
Gram Sabha per VWSC	0.084	-0.029	0.042	0.084	-0.029	0.042	1.				
Gram Sabha per GP	-0.135	-0.059	-0.112	-0.135	-0.059	-0.112	-0.119	1.			
% Contaminated Sources	0.185	-0.069	0.09	0.185	-0.069	0.09	0.444	-0.325	1.		
%Chem Pollution	0.282	-0.048	0.161	0.282	-0.048	0.161	0.054	-0.223	0.705	1.	
% Bio Pollution	0.024	-0.057	-0.008	0.024	-0.057	-0.008	0.573	-0.268	0.81	0.155	1.
%Quality Failures	0.303	0.026	0.206	0.303	0.026	0.206	0.213	-0.247	0.215	0.274	0.073
%Quantity Failures	0.041	0.132	0.082	0.041	0.132	0.082	-0.018	0.291	-0.133	0.029	-0.209
Total # Schemes	0.302	0.142	0.254	0.302	0.142	0.254	0.07	0.011	-0.194	-0.069	-0.214
% NFS	0.365	0.048	0.255	0.365	0.048	0.255	-0.093	0.062	0.088	0.209	-0.05
Age of NFS	0.007	-0.011	0.	0.007	-0.011	0.	-0.062	-0.067	-0.058	0.169	-0.22
Schemes per FY	0.056	0.019	0.044	0.056	0.019	0.044	-0.105	-0.08	-0.415	-0.206	-0.408
SC Pop.	0.588	0.229	0.474	0.588	0.229	0.474	-0.029	-0.208	0.422	0.397	0.259
ST Pop.	-0.002	-0.003	-0.003	-0.002	-0.003	-0.003	-0.1	0.13	-0.306	-0.01	-0.417
GEN Pop.	0.408	0.156	0.328	0.408	0.156	0.328	-0.09	-0.263	0.33	0.402	0.127
TOTAL Pop.	0.469	0.178	0.377	0.469	0.178	0.377	-0.162	-0.192	0.158	0.435	-0.139
% State Pop	0.469	0.178	0.377	0.469	0.178	0.377	-0.162	-0.192	0.158	0.435	-0.139
%Mirity Pop	-0.064	-0.048	-0.061	-0.064	-0.048	-0.061	-0.103	0.337	-0.388	-0.161	-0.407
% SC Pop	0.276	0.17	0.249	0.276	0.17	0.249	0.178	-0.289	0.504	0.192	0.543
% ST Pop	-0.088	-0.062	-0.083	-0.088	-0.062	-0.083	-0.114	0.34	-0.409	-0.168	-0.431

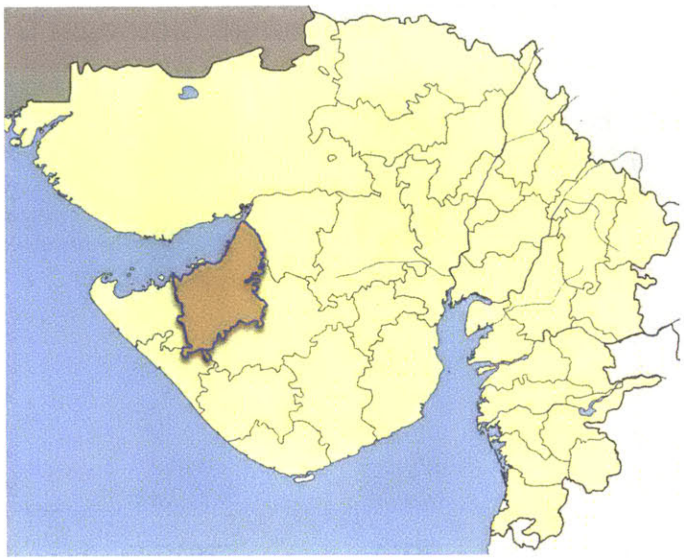
Environmental factors show a significant correlation between contaminated sources and schemes built per year. This can be linked that new schemes are needed to avoid using contaminated sources. Biological pollution also has correlation with schemes built per year, indicating that more schemes are built in places with biological contamination problems. There is also a correlation between biological pollution and minority populations, with the highest for Scheduled Caste communities. This requires further evaluation as local practices, type of sources used, and open-defecation. Using other national databases, such as census and National Biodiversity Authority (NBA), can complement data analysis.

Variable	%Quality Failures	%Qty Failures	Total # Schemes	% NFS	Age of NFS	Schemes per FY	SC Pop.	ST Pop.	GEN Pop.	TOTAL Pop.	% State Pop	%Mirity Pop	% SC Pop	% ST Pop
National Exp.														
State Exp.														
Total Exp.														
% National Exp.														
% State Exp.														
% Total Exp.														
Training per VWSC														
Gram Sabha per VWSC														
Gram Sabha per GP														
% Contaminated Sources														
%Chem Pollution														
% Bio Pollution														
%Quality Failures	1.													
%Quantity Failures	-0.311	1.												
Total # Schemes	0.101	-0.082	1.											
% NFS	0.113	0.308	0.176	1.										
Age of NFS	0.067	0.09	0.111	0.183	1.									
Schemes per FY	0.132	-0.188	0.447	-0.115	-0.124	1.								
SC Pop.	0.181	-0.036	0.18	0.402	-0.063	-0.157	1.							
ST Pop.	0.013	0.097	0.385	-0.209	-0.078	0.436	-0.365	1.						
GEN Pop.	0.081	0.065	0.186	0.518	0.179	-0.156	0.841	-0.443	1.					
TOTAL Pop.	0.11	0.129	0.476	0.41	0.114	0.136	0.688	0.227	0.771	1.				
% State Pop	0.11	0.129	0.476	0.41	0.114	0.136	0.688	0.227	0.771	1.	1.			
%Mirity Pop	-0.045	-0.006	0.225	-0.303	-0.082	0.495	-0.518	0.793	-0.671	-0.162	-0.162	1.		
% SC Pop	0.093	-0.1	-0.176	0.119	-0.169	-0.468	0.739	-0.655	0.537	0.153	0.153	-0.771	1.	
% ST Pop	-0.051	0.006	0.225	-0.29	-0.057	0.503	-0.554	0.796	-0.672	-0.165	-0.165	0.998	-0.813	1.

Technology factors show a correlation between total schemes and total population, which is expected since more people require more infrastructures to deliver water. There is also a correlation with number of Scheduled Tribal (ST) population. On the other hand, Scheduled Caste shows a correlation with non-functional schemes as well as highly populated areas. Number of schemes built per year also shows correlation with ST population, indicating an effort to build more schemes for this community, although not with the intended outcomes yet.

FIETS Analysis of Jamnagar District

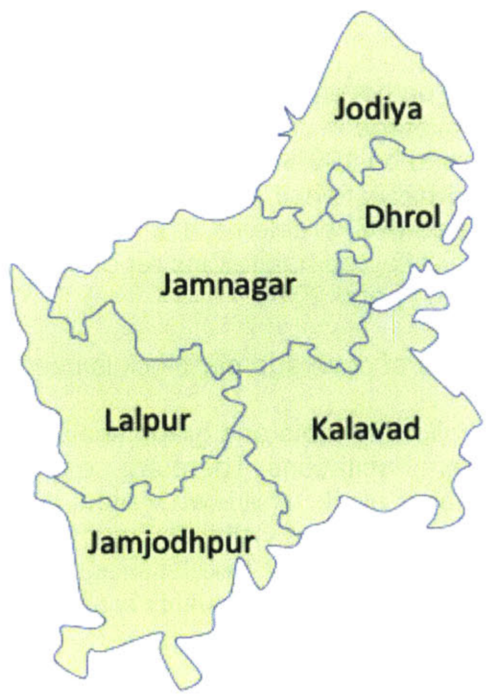
This analysis has the objective of testing FIETS framework and IMIS applicability at local geographical levels. District offices have the nodal role to manage all water projects and multidisciplinary projects, providing an important type of analysis for decision-makers at this level. As mentioned in the IMIS section, district office manages all public projects in their area. Providing a better understanding of water coverage allows them to understand better the interconnection with other related projects at each block.



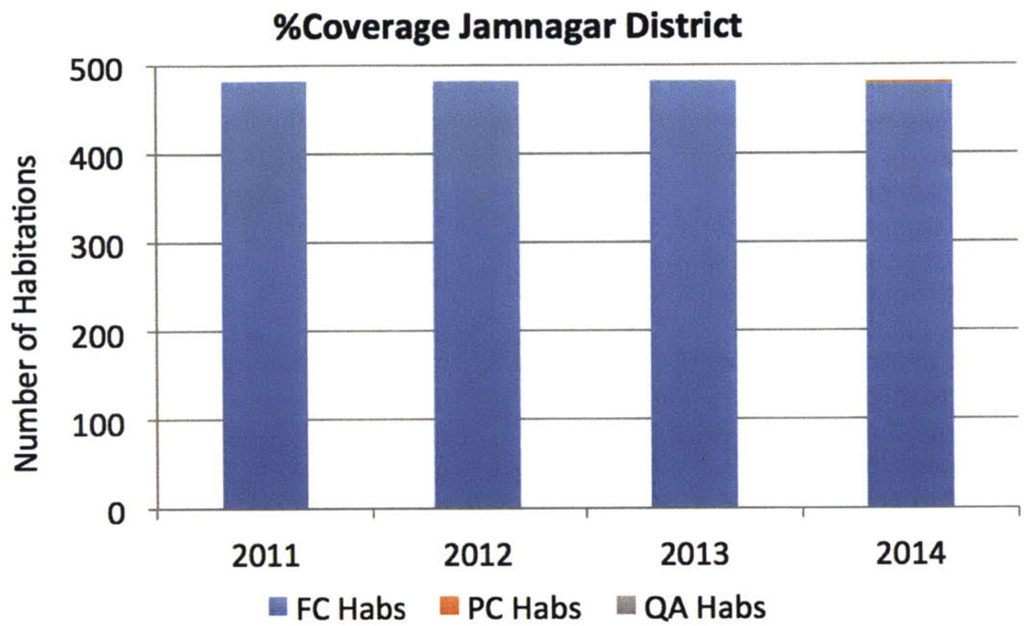
Jamnagar district is selected because during this study we made field visits to 15 villages in this district, did extended field work in one of them, and interviews with District officials, giving a perspective to compare data results with empirical field observations.

Jamnagar district changed its geopolitical structure with the reorganization of districts in Gujarat in 2013. The figures shown represent the current district arrangements in Gujarat and within Jamnagar district.

Other districts could have been selected for higher rates of partial coverage or quality affected habitations.



Water Coverage in Jamnagar District



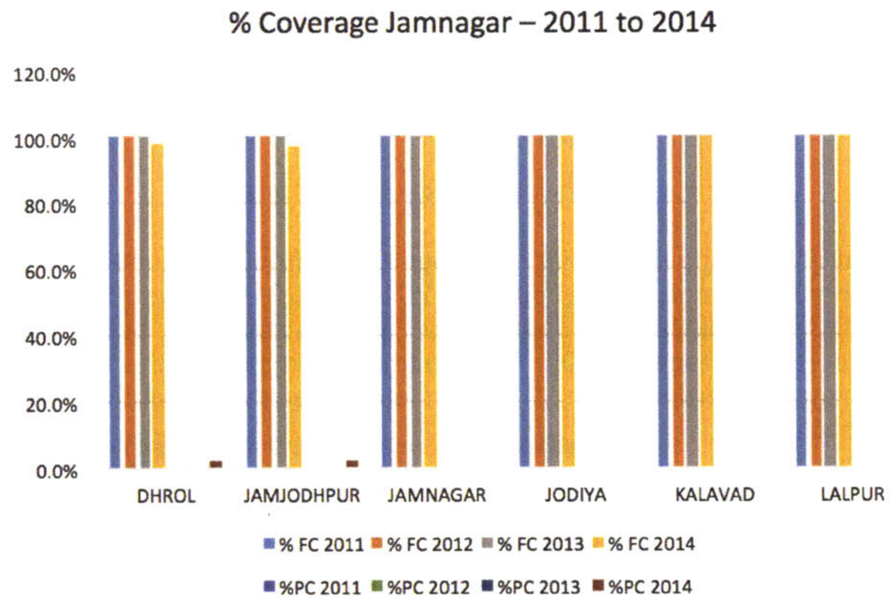
Based on coverage graph and table, the coverage in Jamnagar district shows to be 100% until 2014 when 3 of 481 habitations have Partially Covered (PC) problems. There are no quality-affected habitations reported from 2011 and 2014.

Financial Year	FC Habs	PC Habs	QA Habs	Total
2011	482	0	0	482
2012	482	0	0	482
2013	482	0	0	482
2014	478	3	0	481

Analysis of coverage per block is used to localize the PC problems.

The following table and graph show Dhrol and Jamjodhpur as the two blocks with the problem habitations. There are no previous reported problems in these blocks. In the Jamnagar block, where we visited, there are no problems reported on quantity or quality. During our visit to Jivapar village, the full coverage was obtained with inconvenience, cost, and less regularity and possibly quality. The neighbor village (Amra) had perceived quality problems and this does not show in the data.

Block	FC 2011	FC 2012	FC 2013	FC 2014	PC 2011	PC 2012	PC 2013	PC 2014
DHROL	50	50	50	49	0	0	0	1
JAMJODHPUR	83	83	83	82	0	0	0	2
JAMNAGAR	104	104	104	102	0	0	0	0
JODIYA	63	63	63	63	0	0	0	0
KALAVAD	104	104	104	104	0	0	0	0
LALPUR	78	78	78	78	0	0	0	0
Grand Total	**482**	**482**	**482**	**478**	**0**	**0**	**0**	**3**

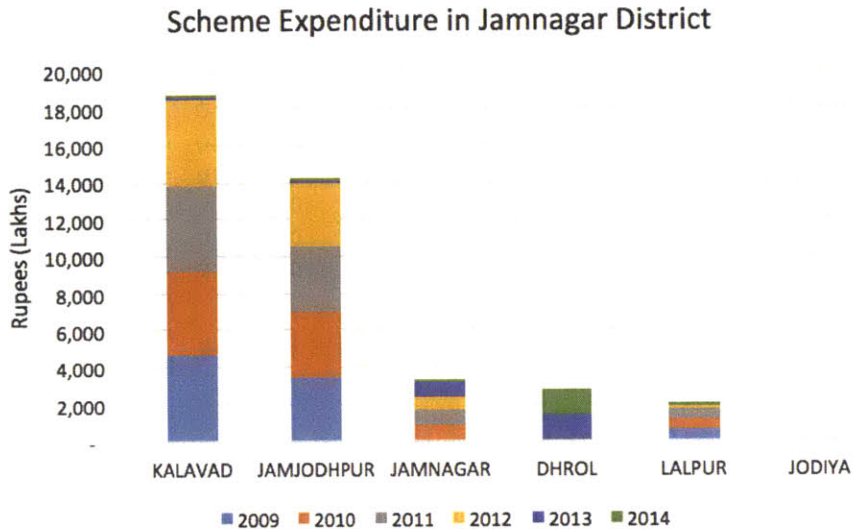


Financial Factors

There is no specific report for expenditure at the block level, however using the data set from schemes built per year, it was possible calculate the total expenditure for schemes by block from 2009 to 2014. Based on the data source it is expected to see a high correlation between expenditure and schemes built per block.

Block	2009	2010	2011	2012	2013	2014	Grand Total
KALAVAD	4,656	4,600	4,605	4,646	119	123	18,749
JAMJODHPUR	3,488	3,513	3,495	3,515	50	30	14,090
JAMNAGAR	120	741	791	791	781	106	3,330
DHROL	11	20	25	42	1,363	1,380	2,840
LALPUR	583	585	600	41	32	32	1,873
JODIYA	28				-	-	28
Grand Total	8,886	9,459	9,515	9,034	2,345	1,671	40,911

Based on the average expenditure there is a large drop from 1,807 lakhs in 2012 to 278 lakhs in 2014. Looking at the expenditure table by year, in 2013 total expenditure was 2,345 lakhs versus 9,034 lakhs in 2012. This decrease on expenditure represents a 74% reduction, which may bring more slipback in the coming years.



Kalavad and Jamjodhpur have the highest expenditures from 2009 until 2012, and Dhrol and Jamnagar have the largest expenditure in 2013 and 2014. There must be a reason for high expenditure in Kalavad and Jamjodhpur, such as coverage, built schemes, or community support. Coverage is 100% for both and in Jamjodhpur there are 2 habitations with quantity problems in 2014. This eliminates the possibility of expenditure for coverage or quality affected habitations.

The next table shows the expenditure on schemes by percentages, showing 92% of funds used in Kalavad and Jamjodhpur from 2009 to 2012. In 2014, 82% of funds are allocated to Dhrol block.

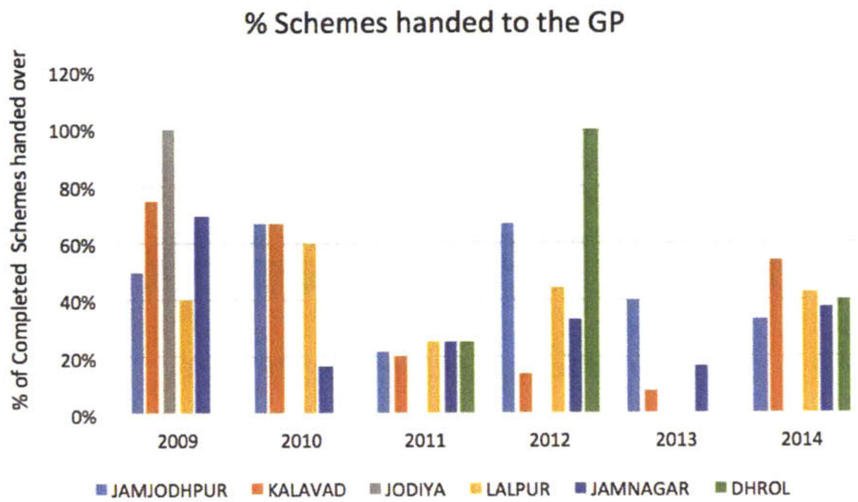
Block	2009	2010	2011	2012	2013	2014	Grand Total
KALAVAD	52.4%	48.6%	48.4%	51.4%	5.1%	7.4%	45.8%
JAMJODHPUR	39.2%	37.1%	36.7%	38.9%	2.1%	1.8%	34.4%
JAMNAGAR	1.4%	7.8%	8.3%	8.8%	33.3%	6.3%	8.1%
DHROL	0.1%	0.2%	0.3%	0.5%	58.1%	82.6%	6.9%
LALPUR	6.6%	6.2%	6.3%	0.5%	1.4%	1.9%	4.6%
JODIYA	0.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%
Grand Total	100%	100%	100%	100%	100%	100%	100%

Institutional Factors

For institutional analysis the only data available below district level is the number of schemes handed over to GP. This variable will indicate how many schemes are given to the local governance for management, operation, and maintenance.

The more schemes are handed to the GP the more involved the local governance. To have a better perspective of how many schemes are given to the GP, the percentage of schemes given to the community versus total schemes built is provided.

Based on the percentage of schemes given to GPs, Jamjodhpur and Kalavad have the highest percent with 50% and 46% respectively. Jodiya has 40% with only 2 schemes in 2009 and no more data for this block since that year. Lalpur, Jamnagar, and Dhrol are the last three blocks and percentages ranging between 33% and 38%.



The year with most schemes given to the community is 2009 with 64%, followed by 2010 with 55%. The year with least community involvement in schemes is 2013 with only 13%. As of 2014, the current percent is 41% but this could increase as the year ends in Mar 2015.

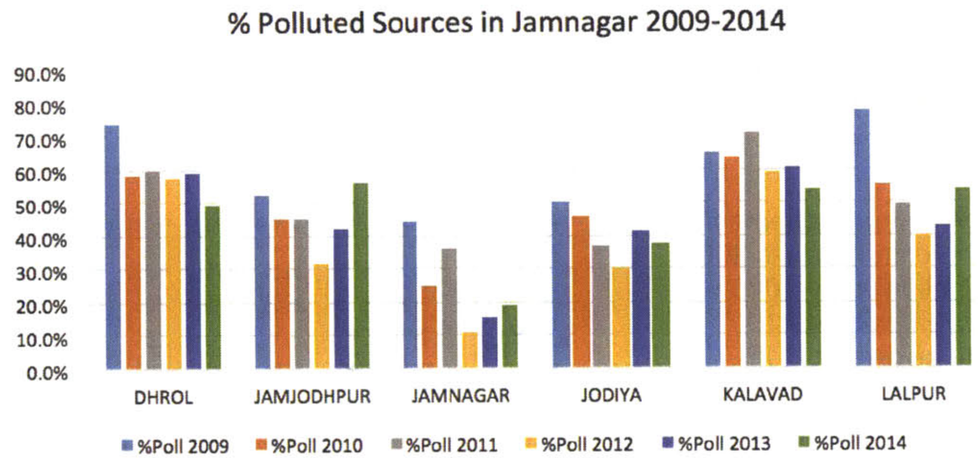
Block	2009	2010	2011	2012	2013	2014	Total
JAMJODHPUR	50%	67%	22%	67%	40%	33%	50%
KALAVAD	75%	67%	20%	14%	8%	54%	46%
JODIYA	100%				0%	0%	40%
LALPUR	40%	60%	25%	44%	0%	43%	38%
JAMNAGAR	69%	17%	25%	33%	17%	38%	35%
DHROL	0%	0%	25%	100%		40%	33%
Grand Total	64%	55%	24%	46%	13%	41%	41%

Based on this data there is a medium to low level of involvement of community at operation of schemes in this district. A high level of involvement would be between 70-100% of schemes handed to the community. The strongest community participation is in Jamjodhpur with 50% Kalavad with 46%, and Jodiya with 40%. Jodiya is an interested block without data from 2010 to 2012.

Environmental Factors

The environmental analysis includes laboratory-testing data from sources tested in the district. This is not relative to all sources existing in Jamnagar but to all sources tested at habitation level. The contamination only shows chemical and biological pollution combined.

Block	%Poll 2009	%Poll 2010	%Poll 2011	%Poll 2012	%Poll 2013	%Poll 2014	Average
DHROL	73.9%	58.4%	60.2%	57.9%	59.2%	49.2%	59.8%
JAMJODHPUR	52.4%	45.5%	45.4%	31.6%	42.4%	56.2%	45.6%
JAMNAGAR	44.6%	24.8%	36.5%	10.8%	15.2%	18.8%	25.1%
JODIYA	50.0%	45.7%	36.7%	30.5%	41.4%	37.4%	40.3%
KALAVAD	65.5%	64.0%	70.8%	59.2%	60.4%	54.0%	62.3%
LALPUR	77.5%	55.4%	49.7%	39.7%	42.7%	53.9%	53.1%
Average	60.6%	49.0%	49.9%	38.3%	43.5%	44.9%	



Based on the graphic, pollution at source is declining in most blocks except Jamjodhpur with a 56% polluted tested sources. There is an increase of pollution between 2013 and 2014 in 3 blocks, including: Lalpur, Jamnagar, and Jamjodhpur.

The block with highest pollution is Kalavad with an average of 62%, followed by Dhrol with 605 and Lalpur with 53%. Jamnagar is the block with least pollution problems since 2009 until 2014 with 25.1%.

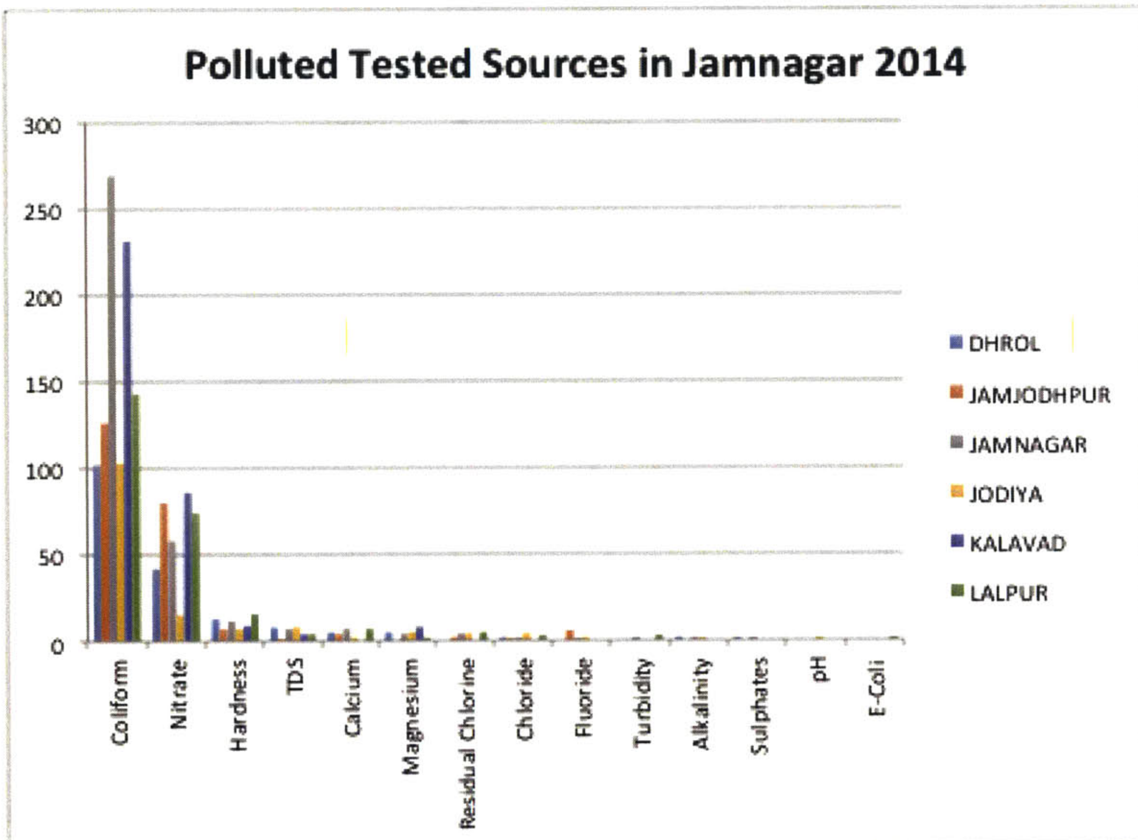
The year with most contaminated samples is 2009 with 61% and this has been decreased gradually to 45% in 2014.

Looking in detail at the parameters of contamination, data show coliform and nitrate as the main quality problems at sources. The following table shows the number of polluted sources in 2014 and previous years for the Jamnagar district. Since these are polluted sources from the samples tested, the number of total samples per year is also included in the following tables.

Financial Year	2009	2010	2011	2012	2013	2014
Sources Tested	605	1,279	1,308	3,188	5,286	3,969

Polluted Tested Sources in Jamnagar District

Parameter	2009	2010	2011	2012	2013	2014	Grand Total
Nitrate	34	220	298	328	542	355	1777
Coliform	67	12	23	39	350	974	1465
Hardness	51	90	67	156	164	64	592
TDS	32	48	35	100	87	32	334
Calcium	31	32	22	76	63	25	249
Magnesium	16	31	15	50	52	24	188
Chloride	14	14	4	36	27	12	107
Residual Chlorine	3	8	2	5	19	15	52
Fluoride	0	7	2	13	17	9	48
Turbidity	6	14	3	21	16	5	65
Sulphates	4	4	2	17	12	2	41
Alkalinity	1	1	0	9	5	5	21
pH	2	0	0	0	3	1	6
E-Coli (MPN /100 ml)	0	1	4	2	2	1	10
Total	**261**	**482**	**477**	**852**	**1359**	**1524**	**4955**

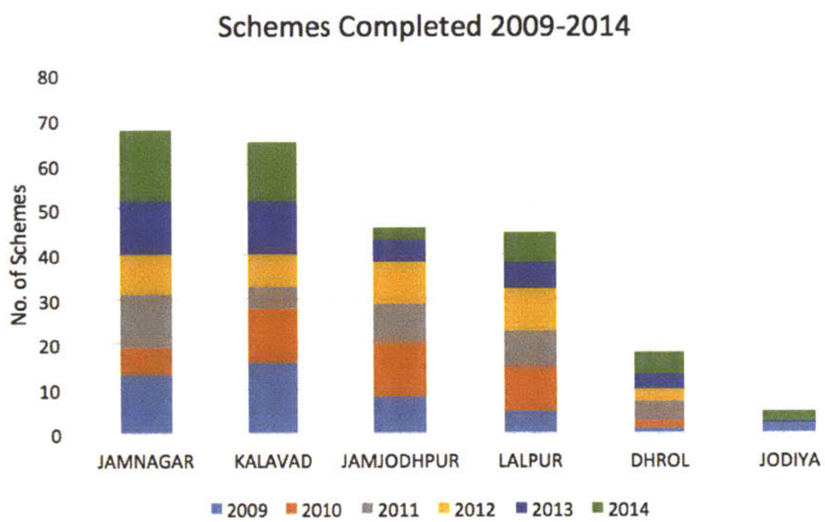


Jamnagar and Dhrol blocks have the highest number of pollution for coliform and nitrate.

Technology Factors

For technology factors the only data available in IMIS formats is the number of schemes built per Block per year, from 2009 until 2014.

Based on this data most of the schemes are built in Jamnagar and Kalavad, with a total of 68 and 65 schemes respectively. Jamjodhpur and Lalpur have 46 and 45 schemes, Dhrol has 18, and Jodiya only 5 schemes.



Row Labels	2009	2010	2011	2012	2013	2014	Total	Avg
JAMNAGAR	13	6	12	9	12	16	68	11.3
KALAVAD	16	12	5	7	12	13	65	10.8
JAMJODHPUR	8	12	9	9	5	3	46	7.7
LALPUR	5	10	8	9	6	7	45	7.5
DHROL	1	2	4	3	3	5	18	3.0
JODIYA	2				1	2	5	1.7
Grand Total	45	42	38	37	39	46	247	42.0
Average	7.5	8.4	7.6	7.4	6.5	7.67	41.2	

The numbers of schemes do not justify the expenditures in Kalavad and Jamjodhpur as they are not the top two blocks nor have a considerable difference with other blocks as they do for financial resources. 53% of schemes were built in Kalavad and Jamjodhpur in 2009 and overall they account for 45% of all schemes built since 2009. Expenditure is 80% for the same period.

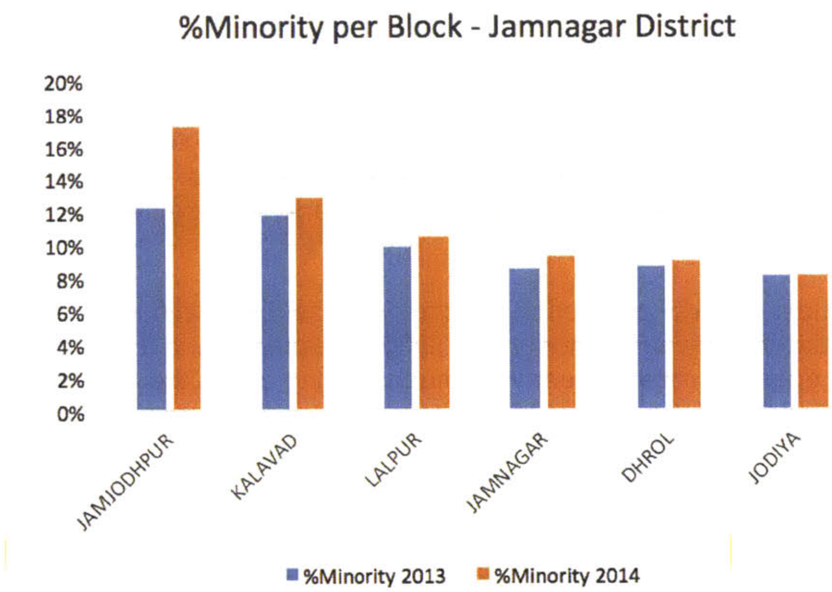
Social Factors

General population and minority population are available per block and lower geographical levels. The population density per block allows understanding water demand in this area.

With the creation of the 7 districts in Gujarat, Jamnagar district change its political delimitations. The next table shows the old and new blocks as well as population changes before and after the change. The change shows between 2013 and 2014 with a 45% drop in population within the district.

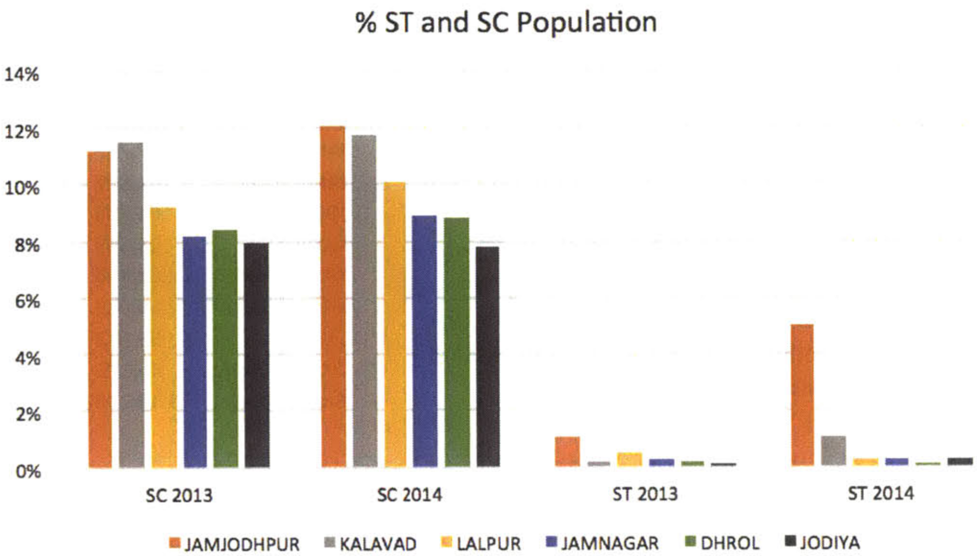
Population Jamnagar District

Block	Total 2013	Total 2014
BHANVAD	99,769	
DHROL	58,310	53,433
JAMJODHPUR	107,753	107,353
JAMNAGAR	201,392	194,898
JODIYA	101,733	85,708
KALAVAD	125,845	110,697
KALYANPUR	182,496	
KHAMBHALIA	165,083	
LALPUR	96,532	98,070
OKHAMANDAL	46,179	
Grand Total	**1,185,092**	**650,159**



Looking at the percentage of SC and ST within each block, allows analyzing if there is social equity of water supply systems. Block with high minority population can be evaluated for performance and how much support has been provided by state and central governments.

The next graph shows that historically blocks with highest minority population are Jamjodhpur, Kalavad, and Lalpur. All blocks have minority population ranging between 8% and 17%.



Looking in more detail at minority population, most of it is Scheduled Caste with more than 95% of minority population across all blocks within Jamnagar. The highest ST population is 5% in Jamjodhpur in 2014, with a significant increase from 1.1% in previous years.

Blocks with the most minority population are the same as those with more expenditure, indicating a correlation between minority population presences and funding allocation. However, Lalpur does not receive nearly as much funding and is the 3rd block with highest minority population.

Summary of Analysis at the District Level

The summary of coverage and FIETS results per block is presented in the next table. Based on this, the closest correlations are for total population. The three higher populated blocks are also the top three in expenditures. Minority population is also highly present in two of these blocks, but not for the other blocks.

		Financial	Institution	Environmt.	Technology	Social
Block	PC Habs	% Expenditure	% Schemes handed to GP	%Pollution	Schemes Built	Population ('000)
KALAVAD	0	46	46	62	65	110
JAMJODHPUR	2	34	50	46	46	107
JAMNAGAR	0	8	35	25	68	195
DHROL	1	7	33	60	18	53
LALPUR	0	5	38	53	45	98
JODIYA	0	0	40	40	5	86

Since expenditure data was extracted from schemes data, there should be a strong relationship between these two variables. However the ranking for both do not match, indicating that deeper research for types of schemes built could provide better insights on these two variables.

Pollution seems to be a growing problem in the district based on the number of polluted samples and total tested. Nitrate and coliform are the two main factors of concern. Nitrate requires looking at agriculture practices since sources of nitrate are likely from fertilizers. For coliform it indicates pollution from human and/or animal waste and could be easier to isolate the sources of pollution.

Chapter 7. Conclusions and Recommendations

This chapter summarizes the key findings and recommendations from using the FIETS framework to analyze failures of water coverage using the IMIS database. For state level findings some may be specifically for Gujarat. However, since the IMIS database has the same information for all states in India, this analysis can be scaled to other states and districts.

General Findings regarding the FIETS Framework and IMIS Database
The IMIS data has a very comprehensive survey platform that reaches the lowest level of community at habitations. The hardware and software development of IMIS provides a great resource for data collection and understanding of water supply in rural India. As part of this platform there has been a wide reach of Internet access as low as habitation levels, empowering local governments with the IMIS platform as well as global access to communicate and share data and information.

The IMIS is found to be a useful source for analyzing FIETS factors and to follow up on problems in coverage status. However, when coverage is high and variance is low, it is difficult to establish relationships between FIETS and slipback as in high coverage states like Gujarat.

The FIETS framework is found to be very useful to analyze slipback monitoring data, categorizing it, and simplifying the data complexity within IMIS. The application of FIETS was successful as it was possible to identify key data that provides performance for FIETS factors. Key indicators found in this study and that should be used by government officials to track performance are:

- Slipback to be easily calculated as the percentage difference of coverage between years, which can be continues or selected by the user
- Number of trainings per VWSC per year
- Number of VWSC per village per year
- Number of failed schemes per completed schemes per year
- Age of failed schemes as current status and keep historical data of failures
- Gram Sabah per VWSC per year
- Schemes handed over to VWSC instead of GP per year and cumulative

All this parameters should be easily accessible for current year as well as be able to display historical trend.

For large regional and interstate water supply projects a different sustainability study is recommended. For the case of Gujarat, the Narmada dam water supply is such a large-scale project that it requires a separate sustainability assessment. By comparison, this study is useful for in-village and small regional water supply systems that rely on local sources. Another assessment is recommended to learn about sustainability of Narmada water supply for all villages that use it as a main water source.

Current guidelines for data entry are very detailed and serve as good reference documents for state and district officials. However, there are still some gaps on data validations that need improvement. The following are the main findings of this study:

- *Slipback definition.* The current slipback format in IMIS is confusing and does not have a clear definition regarding the duration of failure. For example, failure during the pre-monsoon period should be defined as a type of failure, which can extend to increasingly long time periods. By better defining slipback it would be possible to create indicators that help increase visibility and understanding of failure of water supply systems and their impact on the communities. As found in this study, the difference between full coverage between years helps understand performance trends. Current data is shown for present year, and analyzing difference from previous years requires several steps of download and data processing.

- *Non-functional schemes data shows very low failure for states with highest number of schemes, which is not realistic.* More detailed audits of scheme failures are required to improve data reliability for this variable. This is important because it is a direct indicator of performance of infrastructure. This data should also display scheme failures for previous years and display historical trend and performance.

- *State expenditure is shown as lump sum at district level.* Providing more visibility on state expenditure helps identify which strategies are being funded and which require more or less resources. This data is available for national expenditures and enables more detailed analysis of possible reasons of failures within a state.

- *Quality of contaminated sources is confusing to understand, as data is very segregated.* Also, more details of sampling methods would help understand this data set.

- *Identification of sources used by habitations would help to create a monitoring plan to ensure they are sustainable.* This effort will help to develop testing and community awareness with more impact to local communities. Current testing is for all sources but not focused on their actual usage.

- *Narmada water supply is not clearly visible in the IMIS and this is an important factor for status of water supply for habitations.* The Narmada is an external water source hence maybe less sustainable for local communities since it is not maintained by them. By identifying which communities are using Narmada water as main supply will help identify which sector is more vulnerable to this network failures.

- *IMIS format for Total Schemes is confusing.* The data does not clarify that this number includes Completed and On-going schemes and requires further analysis to find this segregation. More visibility on how data is categorized is helpful for general understanding of IMIS.

- *Use indicators that can track progress at state and district levels can help develop goals for better strategies.* Current IMIS goals are focused on coverage of water at household level. However, to reach this goal there is also a focus on sustainability from the community perspective. These community goals require indicators that track performance, such as training per VWSC, Gram Sabah per VWSC, and schemes handed over to GP. These indicators can help establish targets to encourage implementation of programs focused on the community and sustainability with quantitative metrics of performance.

- *Add a category of failure during the monthly report to capture temporary failures of coverage.* This category can include the reason of failure as quantity or quality, and the time of failure.

- *Conduct detailed user interface analysis when creating the IMIS dashboard.* IMIS is developing a dashboard to improve data visualization for users, and these findings can contribute to the development of data visualization for slipback and sustainability. National and state governments are looking at remote monitoring for the future of IMIS and this will enable to measure water supply on real time and more accurately. The use of IMIS is expected to go beyond the NRDWP time frame and be used to develop a smart grid to efficiently manage water supply in current rural areas.

Summary of State-Level Findings on Slipback Problems

Social Variables Findings: Based on statistical data there is no correlation between habitation coverage and FIETS factors *except with minority populations*. There is a strong correlation between fully covered (FC) habitations and percent of scheduled caste (SC) and scheduled tribes (ST). However, there is a fundamental difference with these correlations: SC has a positive correlation indicating more FC in SC communities. On the other hand, ST has negative correlation indicating that there is less FC in highly SC populated areas. This indicates ST areas have less water access than other social groups. These findings further suggest that IMIS data should be compared with Census of India and other socio-economic data.

Correlations found between FIETS factors are summarized as follows:

1. Financial factors: positive correlation between expenditures and density of population. Positive correlation between expenditure and SC populated areas. Positive correlation between expenditure and percentage of non-functional schemes.

2. Institutional factors: more community meetings per VWSC in areas chemically polluted areas. This indicates a proactive action in chemically affected regions, indicating awareness of their impact in the community.

3. Environmental factors: positive correlation between schemes built per year and biological polluted sources. This can indicate that the strategy to solve problems in these communities is building new infrastructure.

4. Technology factors: positive correlation between number of schemes built and ST as well as general population. Also, failed schemes are correlated with SC and general population. These correlations can indicate that since there are more schemes there is a higher chance of failure in highly populated areas. Also, the SC areas are receiving focus on built infrastructure year. Looking at infrastructure built this year, the positive correlation is with ST and minority populations.

It is interesting that even though communities with chemical pollution at sources have higher correlation with expenditures, there is a stronger correlation between biological polluted areas and built infrastructure.

Also, the correlation between new schemes built in 2014 for ST areas indicates a current strategy to solve the current inequality of water coverage for this minority community.

The reduction of state expenditure from 2012 to 2014 is something that may be related to the construction of the Sardar Sarovar project as this also provides drinking water to 75% of habitations. Another analysis for the next few years is recommended to analyze if this drop of invest would have an impact on coverage.

Summary of District, Block, and Habitation-Level Findings

There is less visibility in some factors below district level, such as expenditure, institutional variables, and non-functional schemes. Providing more visibility for these variables could help perform the FIETS framework with same factors as the state analysis.

The key findings for the district analysis are:

1. Coverage: since there is no variance between blocks in Jamnagar District, it is not possible to determine clear impacts of FIETS in a fully covered area. If coverage is high, the correlation between FIETS becomes the center of analysis. However, based on field visits there are questions about the water quality data, such as the case of the village of Amra and Jivapar.

2. Financial factors: High concentration of financial resources between blocks, up to 92% within 2 of 6 districts. There is no direct correlation between this highly concentrated funding and schemes built. The financial data source is from schemes expenditure, which should indicate a large number of schemes built in the high expenditure areas. However, the schemes built per year are not showing the same ratio as of the financial factor per block.

3. Institutional factors: there is only one institutional factor accessible for block level. It shows an average of 42% of schemes are given to the community for operation and maintenance. More visibility to number of VWSC per village, Gram Sabha, and training would provide a better understanding of institutional support at sub-district level.

4. Environmental factors: current analysis use data from polluted tested sources, giving an indicator of potential risk to affect habitations. Data shows an increase of pollution in three blocks with specific parameters of pollution. In the case of Jamnagar key pollutants are nitrate and coliforms.

5. Technology factors: the only variable available is the number of schemes completed per block. The number of schemes per district does not correlate with financial expenditure, since blocks with high expenditure do not have high schemes on the same proportion.

6. Social factors: total population has higher correlation with expenditure than other variables. Minority population is evenly distributed among blocks, ranging between 8 and 17% of total population. The two blocks with the highest minority population are the same two blocks with highest expenditure. However, this correlation is questionable since the 3rd block with highest minority population receives low funding.

Overall, the IMIS is useful for FIETS factors evaluation but correlation with coverage is not always possible. The application of this analysis at the district offices provides information to improve planning of water coverage. In the case of Jamnagar, the high presence of nitrate and coliform polluted sources at known habitations provides reasons to focus efforts on these communities for the coming annual plan.

The number of schemes per block provides data to understand if new schemes are built to compensate for failed schemes that are not reported as slipback. In the case of Jamnagar districts the blocks with lowest schemes built since 2009 require field visits to understand how villages are managing without access to as many schemes as other blocks.

With these qualitative assessments of FIETS factors, financial resources can be use more effectively to provide field assessment of areas identified by analysis of IMIS data.

Priorities for Future Research and Applications

Since the application of IMIS data is a very recent area of study, we provide the following recommendations:

Database development: improve data collection by adding variables to the current formats that are aligned with measuring effectiveness of water coverage. The most

important priorities are: definition of slipback, seasonal coverage into monthly reports, and improvement of water quality data and connect it with sanitation data.
Research: Field based studies to compare IMIS database analysis are highly recommended. These would provide data validation as well learn what variables best represent field survey data. Another important step for research is to test the impact of this analysis for decision-makers. Once data is analyzed what is necessary to enable changes on the planning and strategies of water coverage from district, state, and national levels. This testing can be done at district level offices to understand the impact on the development of annual district plan.

Training: During this research the IMIS use was mainly as a data entry but not as a data source for government officials. This research provides the basic understanding of the IMIS data and how it can be analyzed. This could be modified and used for government official to understand the status of their region as well as give continuity between changes of personnel. This is an important feature of IMIS that could be leverage after developing a training module for data analysis of IMIS.

Integration with other databases: The IMIS has great data but it can be complemented with databases available at state and national level. These databases would increase the data validation of the analysis as well as integrate multiple organizations that can impact the water landscape of all governance levels. Some examples are: census data, groundwater survey, sanitation, health, forest, and agriculture.

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