Urban Water Security Planning Toolkit

December 2017

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Acknowledgements

This toolkit has been prepared by CEPT University under the project "Knowledge Management and Advocacy Partnership for Participatory Ground Water Management in Bhuj" funded by Arghyam. CEPT University is the Knowledge Partner to Arid Communities and Technologies (ACT) for ground water management activities in the city of Bhuj, Gujarat.

This toolkit has been developed based on the experience in Bhuj. It contains guidelines and tools for improving water security that can be used in other cities.

The work on this report was carried out by a CEPT University team led by Dr. Meera Mehta and Dr. Dinesh Mehta and included Dhruv Bhavsar, Upasana Yadav, Aditi Dwivedi and Jigisha Jaiswal.

We would like to acknowledge the extensive support of the ACT team, particularly Dr. Yogesh Jadeja. We are also thankful for comments and suggestions received from the participants of the workshop organized at CEPT University in March 2017.

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Executive Summary

Rapid growth of urban population has severe repercussion on drinking water provision in cities. The year 2016 saw water trains being delivered to drought hit cities in Maharashtra. Over the years, dependence of cities on water being brought from far-off regions has increased. Water security for urban areas remains a distant dream. A paradigm shift in urban water management and planning is needed for cities to become water secure.

In the midst of this discourse lies the story of Bhuj city and its efforts towards becoming water secure. In the past, Bhuj has survived in an arid climate through traditional water management practices. In recent years, the local community led by a NGO-Arid Communities and Technologies (ACT), has made efforts in reviving traditional water conservation practices and exploring alternative water supply systems through participatory management. The Centre for Water and Sanitation (C-WAS) at CEPT University as a knowledge partner to ACT has documented the Bhuj experience. Based on this experience in Bhuj, CEPT has developed a toolkit containing guidelines and tools that can be used in other cities, paving way for them to become water secure.

This toolkit approaches urban water management in an integrated manner rather than the conventional approach where different aspects of the urban water cycle are managed separately. Instead of creating more and more infrastructure to augment supply, it focuses on increasing efficiency of the existing supply system and exploring alternative sources while also incorporating hydro-geological aspects in city planning.

The toolkit is divided into 5 simple modules. A rapid assessment section in the beginning serves as a tool for providing the perspective of city managers as well as citizens on water stress in the city. Subsequently, the first module outlines how the city should undertake an assessment of its existing municipal water supply system and the private water market. The second module delves into the assessment of water resources as components of the hydrological cycle with a water balance assessment-covering rainfall, surface sources and their watersheds, as well as groundwater in aquifers in addition to urban supply. Based on these two assessments, the third module explores opportunities for alternative sources and efficiency improvements in supply system. To enable implementation of these improvement actions, modules 4 and 5 provide tools and methods for citizen involvement and understanding institutional and regulatory framework.

This toolkit is intended for use by local governments, city officials, planners, consultants engaged in city planning as well as NGOs and civil society groups championing the cause of urban water security.

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About this project

Knowledge Management and Advocacy Partnership for Participatory Ground Water Management in Bhuj

Centre for Water and Sanitation (C-WAS) at CEPT University is the Knowledge Partner to Arid Communities and Technology (ACT) for ground water management activities in the city of Bhuj, Gujarat. CEPT supports ACT in documentation of processes related to Participatory Ground Water Management (PGWM) in Bhuj. The project is being funded by Arghyam.

Bhuj, a city located in arid region of Kutch in India, demonstrates how the city that had withstood water scarcity for centuries has revived its traditional wisdom to work towards becoming water secure. In the past, Bhuj has survived in an arid climate through traditional water management practices. With modern piped supply, this wisdom was lost and the system of interlinked catchments and lakes fell into disrepair. Bhuj is now relying on bulk water import from Narmada. In recent years, the local community led by a NGO-Arid Communities and Technologies (ACT), have made efforts in reviving traditional water conservation practices and exploring alternative water supply systems through participatory management. Making cities 'water-secure' is the principle aim of the activities carried out by ACT. The process documentation of ACT's activities in Bhuj and report prepared on strengthening these activities linkages with the municipal services gives a wider picture on how more generic guidelines and tools would be helpful for other cities to adopt such practices. Thus based on the experience of Bhuj, CEPT has developed generic guidelines and tools that can be used in other cities and pave way for them to become water secure.

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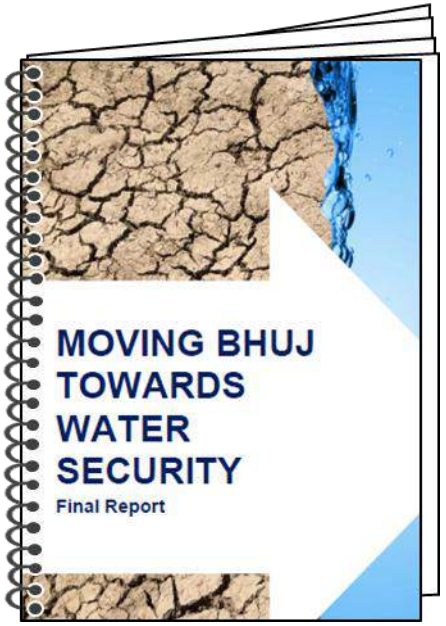
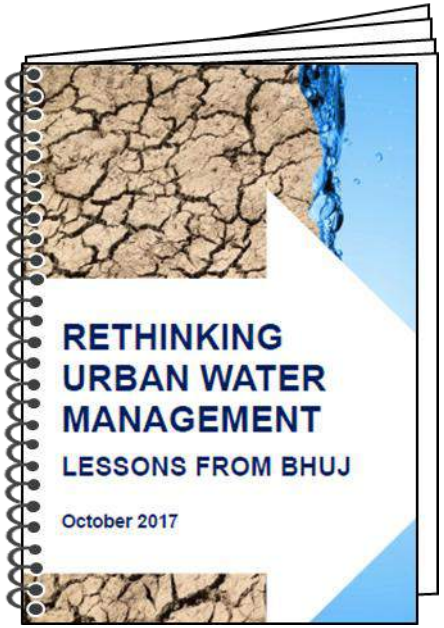
Know more about the Story of Bhuj





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Urban Water Security Planning Toolkit

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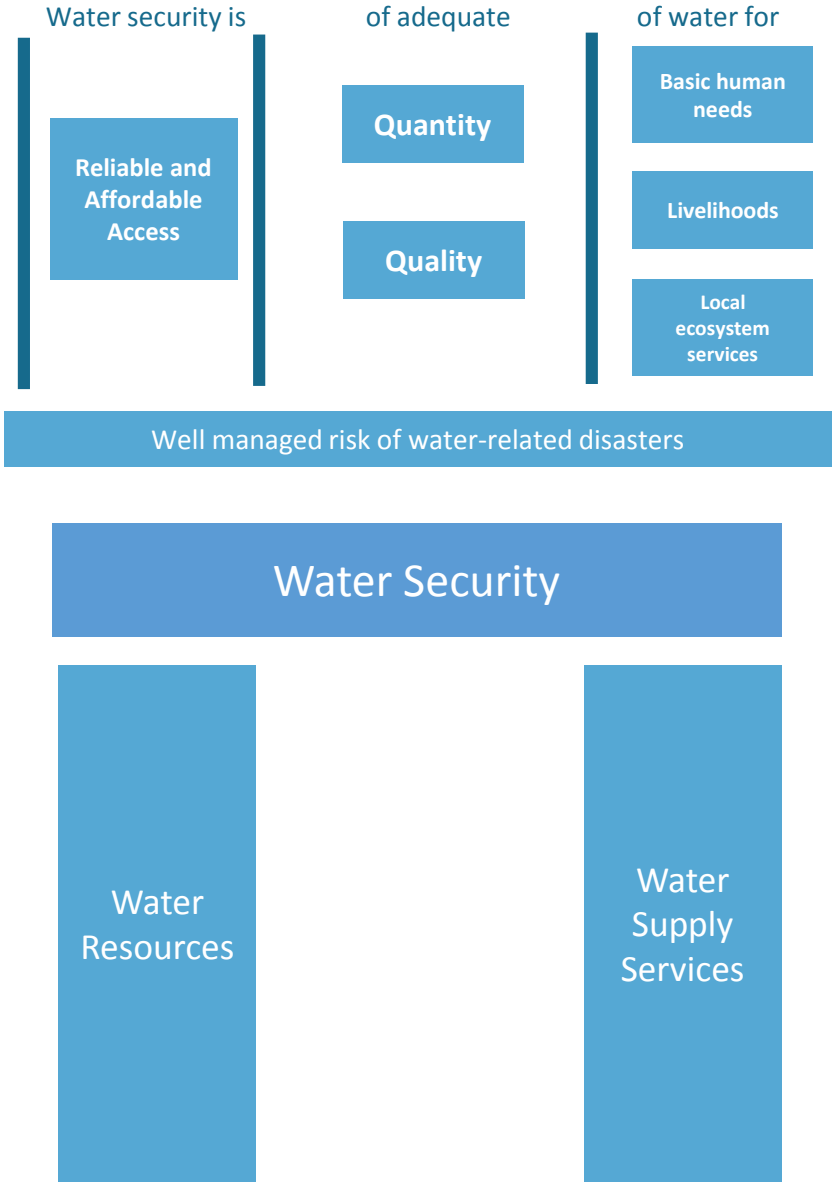
1 Need and Concept of this Toolkit

What is water security?

Figure i: Water Security Framework



Adapted from: WaterAid (2012) Water security framework. WaterAid, London.

Freshwater is the most important resource for mankind, cross-cutting all social, economic and environmental activities. History teaches us that many civilizations were wiped out due to water scarcity. With climate change and resultant uncertain weather patterns, cities have become even more susceptible to water scarcity than ever before.

The global community has also recognized importance of this issue in the "2030 Agenda for Sustainable Development", specifically, in the Sustainable Development Goal (SDG) on water to "ensure availability and sustainable management of water and sanitation for all" and the Target 6.4, which states that "By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity".

Water security is defined as, "Reliable and affordable access of adequate quantity and quality of water for basic human needs, livelihoods and local ecosystem services, coupled with well managed risk of water-related disasters.

This water security framework is developed for urban water users. It is an outcome which we aim to achieve by managing appropriately two base pillars of water resources and water supply services.

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Water Security is emerging as an issue of extreme urgency

Figure ii: Water Stress Level in India

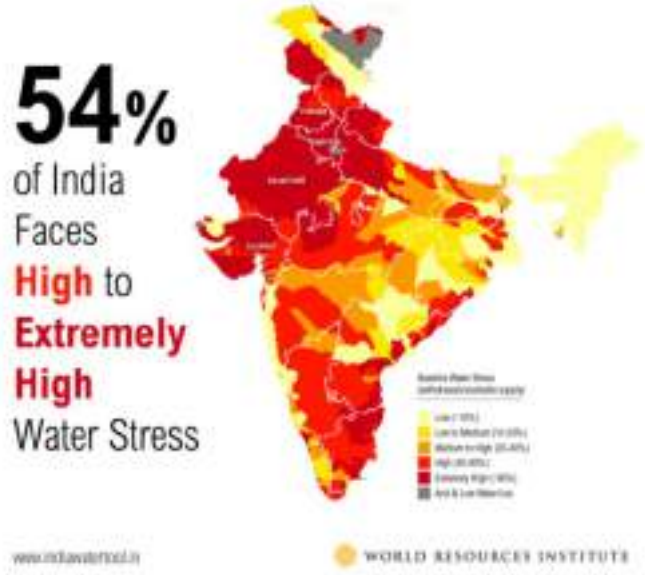
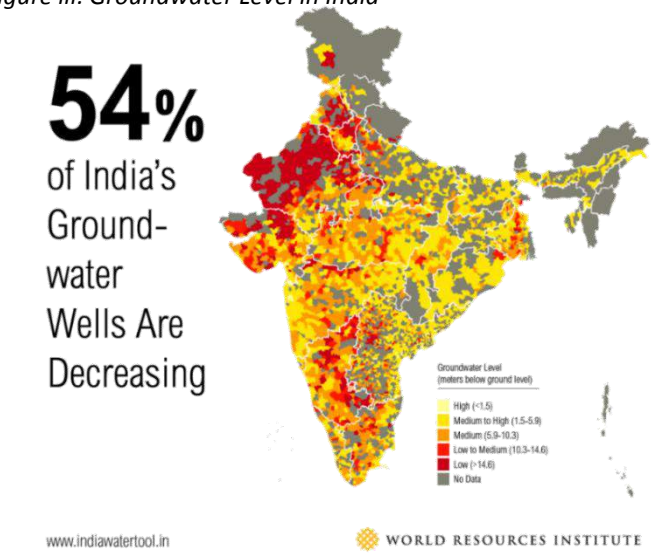


Figure iii: Groundwater Level in India



Water is a critical natural resource for the world's growing urban areas. Globally 2.1 billion people lack access to safely managed drinking water services.* With this scenario, people are forced to rely on sources such as surface water, unprotected and possibly contaminated wells, or vendors selling water of unverifiable provenance and quality. Cities have become more susceptible to water scarcity than ever before.

In recent years, with increasing urbanization water security has become a major concern for cities. Today, cities face many daunting challenges, but water management is one of the most serious. With increasing population, increase in water demand and water services are emerging. This has made the cities go in search for water from places afar. Groundwater levels are depleting rapidly as well as many surface water sources are also becoming polluted.

Various sectors in urban planning also work in silos. The effect of one sector is not studied during planning of another sector. This also acts as a hindrance for many water resources as the catchment links are disturbed due to improper urban planning.

Better urban water management requires that we treat Urban Water Cycle as one system and understand the relationship between various components. In most parts of India, cities face severe water crisis during summer months. Despite this, making cities water secure has remained a distant dream. Cities continue to depend on water being brought from far away. Thus the need of the hour is of making our cities become water secure.

India is expected to become 'Water Stressed' by 2025, 'Water Scarce' by 2050

*Source: UN water facts, 2016

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Water Management in Urban areas is more Challenging

Deteriorating infrastructure

Climate change and
Erratic rainfall patterns

Rivers and lakes are polluted and drying

Increase in water demand

(urbanization and population growth)

Depleting groundwater

Increasing use of bottled water

Increasing dependency on distant sources

Competition amongst different sectors (Agriculture, industry and urban settlements)

Even though water and sanitation access rates are generally higher in urban areas than rural, planning and infrastructure have been unable to keep pace in many regions. Treating all the urban sectors in silos and not having a holistic approach towards the city has emerged many problems.

Accelerating population and migration to urban areas have also resulted in vital need in balancing and managing urban water demand and supply. Moreover developing countries also suffer from economic challenges and are often struggling with insufficient infrastructure and poor resources management.

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Introduction: Urban Water Security Planning Toolkit

About the Toolkit

The effect of population growth and urbanization on water resources is a major concern in India. Likewise, fast growing cities continue to depend on water being brought from far-off regions. Water security remains a distant dream. A paradigm shift is necessary for cities to manage their local water resources and plan for their sustainable use.

Considering the need of the hour, this toolkit is prepared to help urban planners, city engineers, civil society organizations, citizens, etc. to plan for a water secure city. In order to address these issues, Urban Water Security Toolkit takes an integrated approach rather than the conventional approach where different aspects of the urban water cycle are managed separately. It addresses the water services as well as the water resources together.

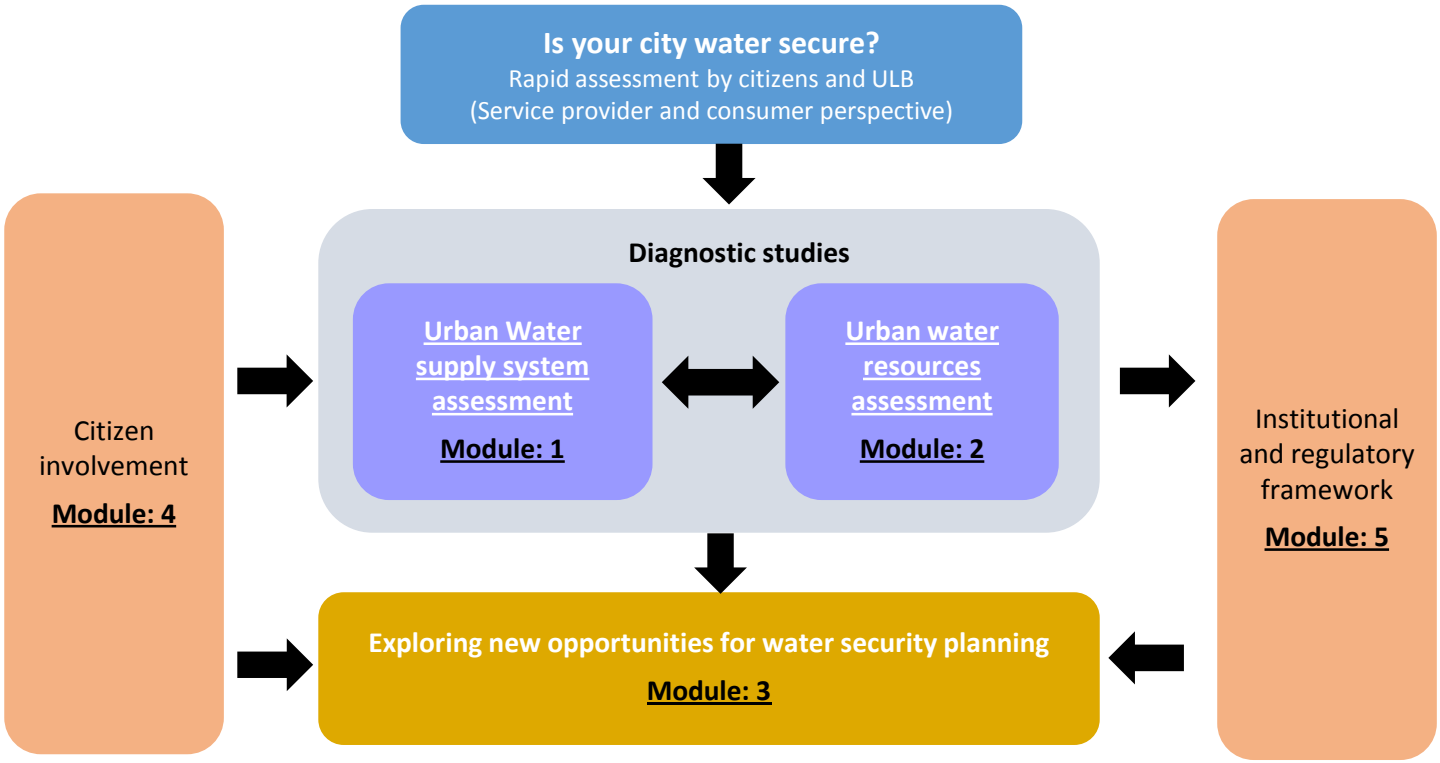
CONVENTIONAL APPROACH	INTEGRATED APPROACH
Supply side management	Both supply side and demand side management
Planning at city scale	Planning at watershed scale
Transportation of water from distant sources of water	Augmentation of local sources, Exploring alternate sources
Building New infrastructure	Increasing efficiency of existing systems
Different sectors of water cycle managed separately	Entire water cycle is treated as one unit
Lack of participatory approach	Integrated and participatory approach

Instead of creating more and more infrastructure to augment supply, this toolkit focuses on increasing efficiency of the existing supply system and exploring alternative sources while also incorporating hydro-geology in city planning.

The toolkit is inspired and is based on the experience of Bhuj, a city moving towards water security. A number of approaches, related toolkits and case studies were taken into consideration - IUWM concept and the toolkits prepared by SWITCH, GWP and IRAP; WSUD and PGWM. These toolkits, though providing useful frameworks, were felt to be too theoretical to suit the capacity and needs of different target users. A step-by-step approach (Do-it-yourself) is needed for city governments, planners and other local users which this toolkit attempts. The toolkit contains 5 modules that can be tailored towards local conditions. The key features of the toolkit are:

- Focus on urban water services and urban water resources together.
- Helps understand the new approaches emerging in the water sector.
- Resource in the form of case studies and decision supporting tools.
- Stakeholders and citizen involvement at all the stages of the toolkit.

Framework



The toolkit is divided into simple modules. A rapid assessment section in the beginning serves as a tool for providing the perspective of city managers as well as citizens on water stress in the city. Subsequently, the first module outlines how the city should undertake an assessment of its existing municipal water supply system and the private water market. The second module delves into the assessment of water resources as components of the hydrological cycle with a water balance assessment-covering rainfall, surface sources and their watersheds, as well as groundwater in aquifers in addition to urban supply. Based on these two assessments, the third module explores opportunities for alternative sources and efficiency improvements in supply system. To enable implementation of these improvement actions, modules 4 and 5 provide tools and methods for citizen involvement and understanding institutional and regulatory framework.

An attempt has been made to develop these modules as user friendly as possible. The framework is so developed that activities under the modules can also be categorized according to a project cycle such as: situational analysis, assessment and planning, and implementation.

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How to use this Toolkit?

Where can the toolkit be helpful?

This toolkit is helpful in preparing an overall plan for water security in a city considering all the aspects of water management. It endorses the preparation of plans for water services and resources by integrating with landuse planning and other plans of the city while also keeping in mind the local hydrogeology. Using the tools available here, an action plan can be prepared and subsequent pilot projects for demonstration can also be planned.

How to use it?

The toolkit takes a step-by-step approach and provides useful tools for cities to become water secure. At the end of a step/topic, tools are provided in the form of templates, guides, calculators and reference materials with which the user can carry out the activities. These tools can be accessed simply by clicking on the icon for the tool. In addition to this, after every topic, snapshots of related case studies are also present along with web links where the user can find out more about them.

The sections and tools can be used independently and give users the flexibility to select a specific topic to work on according to their interests.

In addition to this, each module explains the steps involved for a comprehensive process and a user matrix is also prepared describing the sequential use of each module and its activities according to a project cycle approach such as: situational analysis, assessment and planning, and implementation. By following the sequence of the arrows, the user can decide which activities to initiate.

Who can use it?

This toolkit aims to give support to:

- Urban water sector professionals
- Urban local bodies: City engineers, urban planners, etc.
- Civil societies championing the cause of urban water security
- Academic and research community
- Citizens/ General public
- Consultants engaged in planning
- All the information in this toolkit is useful for independent reading as well.

1. Users can pick up specific topics according to their interests

Example 1

Hydrology-Geology studies/mapping

Follow sections

- 2.2 Rainfall Analysis – runoff/recharge/evapotranspiration
- 2.3 Surface Water Assessment – Water body inventory, Watershed mapping
- 2.4a,b Aquifer Identification, delineation and Characterization
- 2.4c Groundwater monitoring
- Output 2B: Water balance Assessment
- 3.2 Groundwater recharge
- 4.3a Para-hydro-geologists for assessment and monitoring
- 5.3 b) Inclusion of hydrogeology in mainstream planning
- 5.3d Data Sharing: A platform
- 5.4 Capacity Building and Learning Alliance

Example 2

Lake conservation

Follow sections

- 2.3 Surface Water Assessment – Water body inventory, Watershed mapping
- 3.3 Reviving local water sources
- 4.1 Awareness generation
- 4.2 Citizens' forum

Example 3

Demand-supply modelling

Follow sections

- 1.1 Service Provider Perspective
- Output 1A City water profile and performance indicators
- Output 1B: Spatial Analysis
- 1.3 Private Water Sector
- Output 1C: Assessing suture demand
- 3.5d Pricing as a tool for water demand management
- Output 3A: Comprehensive urban water scenario

Example 4

Public participation

Follow sections

- Rapid Assessment: Is your city Water secure?
- 1.2 Citizen perspective of Municipal supply
- 4.1 Awareness generation and information
- 4.2 Citizens' forum
- 4.3 Citizen Involvement in planning process
- Public consultation
- Para-hydro-geologists
- Community managed water supply systems
- Labor donation drives

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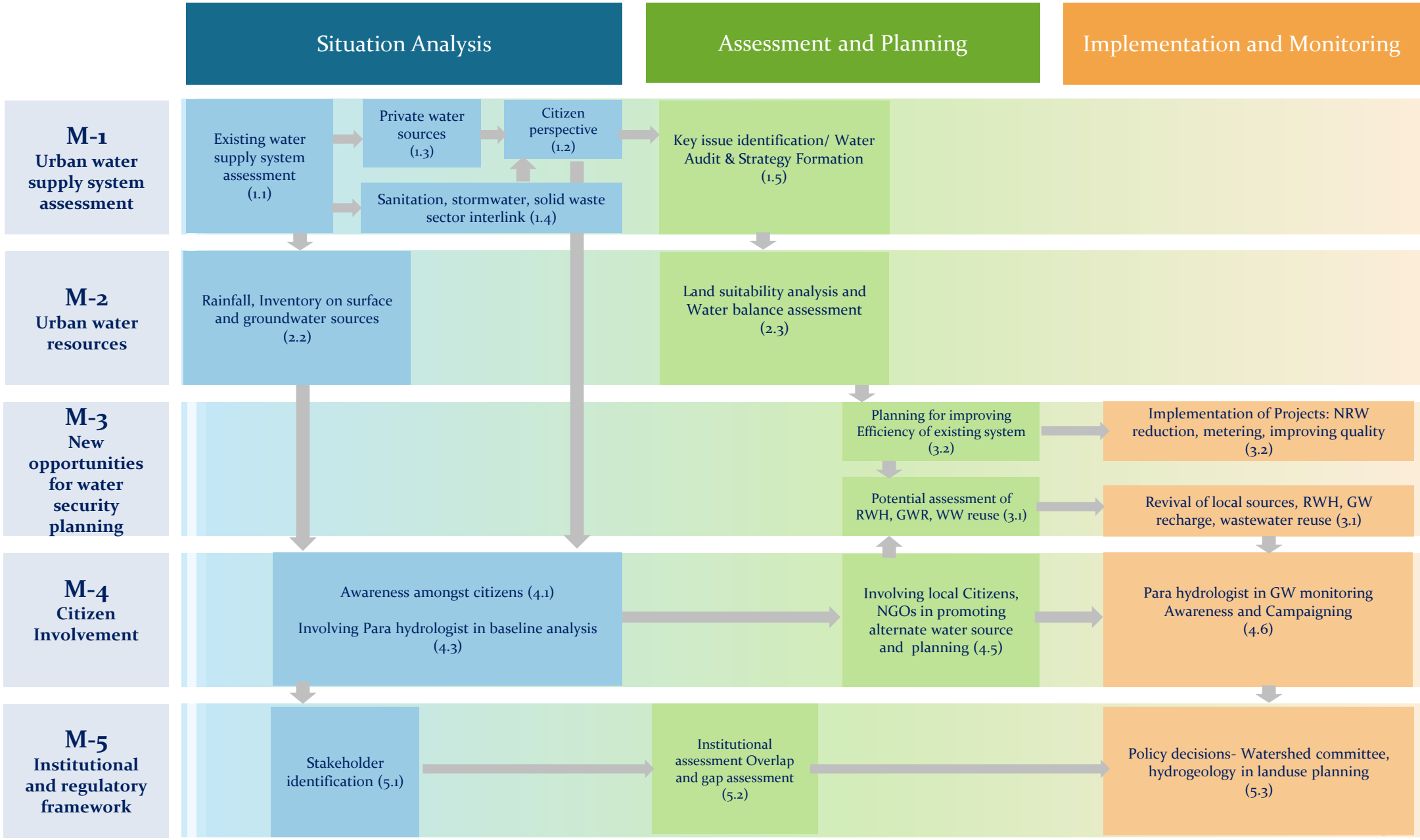
2. Step-by-step approach for city managers and planners



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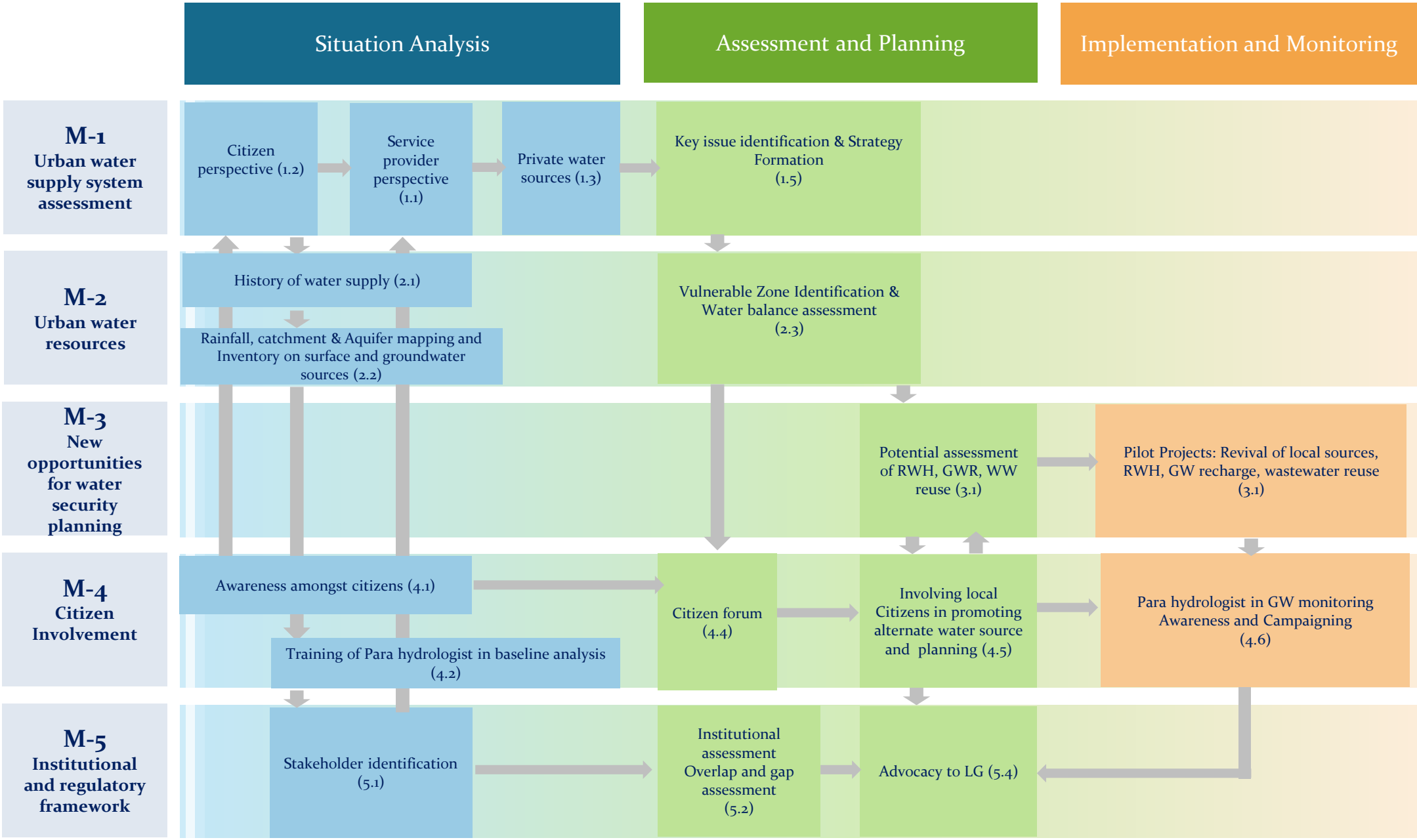
3. Step-by-step approach for Civil society organizations, NGOs



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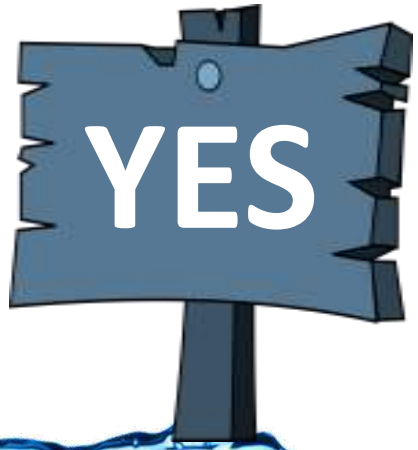
Is your city water secure?

Rapid assessment by citizens and ULB

Is your city water secure?

Usual answers….

City management's outlook



Citizen's outlook

Both City and Citizen perspectives should be considered and if any of them report water insecurity, there is a need to review the city's water management

For a quick assessment-

Questions a city must ask itself
Perspective of city managers, planners and governments

Questions a city must ask its citizens
Perspective of residents of the city

Are you water secure ?

☑ Tick if answer is yes

Questions a City must ask itself .....

1	☐	Is the city able to meet the water demand @135 lpcd?
2	☐	Is the water supply infrastructure covering all localities of the city including all slums?
3	☐	Is the city providing daily water supply with fixed duration to all localities?
4	☐	Is there enough supply during all seasons?
5	☐	Is Non Revenue water < 20%? i.e. water and revenue losses in the distribution system
6	☐	Has the city been free from outbreaks of water related diseases in the past year?
7	☐	Is the groundwater potable and without any colour, taste or odour?
8	☐	Are surface and ground water sources for municipal supply "local" (i.e. same river basin as the city/ aquifer falling inside city boundary/ from less than 50 km away)?
9	☐	Are groundwater levels in the city constant (i.e. seasonal levels similar to previous years)? No cases of borewell deepening?
10	☐	Will the city be able to sustain projected demand at current supply levels for the next 10 years?
11	☐	Is the city free from flooding in inhabited areas?
12	☐	Are Water bodies protected and without instances of land-use change from "water body" to any other land-use in the city plan?

however....

A city level perspective is not enough.
City services are for the residents and their opinion matters!

Questions a City must ask its citizens .....

1	☐	Do you get adequate water for your family's needs?
2	☐	Do you get regular water supply?
3	☐	Are you satisfied with the quality of water?
4	☐	Do you get adequate supply in summer months ?
5	☐	R.O. or bottled water is not required
6	☐	During rainy season, does water quickly drain off from your locality?
7	☐	Do you feel the groundwater level in your area is same or increasing with each passing year?
8	☐	Are you satisfied with the quality of groundwater in your area?
9	☐	Do you feel the city government is taking adequate steps to conserve/ protect water sources?
10	☐	Do you practice water conservation/ harvesting?

For conducting a citizen survey, rapid survey techniques as mentioned on the next page must be adopted.

If you check ...

- ✓ 10-12 Marks - Your city is water secure
- ✓ 7-9 Marks - Your city is moderately water secure
- ✓ 4-6 Marks - It is an alert for the ULB
- ✓ 0-3 Marks - Your city is in serious water crisis

If the citizens answer ...

- ✓ 8-10 – Water secure
- ✓ 4-7 – Moderately water Secure
- ✓ 0-3 – Water insecure

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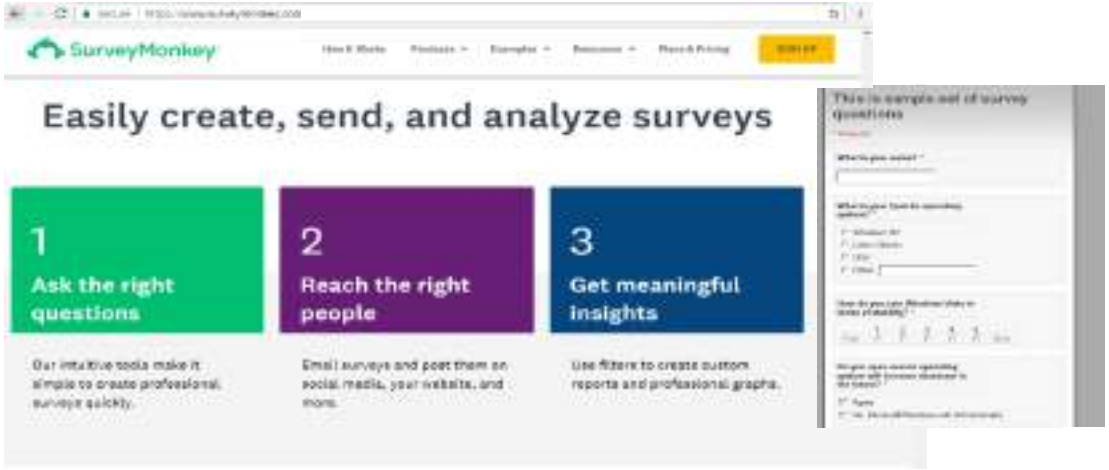
Rapid Survey Techniques

Online forms and survey platforms



E-mail and social media

Phone Interviews

Random sample survey

For assessment of citizen perception at the initial stage of planning, rapid and cost-effective techniques are required. One can float a questionnaire through social media or e-mail amongst the citizens of the city and conduct a survey. Free and simple services like “Google forms” or “Surveymonkey” are available online which also collate the collected data. More traditional methods like conducting interviews on phone, newspaper surveys or filling out physical forms through random sampling can also be used.

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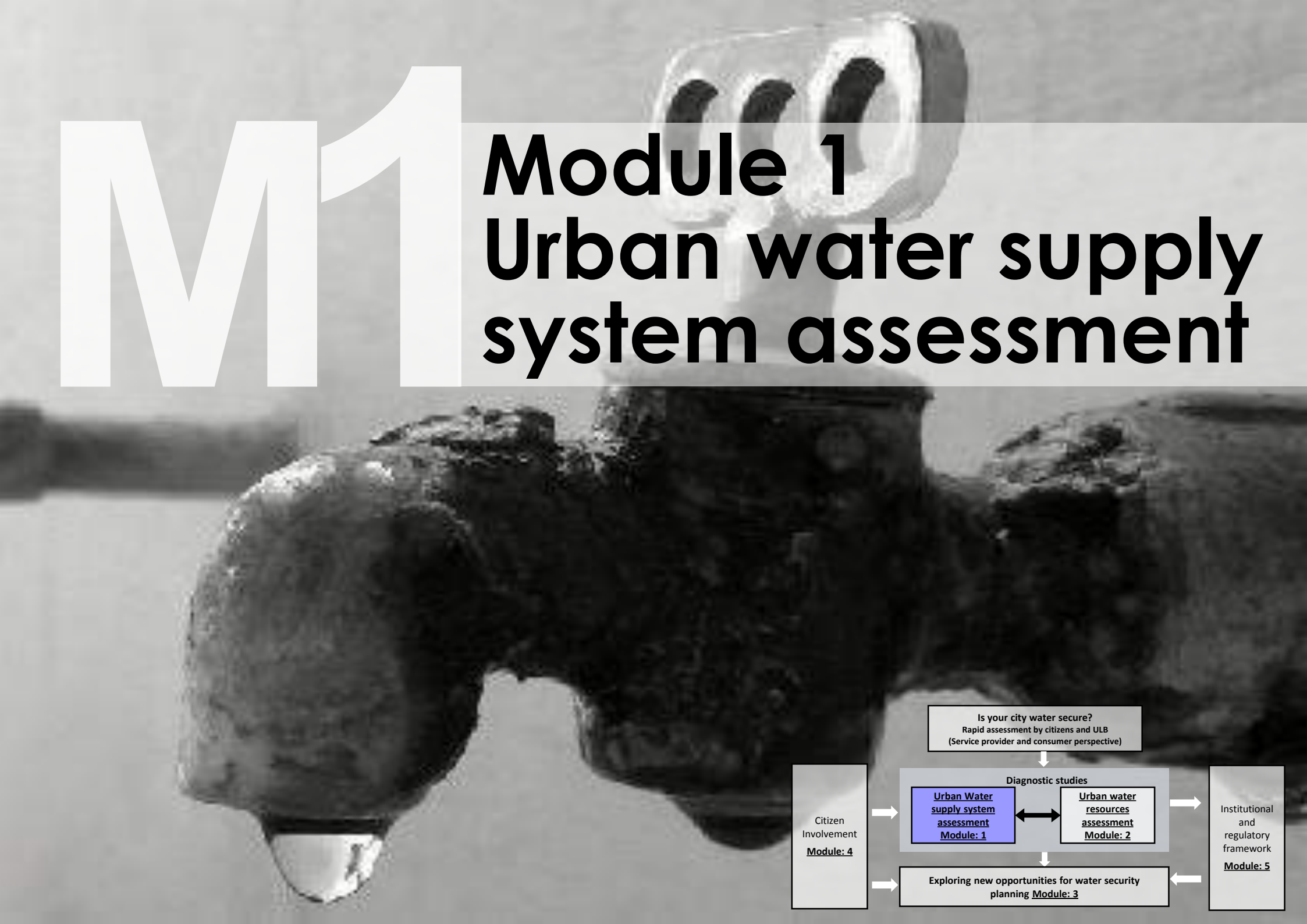
M1 Module 1 Urban water supply system assessment



Module 1
Urban Water Supply System Assessment

Introduction:

Population growth and urbanization is imperative and its effect on the urban water supply system is the major area of concern for many cities in India. Most of the current strategies about water management are blindly focused on developing new sources in order to face the constantly increasing demand of the primary source. Thus paradigm shift is necessary for the cities to manage their local water sources sustainably. In response, the water sector is revisiting conventional practices as it searches for sustainable solution to safeguard the integrity of the resource base. Therefore it is important to undertake assessment of existing water supply system in the city.

Module 1 explains Step-by-step approach how city should undertake assessment and in-depth understanding of existing water supply scenario. It provides an initial sense of the water supply in the city, help in understanding the context and identifying gaps in key services.

Step-by-step approach of this module follows full service chain of water supply starting from the assessment of water source, water treatment plant, reservoirs, distribution system, water connections and per capita water supply.

Learning Objectives: The module will assist the users in:

- Assessment of existing water supply system from service provider perspective, consumer perspective and private sector perspectives.
- Explore interlinkages with other sector of sanitation, solid waste and storm water management.
- Based on existing system assessment and future water demand, identify key issues and strategies.

Target Users:

Planners: This module helps the planners to identify key issues in existing water supply system in the city. It will assist planners to acknowledge cross-scale interdependencies and integrated planning for water, wastewater, solid waste and storm water sectors.

CSOs: This module can be used by CSO's to connect with citizen and identify key issues in existing water supply system from users perspective.

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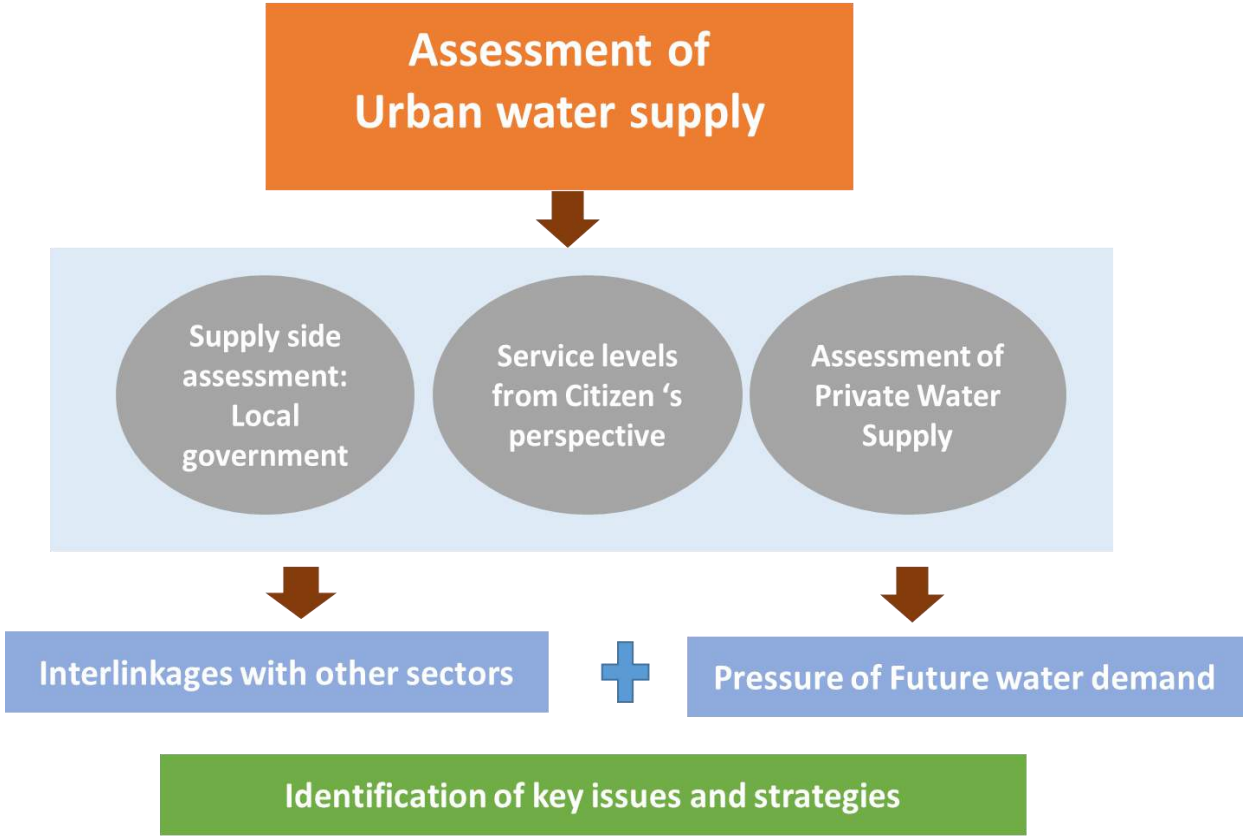
Module 1: Introduction

MODULE: 1



Assessment and in-depth understanding of current water supply scenario is a key step in planning for a water secure city. This module helps the users to undertake details assessment of water supply system from holistic approach of service provider perspective and users perspective along with analysis of private water supply in the city.

The module helps to look at water management from integrated and inclusive perspective and consider interlinkages with other sector of sanitation, storm water and solid waste management. In reality these sectors are closely interlinked with each other in the context of urban water cycle. And hence urban planners and city managers need to account for the interactions between them in wider context of urban watershed.

Another important area to look at during initial assessment study is the pressure of future water demand on current water sources. Based on the assessment of existing supply system, helps in identifying the key issues and challenges and suggest strategies for water security planning.

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1.1 Service provider perspective: Local Government

One of the obligatory functions of local bodies is to provide water supply to the residents. Although this function has been taken over by para-statals or city level boards in many urban centers, providing safe water to the entire population remains the duty of the concerned public authority.

Assessment of water supply system from service provider perspective should be carried to understand:

- Existing infrastructure: Water sources, treatment system, distribution stations, pipe network, water connections, etc.
- Quantity and quality of water supply, frequency of water supply, etc.
- Operation and maintenance of the existing system.

Stakeholder Consultations and discussions to be carried out to understand management and issues in existing urban water supply system from service provider perspective.

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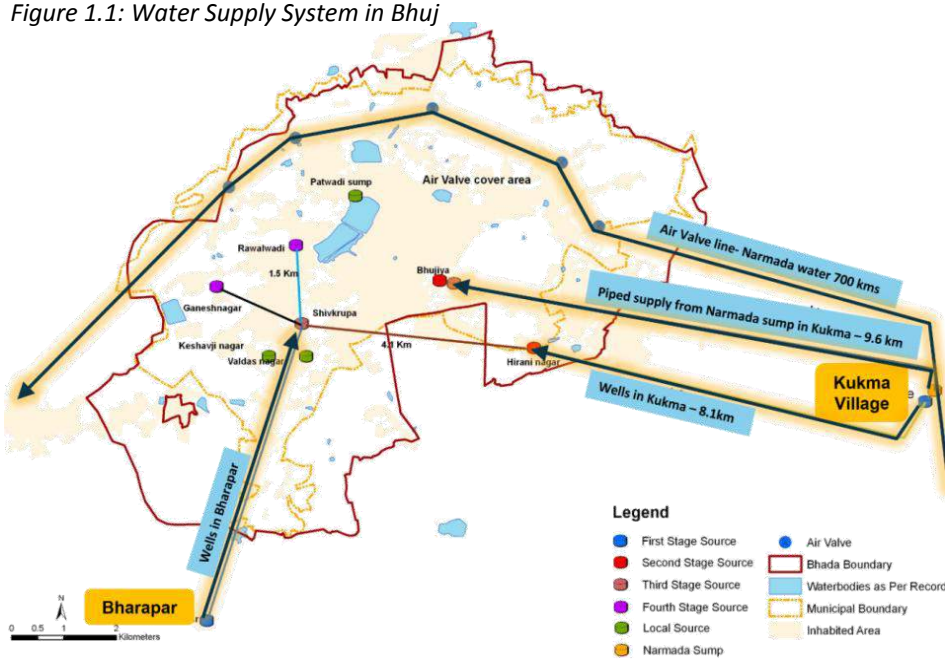
MODULE: 1

1.1 a) Locating and mapping existing water sources of city

Figure 1.1: Water Supply System in Bhuj

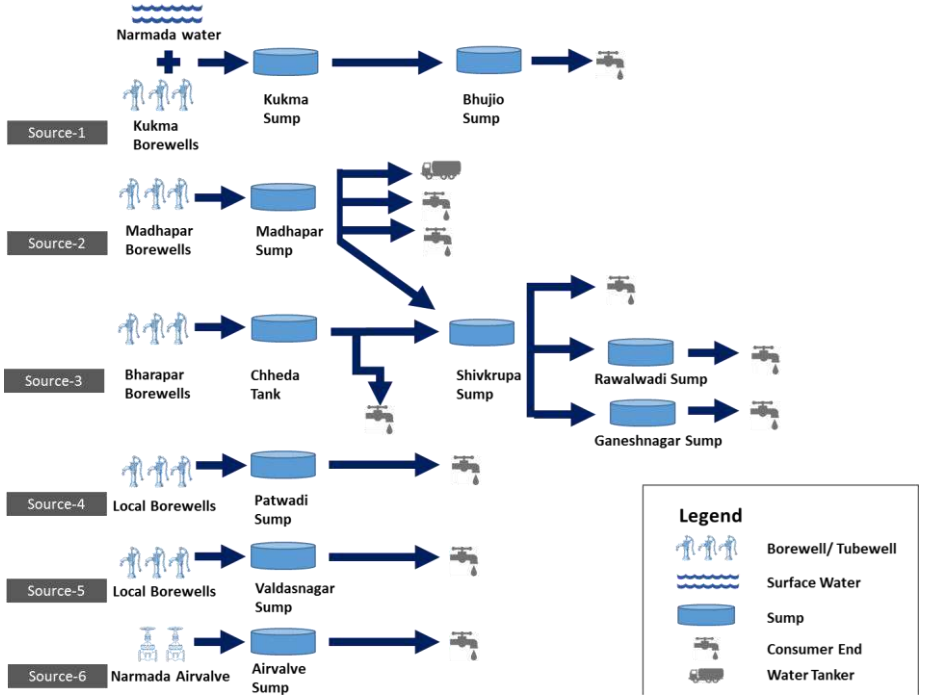


First step in assessment of existing water supply system should begin with identification of all sources of water supply for the city. It can be groundwater, surface water, bulk water purchase or mix of all above.

This involves field visits to locate and map various sources of water in the city. If the source is groundwater than collect details of quantity of ground water extracted, location of extraction points, depth of water level, quality of ground water sources, pump capacity, etc. If the source is surface water than collect details of quantity of surface water extracted, location of extraction points, quality and quantity of surface water sources in different seasons, etc.

1.1 b) Mapping distribution from source to consumers

Figure 1.2: Schematic Diagram of Water Supply System in Bhuj



Next step involves mapping of water distribution system from source to consumer end. User needs to gather information to answer the basic questions like:

- How is the water transported to the city? How much water is extracted each day from sources? What is the pump capacity and daily discharge?
- How old is the water supply network in the city? How much area and population of the city does it cover? What is the length of this network?
- How many water zones are there in the city? How many storage reservoirs and where are they located? What are their capacities?

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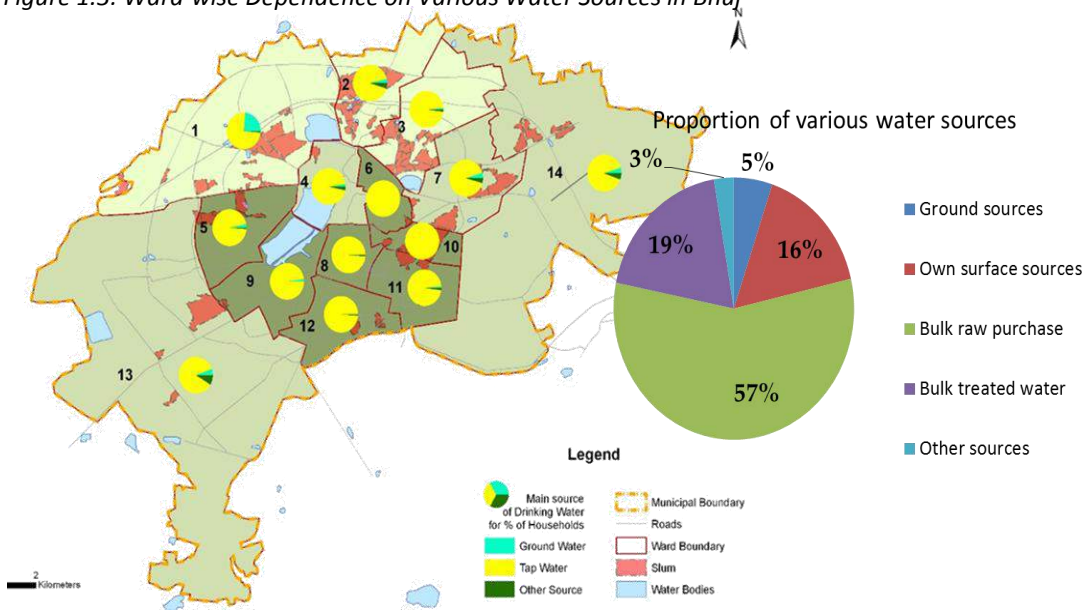
MODULE: 1

1.1 c) Quantity of water supplied

12 MLD	14 MLD	6 MLD	0.5 MLD	32.5 MLD
Kukma Borewells	Narmada Pipeline	Narmada Air Valves	Bharapar Borewells	Total Water Supply

Figure 1.3: Ward-wise Dependence on Various Water Sources in Bhuj



Quantification of amount of water extracted from source and delivered to consumer is an important factor in assessment of existing water supply systems. Most cities do not have bulk meters at either distribution points or consumer meters at users end, which makes it difficult to quantify the amount of water supplied and received. Therefore, the amount should be taken as the best estimates that could be made by the technical staff of water supply department and through bucket measurement at consumer end. The amount of water supply may not be same in the entire city and hence estimation needs to be carried out for different water zones in the city.

1.1 d) Quality of water supply

Water treatment plants are required in city that use surface water source. Those cities supplying water from ground source needs to determine quality of raw water before proposing treatment system and if treatment system is not required than chlorination at distribution station should be mandatory.

Regular monitoring must be undertaken in order to ensure the quality of water. Monitoring is done at various stages of supply such as monitoring of raw water, monitoring at treatment plants and monitoring at distribution network.

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1.1 Checklist for Data collection

This checklist developed by the Performance Assessment system (PAS Project) at CEPT University provides a curated list of data points to be collected in order to assess service delivery.

It is aligned with the Service Level Benchmarking initiative of the Govt. of India.

Data collected with this checklist is useful in the rest of the tools in this module (especially tools 1.6 and 1.7 under Output 1A).

Aside from water supply, it also includes sections on Sanitation and Solid waste which may be used in as much detail as required under section 1.4 in this module.

1.2 Water quality test regime

This tool helps cities formulate their own regimes for monitoring quality of drinking water.

It is a simple Microsoft excel based tool that indicates the number of tests at appropriate locations of the city's water supply system.

It is aligned with norms specified by CPHEEO (Central Public Health and Environmental Engineering Organisation).

It has been developed by UMC under CEPT University's PAS Project

1.3 Standard Operating Procedure Manual for routine water quality surveillance

This Standard Operating Procedure (SOP) is a step-by-step guide for ULB's water supply department staff to institute a framework for routine water quality surveillance.

It provides a set of written instructions on water sampling and analysis regime in a concise format and also contains a set of recording formats to help ULBs to document the water surveillance results for better decision making and improved governance.

It has been developed by UMC under CEPT University's PAS Project

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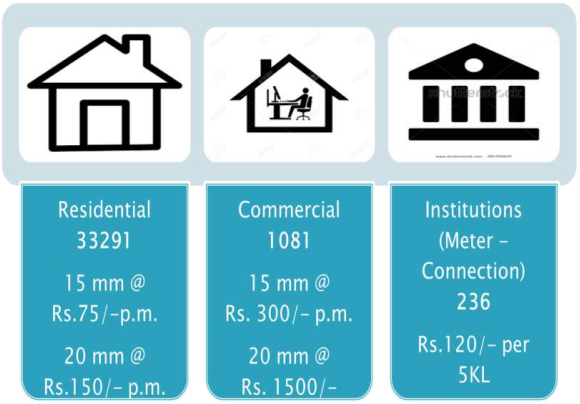
MODULE: 1

1.1 e) Financial Assessment

Water connections, Metering and tariffs (Residential/commercial/ institutional)

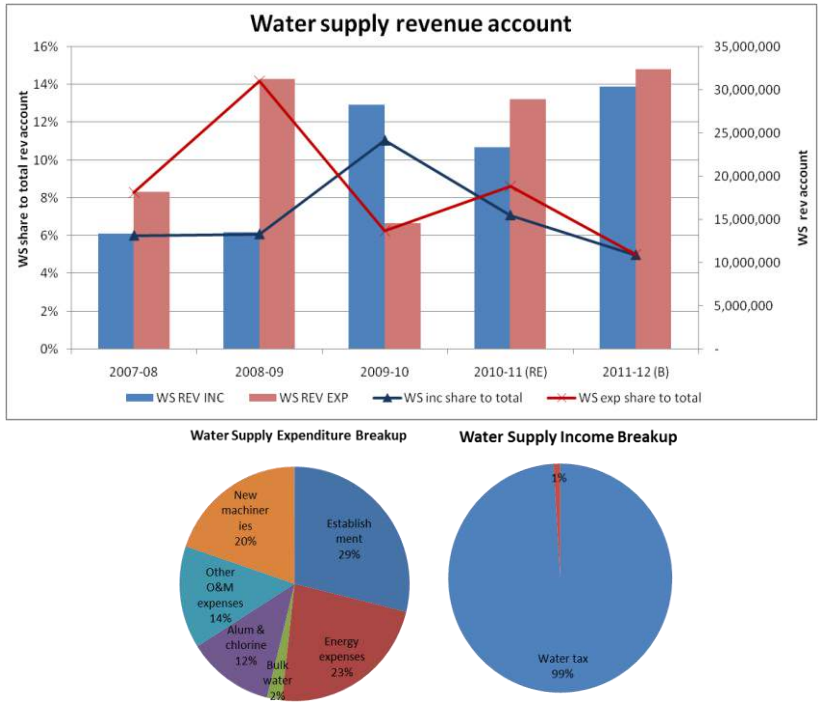
Figure 1.4: Water Tariffs in Bhuj



Schedule of rates for water supply connections				
Connection size (inches)	New Connection Cost (Rs.)		Annual Flat Tariff	
	Resd.	Comm.	Resd.	Comm.
½"	1,712	7,260	806	3,580
¾"	3,210	14,376	1,555	7,138
1"	7,424	32,404	3,662	16,152

Finance related data

Figure 1.5: Water Supply Revenue Account of Bhuj



One of key challenges in the urban areas is to make water services financially sustainable. In most cities water is supplied at highly subsidized rate or free of cost. Hence it is essential to undertake financial assessment of the water services in city.

First determine water tariff structure in the city. Water can be charged through consumption based tariff (metering), through flat rates or through water taxes. Water tariff also varies between domestic and non-domestic uses. The charges are often higher for commercial, institutional and industrial use. There is also one time connection charge based on size and purpose of use.

Analysis of revenue receipt and revenue expenditure gives an idea of financial health of water supply services in the city. For this, collect audited municipal account statement of the city for last 3-5 years. This is now also available online in public domain as per the Fourteenth central finance commission.

The main sources of revenue receipts for the water supply department are water tax, water charges, connection charges, bulk supply charges and other sources while for revenue expenditure are establishment, electricity, consumables, repairs and replacements, which vary from one city to the other.

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MODULE: 1

1.1 f) Efficiency in service operations

Figure 1.6: Schematic Diagram of Water Supply System in Achalpur

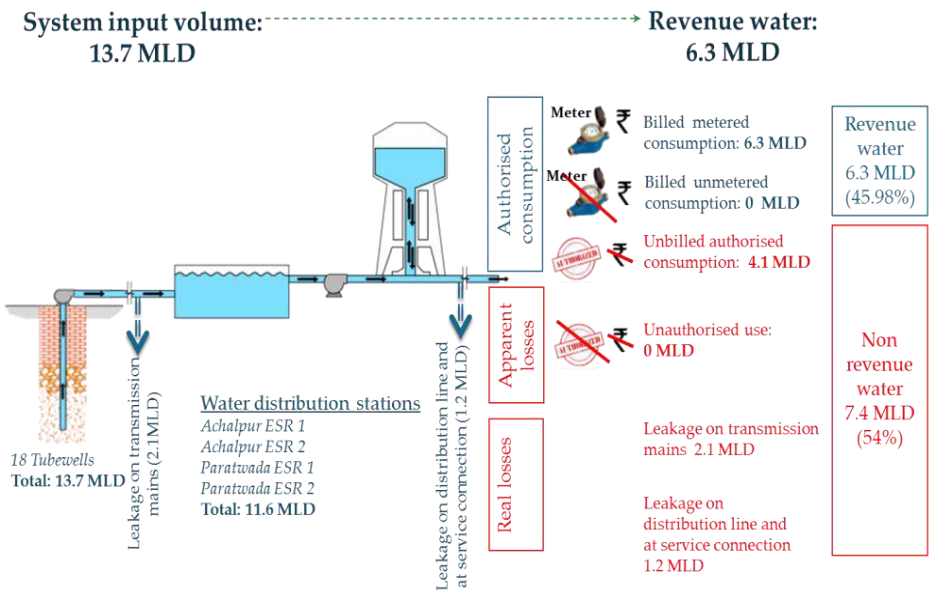

Figure 1.7: Standard IWA Water Balance Chart

System input volume 6,299 (Task 1)	Authorised consumption (54.2%) 3,414 (Task 5)	Billed authorised consumption (53.7%) 3,381 (Task 2)	Billed metered consumption 0.0	Revenue water (53.7%) 3,381
			Billed unmetered consumption (53.7%) 3,381	
		Unbilled authorised consumption (0.5%) 33 (Task 4)	Unbilled metered consumption 0	Non-revenue water, NRW (46.3%) 2,918 (Task 3)
			Unbilled unmetered consumption (0.5%) 33	
	Water losses (45.8%) 2,885 (Task 6)	Apparent losses (16.8%) 1,058 (Task 7)	Unauthorised consumption (16.8%) 1,058	
			Consumer metering inaccuracies 0	
		Real losses (29%) 1,827 (Task 8)	Leakage on service connections up to point of customer metering (15.6%) 980 (Task 9)	
			Leakage on transmission mains (9.9%) 624 (Task 9)	
			Leakage and overflows at utility's storage tanks (3.5%) 223 (Task 9)	

Source: Based on actual flow measurement using portable ultrasonic flow meter and bucket survey method at the consumers' end.

The Key step towards curbing urban water losses and designing a sustainable water supply system consists of conducting a comprehensive assessment of water that is pumped in to the system and water that is delivered to consumers.

Most cities report 30-50% NRW. It is an expression used for the difference between the quantity of water produced and the quantity of water which is billed. However, in most cases, these estimates are not based on accurate measurements. NRW addresses following questions:

- How much water is being lost?
- Where are the losses occurring?
- Why are the losses occurring?
- What strategies can be introduced to reduce losses and improve performance ?

A preliminary water audit can generate estimates of water production, consumption and losses in a municipal water supply system and help develop a realistic Improvement Plan for the city.

NRW tool helps cities to calculate Non-Revenue Water and provide measures to reduce NRW and increase efficiency of existing water supply system.

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1.4 NRW calculation tool

This tool helps cities to calculate Non-Revenue Water and provide measures to reduce NRW and increase efficiency of existing water supply system.

It is a simple Microsoft excel based tool that requires user to enter data in input sheet. Detailed guide is also provided which will help users to understand various methods to calculate input data.

Based on input data, tool calculates NRW of city and shows its result in form of water balance diagram.

The tool also provides a detailed list of measures to reduce NRW in the city.

It has been developed under CEPT University's PAS Project

1.5 Water Audit Methodology

Indian water utilities report 30-40% NRW. However, in most cases, these estimates are not based on proper measurements.

While a full-fledged water audit can be very expensive, this presentation demonstrates application of a 'low-cost' methodology that enables estimation of water losses in the system and compute NRW.

It has been developed under CEPT University's PAS Project

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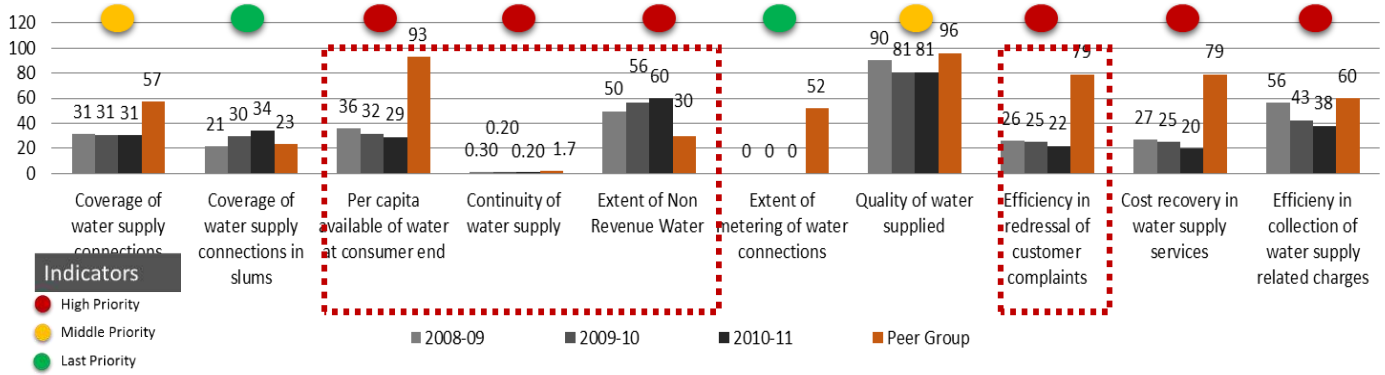
Output 1A: City water profile and service performance indicators to identify gaps

MODULE: 1

Key performance indicators

Figure 1.8: Key Performance Indicators of city X



Local action indicators

Figure 1.9: Coverage of water supply services of City X

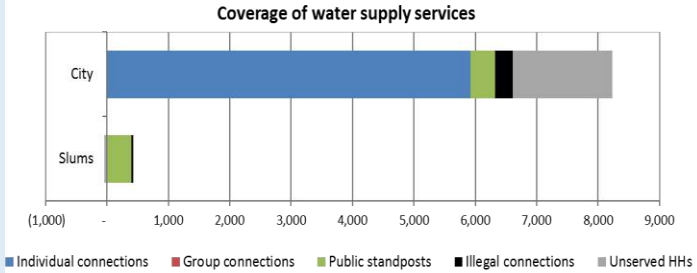
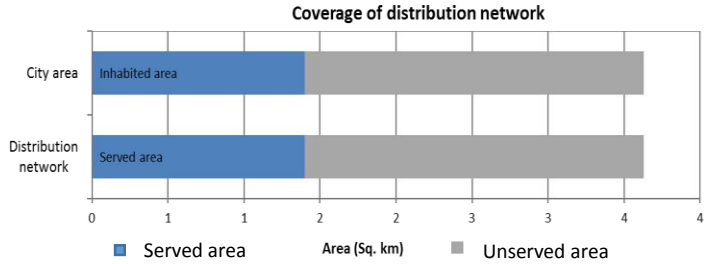


Figure 1.10: Coverage of Water Distribution Network of City X



Data collected from the assessment of existing water supply system can be assessed through various indicators which can measure performance level of the city. This will help identify gaps in the service levels and priority areas for intervention.

Service Level Benchmark (SLB) published by MoUD details out the process of calculating the indicators and assess reliability of the same. Key indicators in water supply services are: Coverage of water supply, Per capita available of water at consumer end, Extent of metering of water connections, Extent of non revenue water, Continuity of supply, Efficiency in redressal of customer complaints, Quality of water supplied, Cost recovery in water supply services, Efficiency in collecting water supply related charges.

This can be done using the first module of SANIPLAN for performance assessment. SANIPLAN provides a structured approach to data collection for this. Performance indicators have been developed to capture different city contexts with full service chain of water services. SANIPLAN also enables traffic light analysis by comparing with benchmarks and peer performance.

Sources of Data

Service Level Benchmarking

All Indian cities are required to publish information about their service levels annually in order to receive performance based grants according to the requirements of the 13th and 14th Central Finance Commissions.
The ministry of Urban Development, Govt. of India has published national databooks containing this information.
The cities are also required to make this information available on their websites.

PAS Project

The Performance Assessment System initiative of CEPT University has developed a framework for assessing UWSS service delivery. It is aligned with the SLB initiative.
An online module helps cities fill in data, calculate performance indicators, set targets for future and compare with other cities.
PAS publishes annual databooks for the states it has been implemented in. This city-wise data is also available on the PAS website along with interactive dashboards.

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1.6 Service Level Benchmarking Handbook

A Handbook on Service Level Benchmarking has been developed and released by the MoUD, which seeks to (i) identify a minimum set of standard performance parameters for the water and sanitation sector that are commonly understood and used by all stakeholders across the country; (ii) define a common minimum framework for monitoring and reporting on these indicators and (iii) set out guidelines on how to operationalize this framework in a phased manner.

The framework encompasses 28 performance indicators.

1.7 Water profile and Indicators calculation tool

This Excel based tool provides structured input formats for assessment of water supply profile in the city.

It covers aspects related to: Demography, water source, treatment, distribution system, storage system, connections, metering, and water tariff.

Based on the data input city can analyze its existing performance through the set of indicators suggested by the Service level benchmarking (SLB) framework of the Government of India.

Users can select different actions for service improvement.

It has been developed under CEPT University's PAS Project

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Output 1B: Spatial Analysis for identifying intervention areas

Figure 1.9: Water Supply Coverage Zones of Bhuj

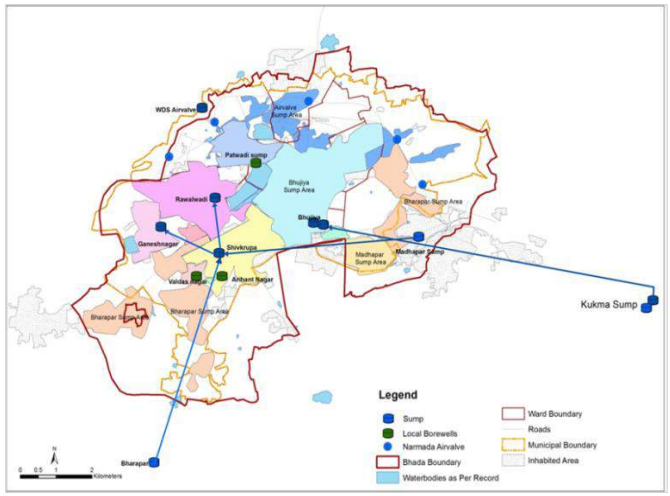
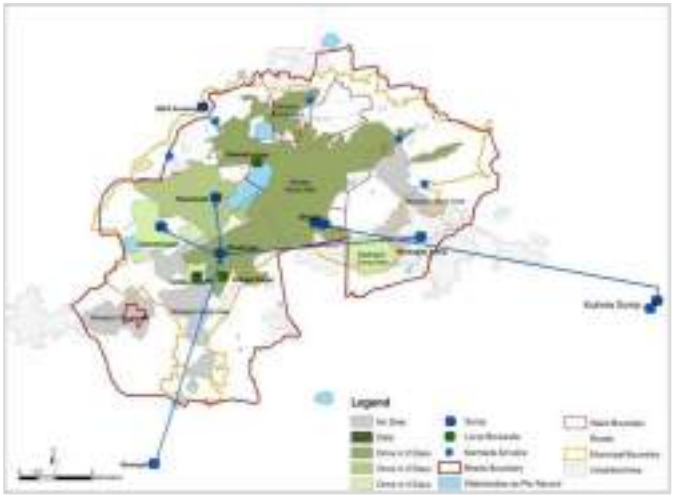


Figure 1.10: Water Served and Unserved Areas of Bhuj

Figure 1.11: Frequency of Water Supply in Different Areas of Bhuj



Source: ACT (2015)

Water supply coverage and distribution zones

The detailed assessment of the water supply in the city should also include spatial analysis.

It is important to understand the variation in service delivery over space. For this purpose, maps with ward and administrative boundaries and other features should be used to depict the analysis of water supply in the city. Spatial

Served vs unserved areas

analysis also helps in identifying areas which require special attention.

This should include mapping water zones and water connection coverage in the city, served versus unserved areas, frequency and quantity of water supply in different areas, location of water sources, treatment plant and

Frequency of water supply in different areas

distribution stations, flow of water from source to treatment to distribution, storage and consumer end.

Spatial analysis will help identify equity in service delivery across city and guide future development areas and plan for water services in those areas.

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1.2 Citizen perspective

MODULE: 1

"From being process centric to becoming citizen centric"

Currently municipal performance in most Indian cities is assessed primarily based on qualitative and quantitative information provided by the Urban Local Bodies (ULBs) and service providers.

The main focus of service providers tends to be on creating new assets, rather than delivery of services and performance efficiency. Moreover, in the absence of reliable service data, the planning processes that inform the creation of new assets are often not aligned with the needs and priorities of citizens (SLB-connect report, WSP).

Citizen perspective surveys can act as additional diagnostic tool that can measure the level of satisfaction of actual users of municipal services. Citizen perspective can also allow ULBs to assess the level of awareness among citizens about their rights and responsibilities. Through these processes, an enabling environment is created for strengthening accountability pressures on providers to deliver improved service outcomes.

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MODULE: 1

1.2 a) Citizen survey

CITIZEN PERSPECTIVE ON:

- Access to water
- Continuity
- Adequacy
- Water quality
- Complaint redressal
- Ease of Bill payment
- Toilet Access
- Toilet Usage
- Access to Sewerage Network

MOBILE-WEB SYSTEM to capture user perspective of citizen in water sector.

One of the mobile-web systems for tracking performance of city governments in water sector is the **SLB Connect tool.**

The mobile-web system allows data capture on field using mobile phones and data monitoring and analysis through a web server and dashboard.

This is an initiative by the Water and Sanitation Program (WSP)

RANDOM SAMPLE SURVEY of the users and the aggregation of the users' experiences.

- Citizen / public hearings
- Focus groups discussion
- Voluntary Feedback
- Interviews
- Citizens' committees
- Citizens' report cards
- Complaint analysis
- Feedback on websites

Source: SLB connect; UMC under PAS Project (2104)

Citizens feedback has become a major data collection tool for "program evaluations" and "performance-based budgeting systems" in many countries. It is important to assess citizen perspective on access to water connection, continuity of water supply, sufficient quantity and quality of water supply, ease of bill payment, etc.

Such perspective can be evaluated through either mobile-web based system known as SLB-Connect tool or through random sample users and aggregation of the users experience.

SLB-Connect tool is an initiative by the Water and Sanitation Program (WSP) aimed at strengthening citizen engagement for delivering improved service outcomes. Designed as an extension of the Service Level Benchmarks (SLB) program rolled out by the Ministry of Urban Development, it uses Information and Communication Technology (ICT) to track service delivery from the citizen's perspective i.e. the "service experience".

Other method entail a random sample survey of the users of different public services (utilities), and the aggregation of the users' experiences as a basis for rating the services. Conducting citizen surveys at regular intervals and using the feedback to improve service delivery resulted in better satisfaction levels among citizens.

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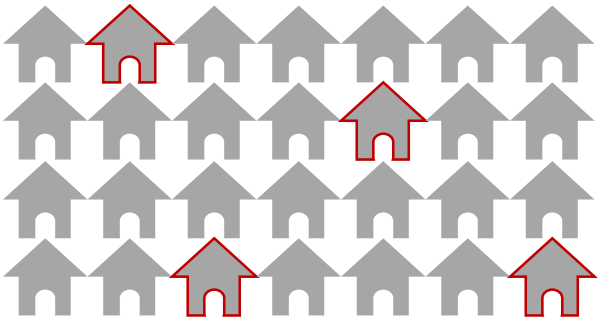
MODULE: 1

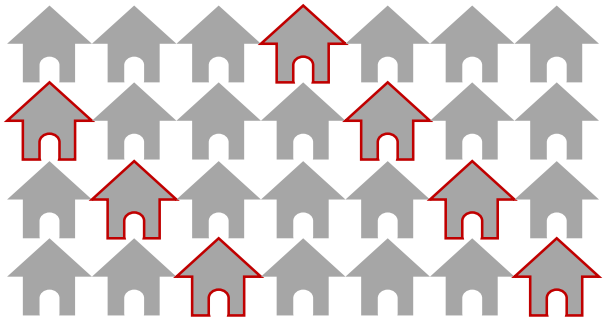
1.2 b) Sampling methods

Probability based

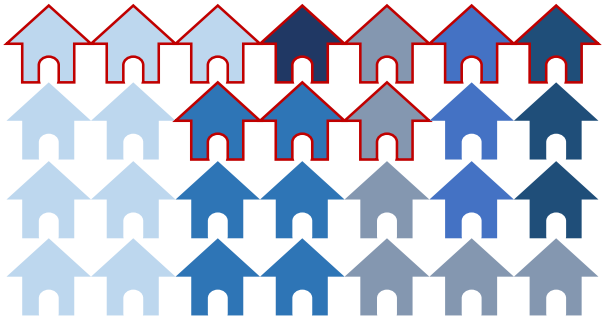
Random



Systematic – "every nth"

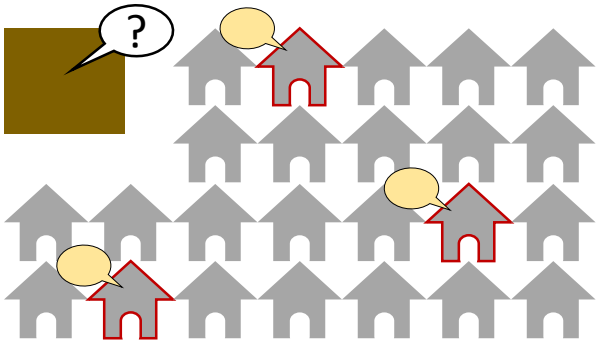


Stratified (e.g.: by water zones, income/cultural groups

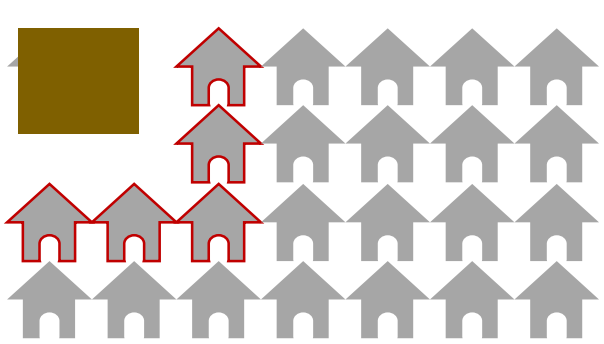


Non Probability based

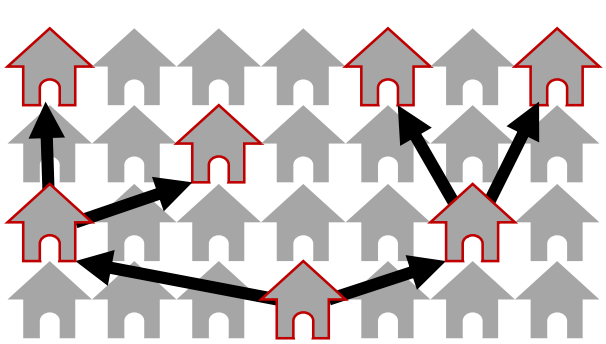
Volunteer



Convenience



Snowball



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MODULE: 1

Case study

SLB Connect

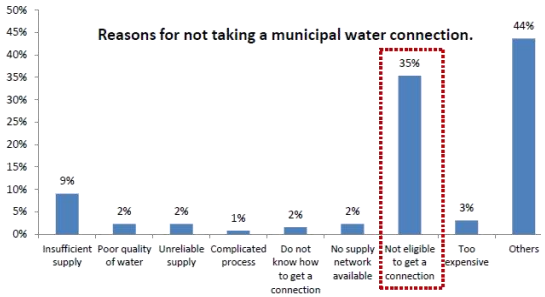
SLB-connect tool allows data capture on field using mobile phones and data monitoring and analysis through a web server and dashboard. Results of survey make simple to understand through graphical as well as spatially with the help of dashboard on real time. Analysis on dashboard seen through very simple representation of Traffic light color, i.e. Red shows poor performance and green shows good performance. Dashboards also provide grid and map views too. Results can be analysis as per customized requirements and also provide customized views for city managers.

The information generated through citizen feedback survey is an on-field assessment of service delivery and provides useful insights into, citizens' views and concerns which are valuable for the city's to undertake service improvements and reforms.
Read more

Figure 1.12: Illustration of SLB Connect Data of City X

Table 1 : Citizens feedback on performance in water supply service

Parameter	City	Slum	Non Slum
Access to municipal water supply	91%	77%	95%
Adequacy of water	78%	69%	81%
Water Supply Pressure and Time	57%	55%	60%
Quality of water	78%	76%	79%
Complaints redressal	5%	3%	6%



Source: SLB connect

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1.3 Private Sector: Coping Mechanisms

In urban area, apart from municipal water sources, large amount of groundwater is also extracted by household through private borewells, private tanker vendors, RO bottled water supplier, industrial and agricultural users, etc. Hence assessment of private water sources is essential for preparation of water security plan for city.

The intermittent and unreliable water supply from service provider has created huge market for private water suppliers that sources its water primarily from borewells in and around city. In addition there are thousands of households that use individual borewells to supplement their water requirement.

Thus to adopt more comprehensive approach, both urban planners and civil society organization should assess the issues and challenges faced by private water market as well as those that emerge due to their operations.

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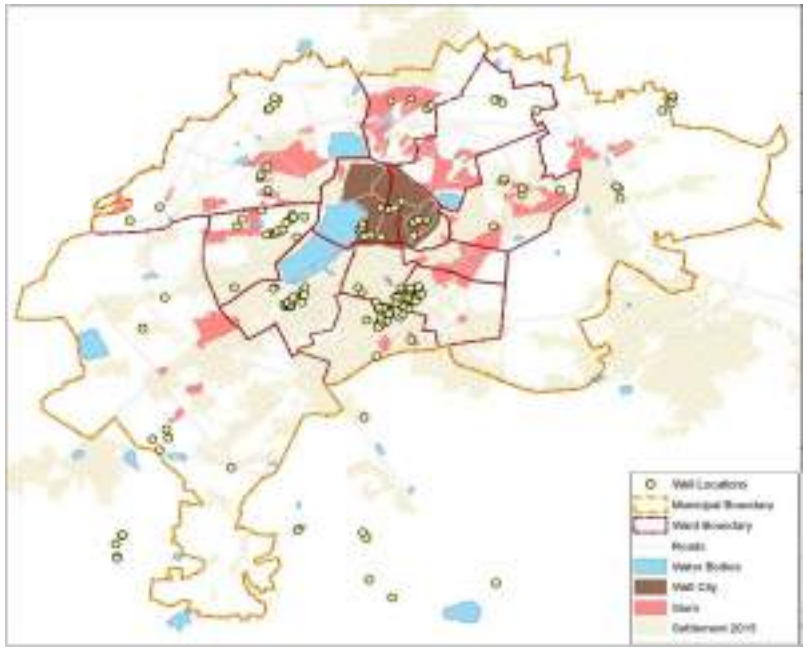
MODULE: 1

Private water providers: Private Wells, Private tankers supplier, R.O. bottles

Landscape analysis of privately owned wells/ borewells by household, private tanker suppliers/RO bottled water and industries is an important exercise in preparation of water security plan of city.

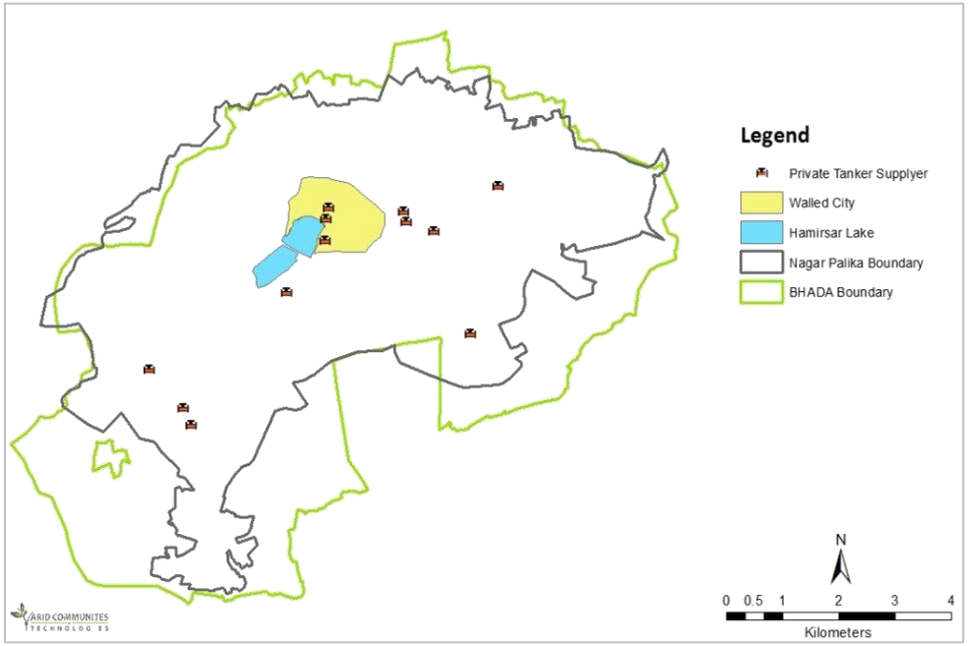
This gives an idea of overall consumption of water sources in the city and helps to prepare integrated water source management plan to fulfill future water demand.

Figure 1.13: Location of Wells in Bhuj



Source: ACT; CEPT (2015)

Figure 1.14: Location of Private Water Suppliers in Bhuj



Source: ACT; CEPT (2015)

Private wells/ borewells (Field survey):

- Location, use of wells (households/ industries/ tanker supply/ agriculture)
- Quality and quantity of water extracted each day
- Pump capacity, hours of pumping
- Depth of groundwater level, depth of well, age of well, discharge capacity, seasonal fluctuations

Landscape study of private tanker suppliers

- Locations and numbers of source, depth of water level, quality of tanker water
- Details of total tanker suppliers, trips /day, total quantity of supply per day
- Distribution area, use of water (household purpose/ construction purpose/ commercial)
- Total number of tankers, tanker capacity
- Cost of selling/tanker

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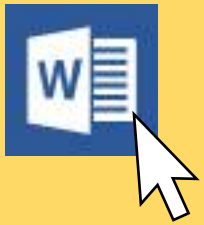
TOOLS

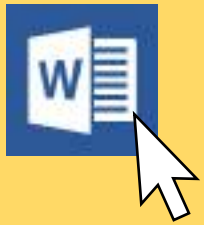
MODULE: 1

1.8 Template for landscape analysis of Private Borewells



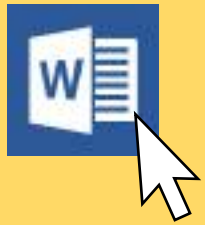
This template provides list of details to be collected for analysis of private borewells in city.

1.9 Questionnaire for landscape analysis of society managed water schemes



This survey form provides details of information to be collected during survey of society managed water supply scheme.

1.10 Template for landscape analysis of Tanker water supply



This template provides list of details to be collected for analysis of both government and private tanker water supply in city.

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1.4 Interlinkages with other sectors

It is important to acknowledge urban water system as single component and recognize interlinkages of water, sanitation, storm water and solid waste sector with each other.

Such linkages are often neglected at the decision making. It is no longer sufficient to plan these sectors in silos without considering the positive and negative impact of one on others.

Negative interactions include the impact of poor sanitation on the water quality of potential water sources, both surface and ground (Lee and Schwab, 2005; Tucci et al., 2009); and cross-contamination that takes place between leaky sewers, foul water bodies, and drinking-water supply pipes, which is particularly a problem with intermittent supply (Vairavamoorthy et al., 2007).

Positive interactions include opportunities for considering a portfolio of water sources, reuse, recycling, and cascading use of water (Mitchell, 2004; GWP, 2010).

Managing urban water across different institutions and organizations while allowing all players and end-users to be part of the process ensures the sustainability of the planning process and its outcomes.

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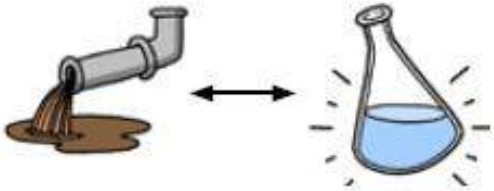
MODULE: 1

1.4 a) Sanitation and stormwater Profile

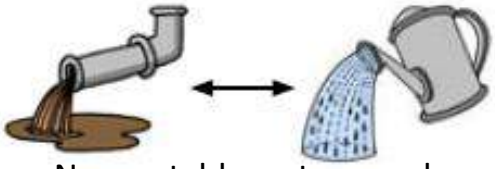
Linkages within the urban water cycle

Stormwater management

Domestic water consumption



Water quality



Non-potable water supply

Source: Image courtesy switch toolkit

Assessment across sanitation service chain

Access	Collection	Conveyance	Treatment	Disposal/Reuse
• Dependency on of individual, community and public toilets • Spatial variations where possible	• Assess dependency on onsite systems (septic tanks, double pits etc) or centralized sewer system • Assess details related to location, size, design and access for emptying • Distance from drinking water source	• Coverage of sewerage system in city and outfall • Presence of open drain and its outfall • Presence of treatment system and its efficiency • Location of disposal of untreated waste		• Extent and Nature of reuse • Landscape analysis of reuse potential and market study

Conventionally, wastewater sector has been managed independently. However it is important to recognize its strong linkages with water and storm water sector. Poor management of sanitation affects both surface water and groundwater quality. While reusing the treated wastewater for non-potable purposes has positive impact as it reduces the fresh water consumption.

Similarly blocking or encroachment of natural drains may reduce the natural flow of rainwater in rivers and lakes along with water logging in other areas.

Thus assessment of stormwater should include mapping of natural drains, coverage of stormwater drainage in city, mapping and incidence of water logging areas. While sanitation sector assessment should follow entire sanitation service chain i.e. access, collection, conveyance, treatment and reuse/disposal.

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MODULE: 1

1.4 b) Solid Waste Profile

Impact of Solid waste dumping on urban water cycle

- Blockage of natural drains
- Reduces the water flows in lakes and rivers
- Surface water and groundwater quality

Assessment across solid waste service chain

Collection	Transportation	Segregation	Treatment/ Disposal
• Door-to-Door collection of garbage • Collection of waste from streets	• Transportation of waste to dump site	• Segregation at source • Segregation at disposal site	• Presence of landfill site • Location of dumping site • Dumping of waste in rivers, lakes and drains

SWM plays major role in water security planning of city as unregulated dumping of solid waste in waterbodies and canals may block the natural path of rainwater and cause flooding in areas along with reduce water flow in lakes and rivers. Apart from above, it also affects the quality of water. Solid waste management should follow SWM service chain i.e. collection, transportation, segregation and treatment/disposal.

Thus, in integrated urban water management plan (IUWM) WSS services needs to plan and executed in holistic manner thereby recognizing impact of one sector on another.

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Output 1C: Assessing Future water demand

Figure 1.15: Population and Water Demand Projection for Bhuj

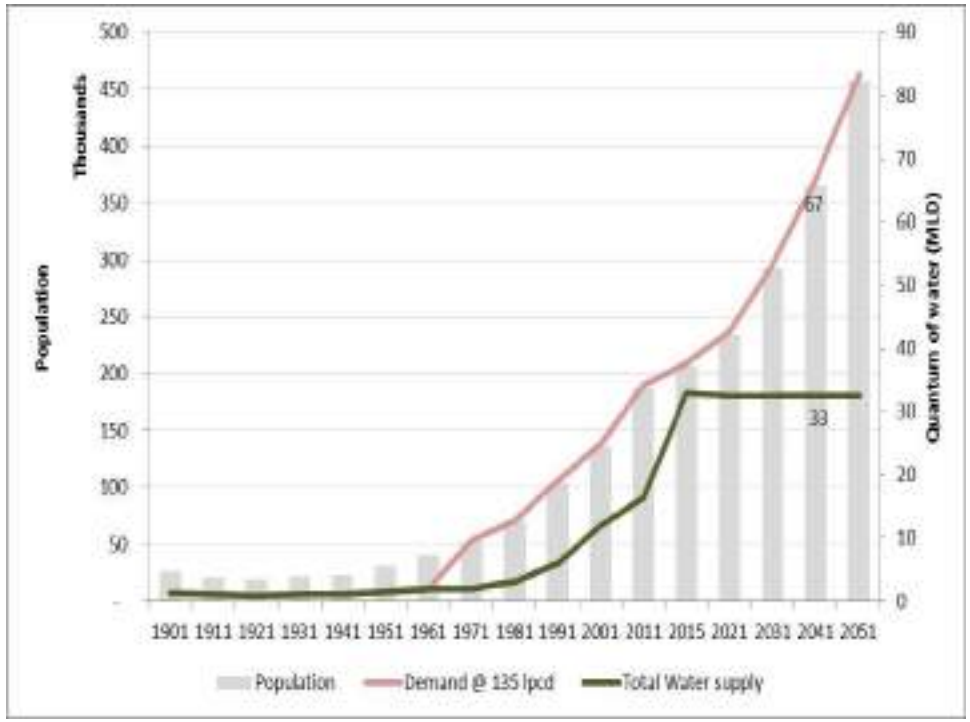
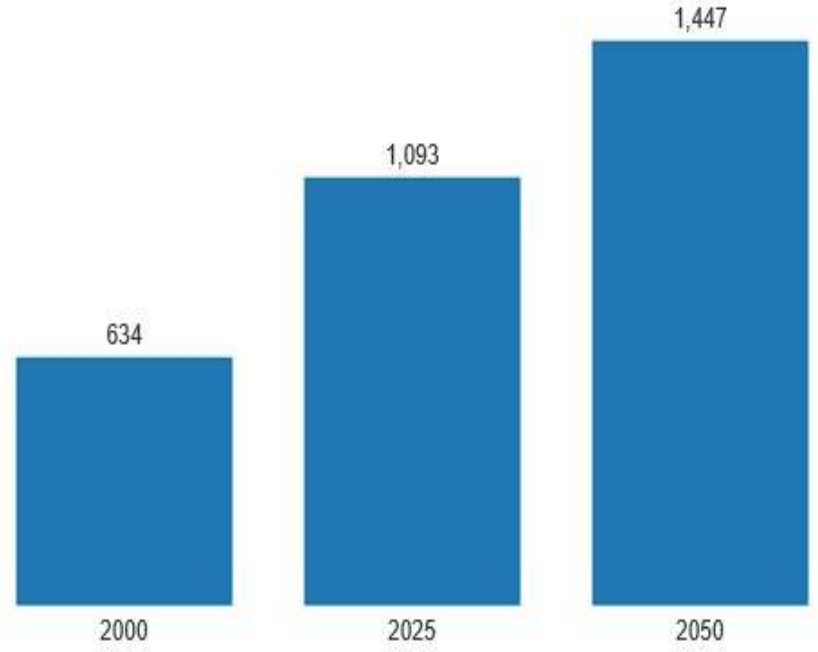


Figure 1.16: Population and Water Demand Projection of India



Source: International Business times "**Indo-French project 'Swachh Neer' aims to tackle water scarcity' based on central water commission data**

With increase in urbanization, demand for water will increase and existing sources would not be sufficient to cater future demand. This will pose greater challenge in providing safe and good quality water. Hence it is essential to estimate future demand of water based on population projections, per capita requirement, losses estimation, commercial and industrial demand, etc.

It should also be based on the extension municipal boundary in next 20-30 years. The project planning will be for the area of city likely to be after 20-30 years.

Other factors that may account for increased urban water demand are growth in urban population; increase in industrial and commercial demand, rising incomes that increase expectations of water quantity and quality, which can result in demand for increased water quantity and better services (World Bank, 2012).

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1.11 Tool for Population projection and water demand projection

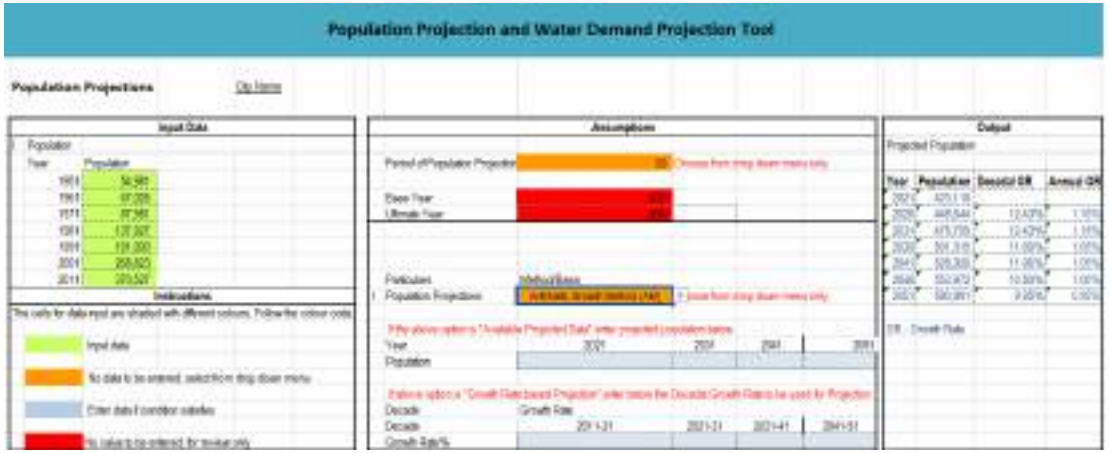
The Excel based tool will help users project population and water demand over next 40 years.

It requires users to input past population and based on the growth rate, it projects population based on different methods viz. Arithmetic growth rate, Incremental increase, geometric growth rate, etc.

Based on the population projections it estimates future demand of water for the city.

It is based on ADB's tool of population projections.

Figure 1.17: Illustration of Population Projection and Water Demand Projection Tool



Population Projection and Water Demand Projection Tool

Water Demand

Year	Population	LPCD	Losses	Demand	Losses	Fire Demand	Total demand	Present Source	Deficit
			%	MLD	MLD	MLD	MLD	MLD	MLD
2011	370,527	135	45	50.02	22.51	1.92	74.46	81.05	-
2016	395,950	135	45	53.45	24.05	1.99	79.50	60.79	18.71
2021	423,118	135	35	57.12	19.99	2.06	79.17	45.59	33.58
2026	448,644	135	30	60.57	18.17	2.12	80.86	34.19	46.66
2031	475,709	135	25	64.22	16.06	2.18	82.46	25.64	56.81
2036	501,315	135	20	67.68	13.54	2.24	83.45	19.25	64.22
2041	528,300	135	15	71.32	10.70	2.30	84.32	14.43	69.89
2046	553,972	135	15	74.79	11.22	2.35	88.36	15.43	72.93
2051	580,891	135	15	78.42	11.76	2.41	92.59	16.43	76.17

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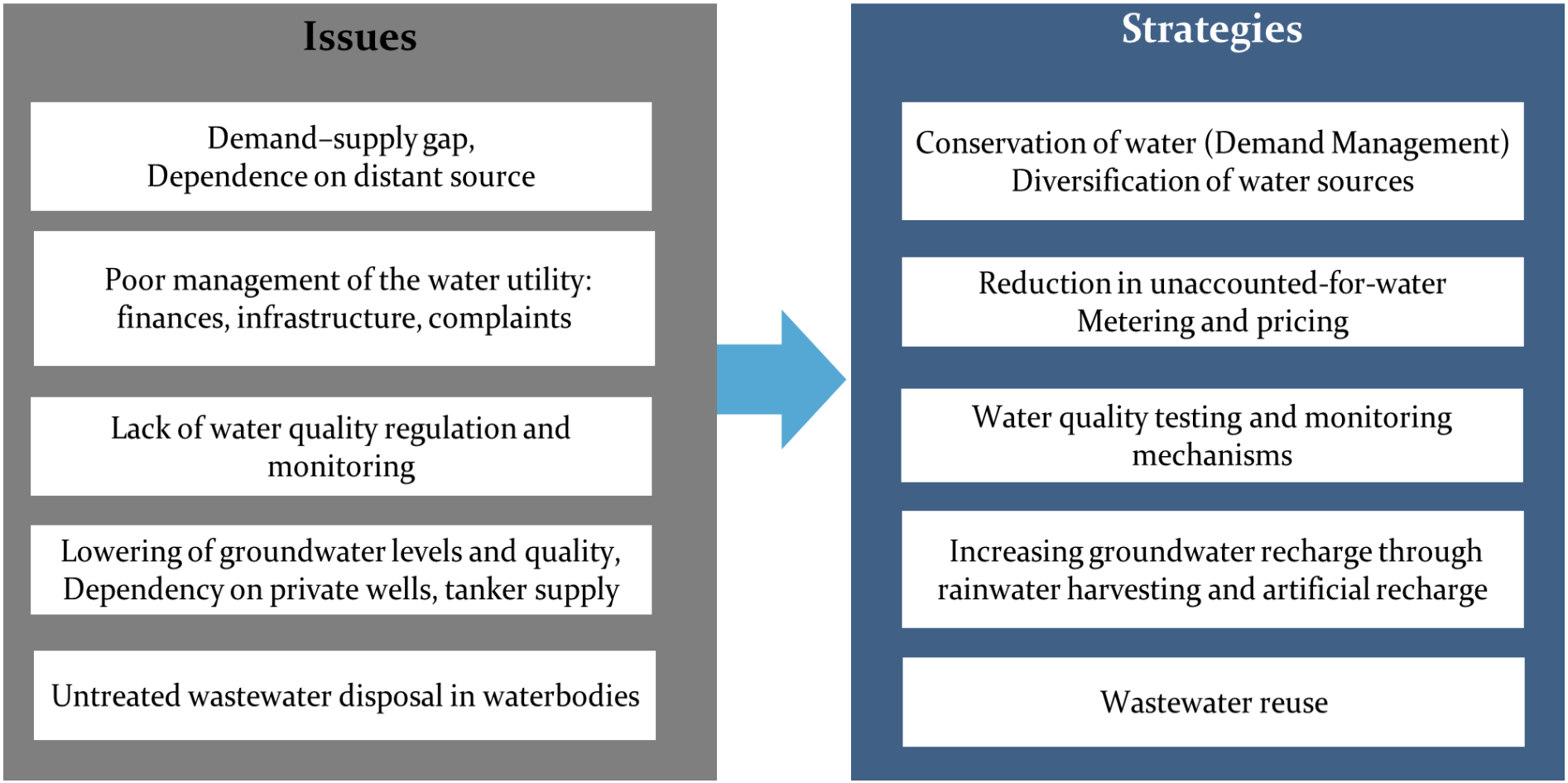
1.5 Identification of issues and strategy development



The module should be summarize by identification of key issues and challenges in the existing urban water supply system and strategies to overcome those issues and plan for urban water secure city.

There is a need that city look at urban water management from a different perspective and develop strategies that can respond to all these challenges simultaneously. This will require assessment from Water resources perspective to enhance urban water system.

Assessment of urban water resources including geo-hydrological, Aquifer and Watershed study is detailed out in next module.

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MODULE: 1

Case Studies

Performance Improvement Plan

Bhusawal: Performance Improvement Plan (PIP) for water supply and sanitation

Bhusawal, class A municipality is located in Jalgaon District in the Maharashtra state, India. Detailed assessment of water, sanitation and solid waste sector was undertaken to identify key issues and challenges in the city. Based on the assessment, plan for improving performance of WSS services was prepared. The proposals suggested are focused on two key areas of establishing 24X7 water supply system and moving towards an open defecation free BMC, as well as improvements in key processes and operations related to the above areas.

Read more

Preliminary Water Audit

Kalol: Estimation of Water Losses and Strategy for Loss Reduction

Based on preliminary water audit study, NRW in Kalol is observed to be 46 per cent. NRW includes water losses and free supply of water. The water audit results give component wise amount of water being lost from water supply system. Based on these results, suitable set of interventions need to be taken. The first set of suggestions includes those that can be taken immediately and at relatively lower costs by the Kalol municipality. A second set of suggestions for more detailed studies is also identified for further diagnostic to reduce NRW and improve efficiency in service provision.

Read more

Climate Change and Urbanization:

Indore: Building Resilience in the urban water sector

Indore is the largest and fastest growing city in the central Indian state of Madhya Pradesh. This report is the outcome of research in Indore carried out by the Institute for Social and Environmental Transition (ISET) and the Pacific Institute, supported by TARU, over a period of three years. The purpose of this research was to understand the complex dynamics of the water sector, to investigate the needs of urban water managers and ultimately to suggest strategies that can help these managers meet ever growing needs.

Because of the inadequate and unreliable water supply situation, residents supplement their needs via household and community self supply, installing in-house storage, as well as supply from water tankers and packaged water providers. However, the ability to make such arrangements varies, and this has led to significant differences in water use between lower income and higher income communities. The objective of this study was to identify a resilience strategy for Indore that could make Indore's water supply more sustainable and resilient in the face of urbanisation and climate change.

Read more

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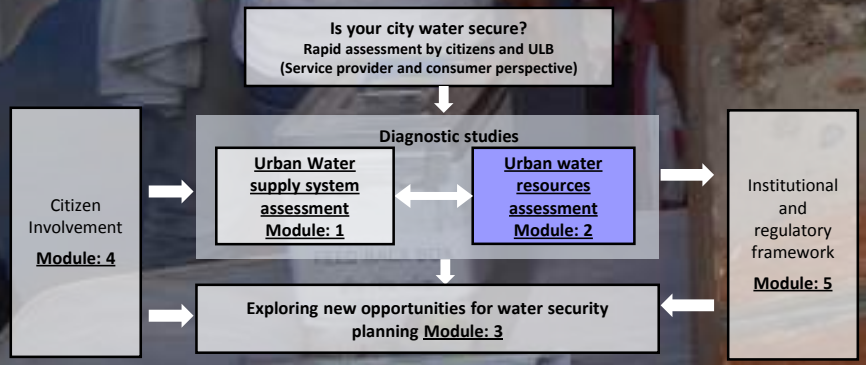
Module 2
Understanding urban water resources

M2



Module 2
Understanding urban water resources

Introduction:

The hydrological cycle describes the movement of water above, on and below the surface of the earth.

The principles of IUWM maintain that we must take into consideration all parts of this water cycle in our planning activities and not just those that affect urban water supply.

Understanding our resources is the first step towards better management.

This module describes a step-by-step approach with which a city can undertake assessment of its hydro-geological characteristics and water resources.

It is an important exercise for an integrated approach providing a contextual understanding of the sources of water and how to incorporate their management in urban planning.

Learning Objectives:

More specifically, this module will assist users in-

- Building a historical perspective of water use in the city – knowing how the city has used water in the past provides valuable insights for water management in present day.
- Looking at water from a resources perspective rather than a supply perspective. The majority of resources in our context fall under two categories – surface and ground. Thus this module goes in to details about assessment of –
    - Rainfall
    - Surface water – lakes rivers and their catchments
    - Ground water and Aquifers
- Undertaking a Water Balance Assessment

Target Users:

Planners: This module helps planners and city managers thinking of water from a resource point of view instead of the traditional demand-supply perspective. It provides tools to help integrate geo-hydrology in mainstream city planning in order to actively take measures to protect/preserve/better utilize available resources based on a land suitability and water balance approach.

CSOs: This module can be used by CSOs with experience in geohydrology/ local history to create useful databases for city managers as well as creating awareness amongst other citizens about the local water resources and water balance.

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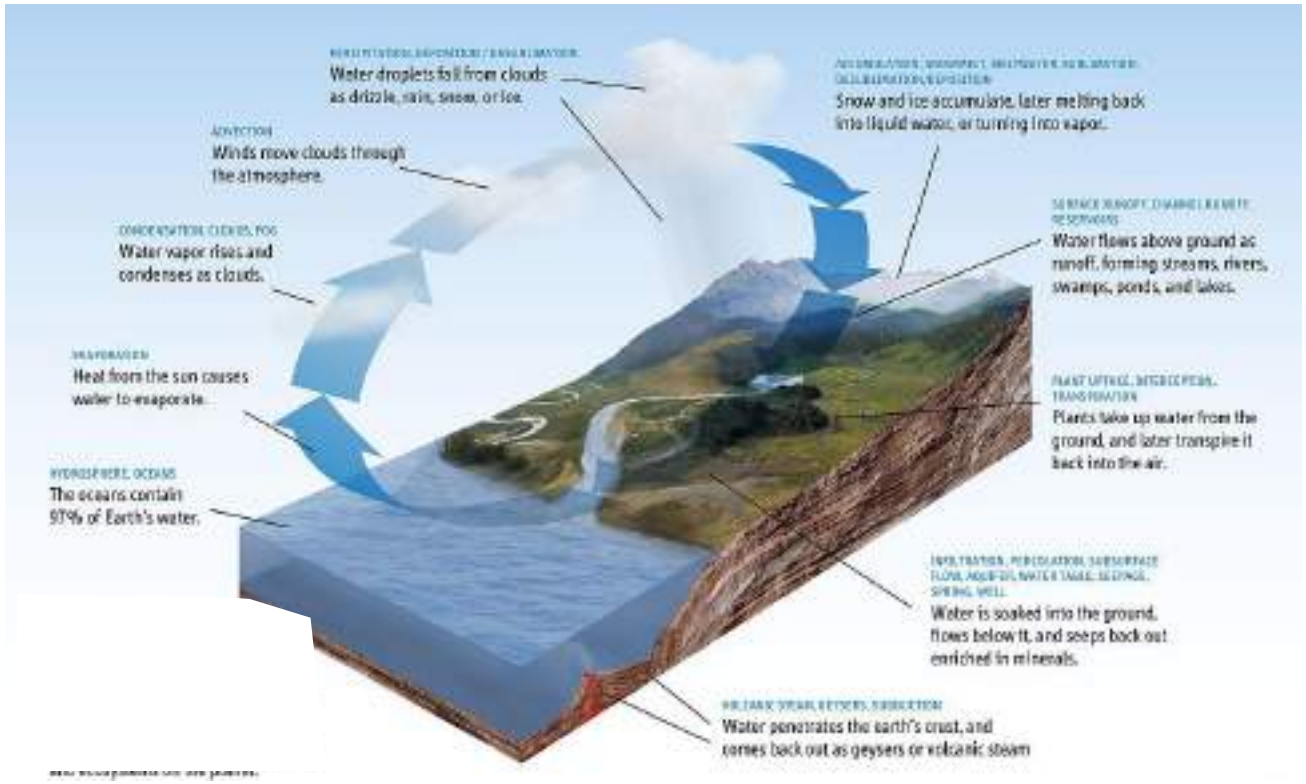
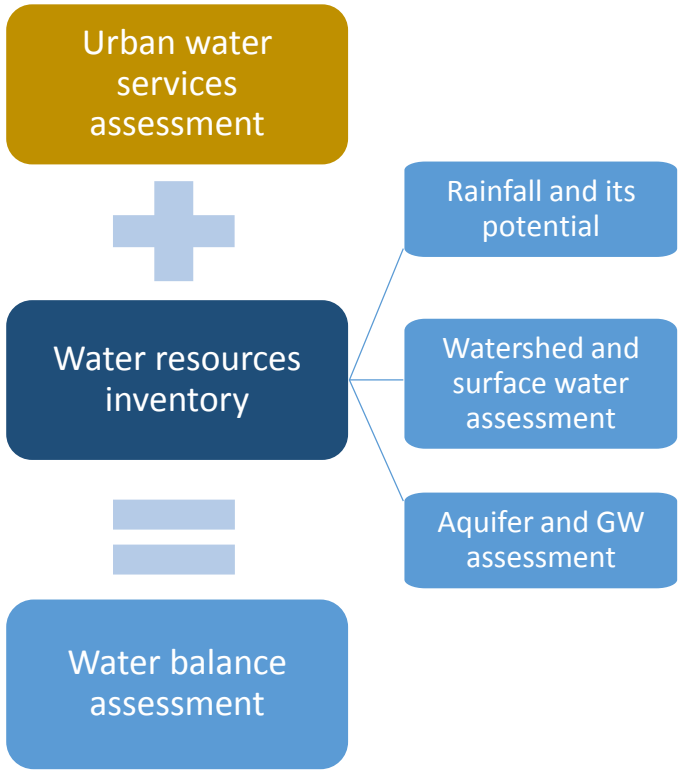
MODULE: 2

A "Resources" perspective of water management

Figure 2.1: Water Cycle and its Components





Water resources are sources of water that are potentially useful.

The majority of our resources in our context fall under two categories – surface water and ground water.

The hydrological cycle describes the movement of water above, on and below the surface of the earth and across these sources of water.

Drawing water from these sources we use it for agricultural, industrial, household and recreational activities. However, one also needs to consider the environmental uses of water in order to do a water balance assessment that considers urban water services as well as the natural water cycle.

Urban water services assessment has been covered in the previous module. This module deals with an inventory of natural water resource by assessing rainfall, watersheds, water bodies, Aquifer and groundwater. This information, combined with urban water supply gives us a completer picture of the cycle in the form of a water balance.

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2.1 Documenting history of water management

MODULE: 2

Photo: Mavjibhai Ranchhod Gajjar (1836 – 1912)

How has the city used its water resources in the past? Understanding the evolution of water supply system and its management is crucial for preparation of water security plan of any city.

What to document?

Architectural and planning efforts made by old rulers of the region. E.g.: Traditional well systems- stepwells and private, Changes done to natural catchments and watersheds, New Lakes or canals - extensions, diversions.

Natural calamities and changes to water supply thereafter – earthquakes, drought.

Advent of modern piped supply and changes due to it, Development of current municipal supply system – timeline of source development, urban expansion, water imports/exports

Environmental significance – e.g.: point for migratory birds

Where to look for information?

Documents – District Gazetteer | Books on local history | Land deeds and records for prominent city structures/buildings | Survey of India maps

Public consultation and interviews- Mayors of city in past few decades | Local historians, scholars, researchers | House owners in oldest parts of the city | Long term Municipality engineers | Decedents of old rulers

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MODULE: 2

Case Study

Documentation of History of water supply system of Bhuj

The journey of Bhuj city from evolution of its traditional water supply system to its complete decline and subsequent transition to centralised systems eventually led to higher dependence on distant sources and complete neglect and misuse of its own groundwater.

Evolution of Hamirsar System: During inception of Bhuj, Hamirsar Lake system was developed by merging adjoining catchments with the original catchment of Hamirsar through channels, underground tunnels and canals until the catchment was enough to sustain the system. The rulers had good knowledge of local geology and the lakes were strategically situated as "feeder" or "recharge" lakes on impervious and pervious geology respectively. The 3 main lakes had specified uses – washing, drinking reservoir and wetland for local and migratory fauna. The entire catchment system was well-managed and de-silting and cleaning of lakes, channels and canals were done regularly. The urban area had open wells allotted to communities to use and manage.

Shift from the Traditional to a Municipal System and resultant breakdown of catchment system

After annexation by the British, the water supply systems came under direct purview of the East India Company which introduced a more centralized management staffed by civil engineers, who were largely not familiar with local water resource management systems.

There was very little effort to understand and improve the traditional systems. With time traditional society also declined under the regime. Soon with spurt of economic activities in and around Bhuj and rapid population growth, piped water system was introduced in 1968.

This resulted in a significant increase in average household consumption and a need arose to "bring" water from outside. First, water from the bore wells dug at Bhujodi village, nearly 20 Km away from Bhuj, was used to meet the demand for water. After the earthquake of 2001, the water supply system was revamped and water from Narmada through Narmada canal was also brought to Bhuj.

With a greater share of municipal water coming from external sources, there was neglect of the 'traditional wisdom' related to natural water systems. A number of natural drains leading to lakes and drawing water from their respective catchments were lost due to construction activities. Many lakes were also lost as they were filled and converted to buildable land. Hamirsar no longer filled up every year and groundwater started deteriorating.

Modern revival in Bhuj

In recent years, the local community led by a NGO-Arid Communities and Technologies (ACT), has made efforts in reviving traditional water conservation practices and exploring alternative water supply systems through participatory management. The community has created an active committee for such actions. Hamirsar lake now fills up again every monsoon and groundwater is being monitored. Decentralized drinking water schemes are being explored to be able to move away from dependence on Narmada. Read more

Figure 2.2: Catchment Area of Bhuj

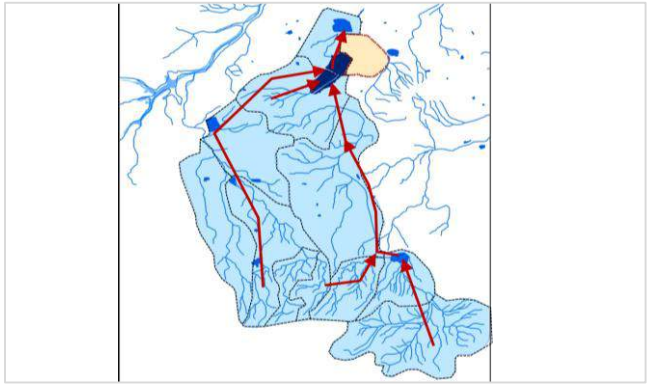
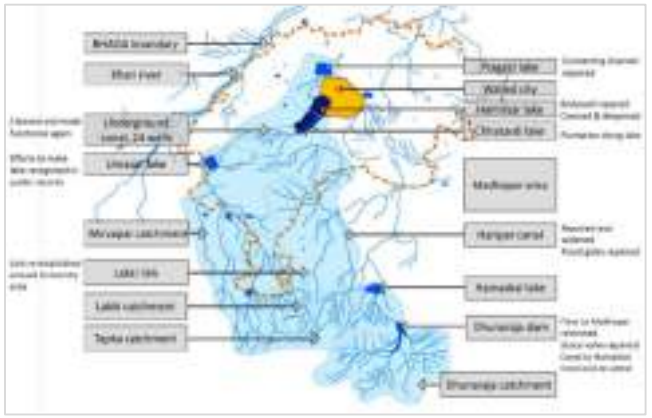


Figure 2.3: Issues in Catchment Area Mapped in Bhuj

Figure 2.4: Local Water Sources Revival Plan in Bhuj



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2.2 Rainfall Analysis

MODULE: 2

Photo: Financial Tribune

Rain is a major component of the water cycle and is responsible for depositing most of the fresh water on earth.

Rainfall is a major contributor to the overall climate of the region and hence it is important to study trends over time. An assessment of the average amount of rainfall received over the year as well as trends in intensity and variation from average gives an idea of the total amount of water available in the region.

Aside from studying the quantity of rainfall it is also useful to understand what happens to the rain water upon reaching the surface of the earth. A large amount flows over the surface guided by the contours. This is called run-off. Yet another part return through the atmosphere through the processes of evaporation and transpiration. Some amount is absorbed by the earth and recharges the aquifer.

Precipitation = Run off + Recharge + losses

Losses= Interception, Evapo-transpiration

These assessments are useful in estimations for natural water pathways in hydrological balance.

Sources of data: The Hydrometeorology branch of the Indian Meteorological Department (IMD) conducts rainfall monitoring and compiles statistics from hundreds of observation stations across India.

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MODULE: 2

2.2 a) Annual rainfall received

Annual rainfall = Total rain (in mm or cm) measured by a rain gauge in the whole year

Average annual rainfall = Average of annual rainfall in a region over a long term

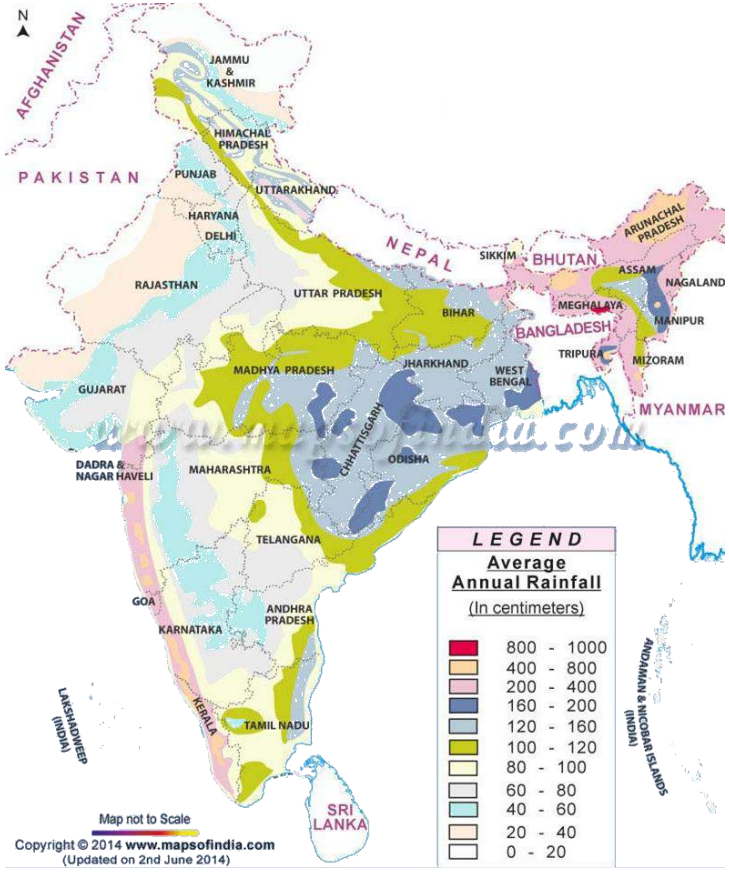
Rainfall affects the overall climate of a region

Arid climate: AAR < 40 cm

Semi-arid: AAR 40-75 cm

Humid: AAR > 75 cm

Figure 2.5: Average Annual Rainfall in India



2.2 b) Variation in annual rainfall

Variation in annual rainfall – Amount of deviation from normal rainfall (35 years average) gives annual variation of monsoon

Excess:+20% or more

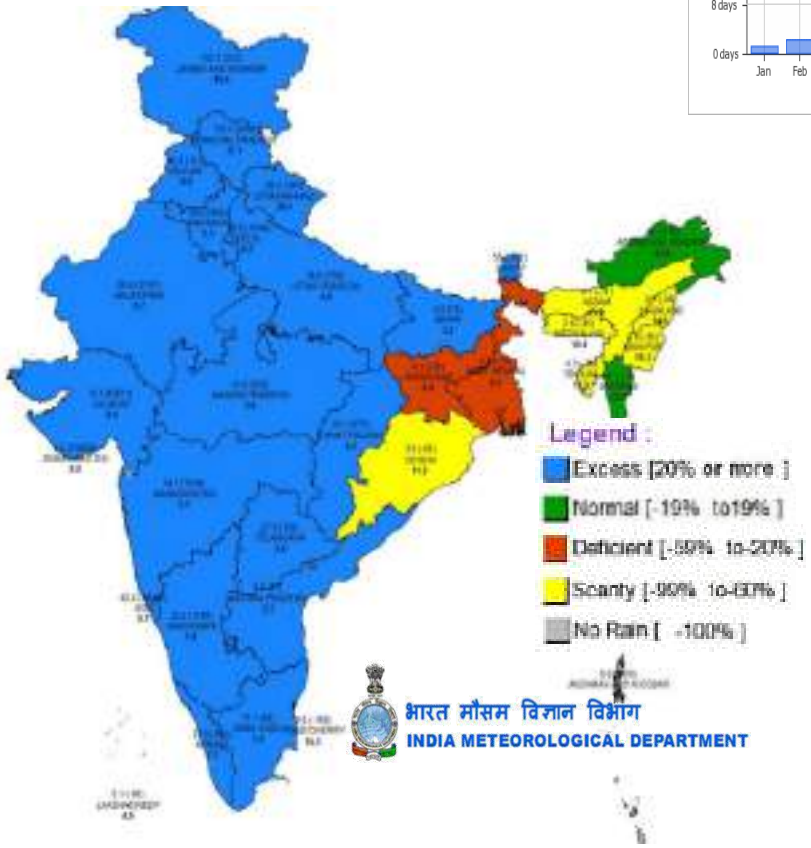
Normal:+19% to -19%

Deficient:-20% to -59%

Scanty:-60% to -99%

No Rain:-100%

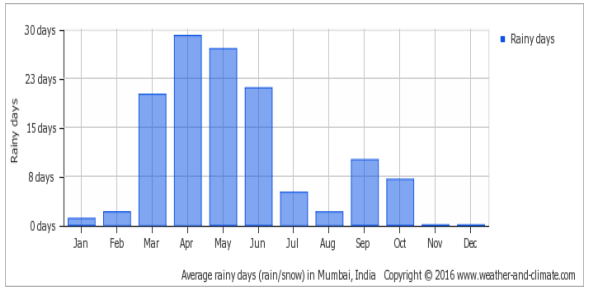
Figure 2.6: Annual Variation of Monsoon in India



2.2 c) Number of Rainy days

Number of rainy days in the year - If a high amount of rain falls in only a few days, most of it will result in runoff

Figure 2.7: Number of Rainy Days in India



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MODULE: 2

2.2 d) Runoff

Runoff is the flow of water that occurs when excess stormwater, meltwater, or other sources flows over the Earth's surface

Estimated as a % of rainfall depending on the type of catchment

Barlow's table for runoff %				
Description of catchment		Light rain	Average/ varying rainfall	Continuous downpour
A	Flat, cultivated, and absorbent soil	7%	10%	15%
B	Flat, partly cultivated, and stiff soil	12%	15%	18%
C	Average catchment	16%	20%	32%
D	Hills and plains with little cultivation	28%	35%	60%
E	Very hilly, steep and no cultivation	36%	45%	81%

Source: ACT; CEPT (2015)

2.2 e) Recharge

Recharge is the process where water moves from surface water to groundwater

Primary method through which water enters an aquifer

Estimated as a % of the amount of rainfall, depending on the geology

Hydrogeological situation		Rain infiltration
1	Alluvial areas a. Sandy Areas b. Areas with higher clay content	 20-25% of normal rainfall 10-20% of normal rainfall
2	Semi-Consolidated Sandstones (Friable and highly porous)	10-15% of normal rainfall
3	Hardrock area a. Grantic Terrain (i) Weathered and Fractured (ii) Un Weathered b. Basaltic Terrain (i) Vesicular and Jointed Basalt (ii) Weathered Basalt c. Phyllites, Limestones, Sandstones, Quartzites, Shales, etc.	 10-15% of normal rainfall 5-10% of normal rainfall 10-15% of normal rainfall 4-10% of normal rainfall 3-10% of normal rainfall

Source: ACT; CEPT (2015)

2.2 f) Evapo-transpiration

Evapo-transpiration is the process by which water is transferred from the land to the atmosphere by evaporation from the soil and other surfaces and by transpiration from plants

Estimated as a factor of

Energy available for evaporation + wind to transport moisture (Pan-evaporation)

Type of crop/vegetation (Consumptive use)

Coverage of vegetation

Cropping/ growing season

ET for Month A and crop type B

ETAB= Pan-evaporation A

X Consumptive_use_kB

X Area_covered_by_cropA

These can be calculated using the water balance template introduced towards the end of this module

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2.3 Surface Water Assessment

MODULE: 2

Inventory of surface water

Source: Flickr, Nevil Zaveri

Surface water is water on the surface of the earth such as in a river, lake, wetland, or ocean.

A large amount of urban water supply is dependent on surface sources. Surface sources also have crucial geological connections with GW.

Hence assessment of surface water sources is essential for integrated water security plan for city.

The first step is an inventory of Surface water sources. This includes mapping and water quality testing Tools are available to enable users to plan and carry out these activities.

The next step is mapping and assessment of the catchment area of these water bodies. This includes mapping of watersheds while also keeping in mind urban landuse.

These exercises together give a clear view of the situation of surface water sources in the city.

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2.3 a) Mapping water resources

1. Identify and map existing rivers, streams, lakes, canals, irrigation dams, check dams, tanks etc.
2. Present condition of water bodies (structural damage, silting, vegetation encroachment, urban encroachment, dry, solid waste dumping)

2.3 b) Quality testing

Impure water has following characteristics

- a bad taste,
- color,
- odor, or
- cloudy appearance (turbidity)
- causes hardness,
- causes corrosiveness and staining
- damages growing plants and is a cause of disease

1. Physical Test : turbidity, pH, TDS, taste, colour, odour and temperature
2. Chemical Test : total hardness (as CacO3, ppm), chlorides (as Cl) , sulphates (as SO4), fluorides(as F), nitrate (as NO3), calcium(as Ca), magnesium (as mg), alkalinity and acidity(pH)
3. Bacteriological Test : total coliform and faecal coliform e.g.: e-coli

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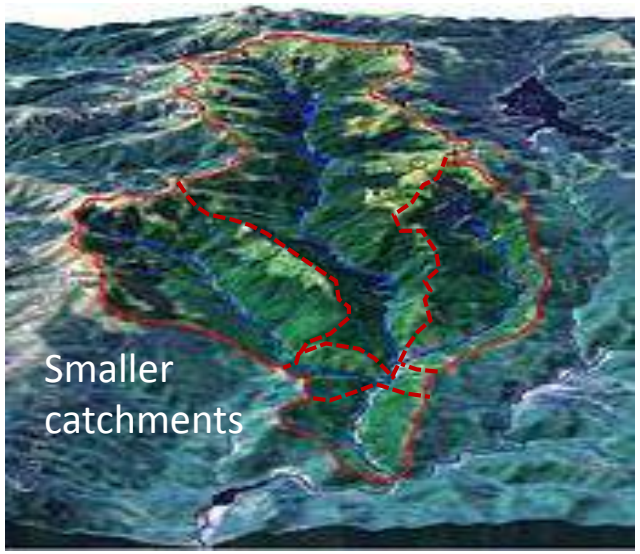
MODULE: 2

2.3 c) Mapping urban Watersheds and land use

Figure 2.8: Watershed of Region X



A Watershed (also known as Catchment or Basin) is an area from which all water drains into one stream / collects to one point.

In order to effectively manage a water source, it is important to manage its catchment. Further, upstream activities have impact downstream. Therefore, an integrated approach calls for Watershed assessment and management. This in turn leads to a requirement of watershed level planning and management.

The first step is mapping the watershed. While traditional geographical methods can be applicable in this process, care must be taken in urban areas where the natural water flow has been altered by the built up area. In such cases, the municipal storm water drainage must be included in the analysis.

Features that must be included while mapping:

- Land forms- Natural drainage, existing streams, lakes, sea
- Physiography, Contours, slopes, watershed boundaries
- Soils
- Land use, cropping pattern and built-up area
- Storm water drain network, % road coverage by length, Incidences of water logging
- Other boundaries – protected forest etc.

Sources of data:

- Cadastral maps available with District land record office or Talati at Panchayat office provide details about Farm lands, Local roads, Grazing, Settlements and water bodies and tanks
- Toposheets available with Survey of India or the Irrigation department provide information about River and streams, Roads, Contours, Water bodies, Important landmarks
- Regional level landuse is available at ISRO's Geo-portal Bhuvan: *http://bhuvan.nrsc.gov.in/*
- Local land use can be found in urban Development Plans / Master plans
- Storm water network maps are available in ULB engineering departments
- Contours and natural drainage can also be extracted from Digital Elevation Models with the use of GIS software
  - Global DEM available from SRTM database http://srtm.csi.cgiar.org/ at 90 m resolution
  - Indian DEM with higher resolution at Bhuvan
- Google maps – to compare on-ground situation with rest

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MODULE: 2

Case Study

Mapping water bodies and issues in catchment in Bhuj: A study was done of the traditional lake catchment system of Bhuj and a subsequent analysis of present situation of the catchments revealed broken links in the system. With efforts of a local NGO, ACT, Bhuj Municipality and a citizen committee, JSSS restoration activities were carried out. Hamirsar lake now fills up in the monsoon season. Read more

Figure 2.9: Locations of Lake in Bhuj

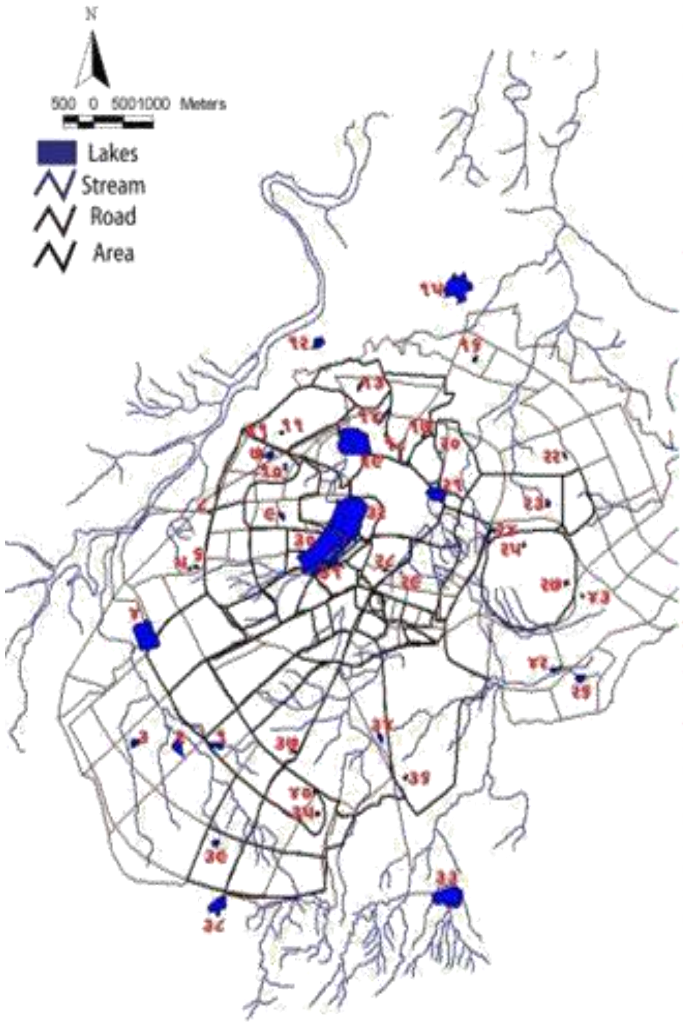
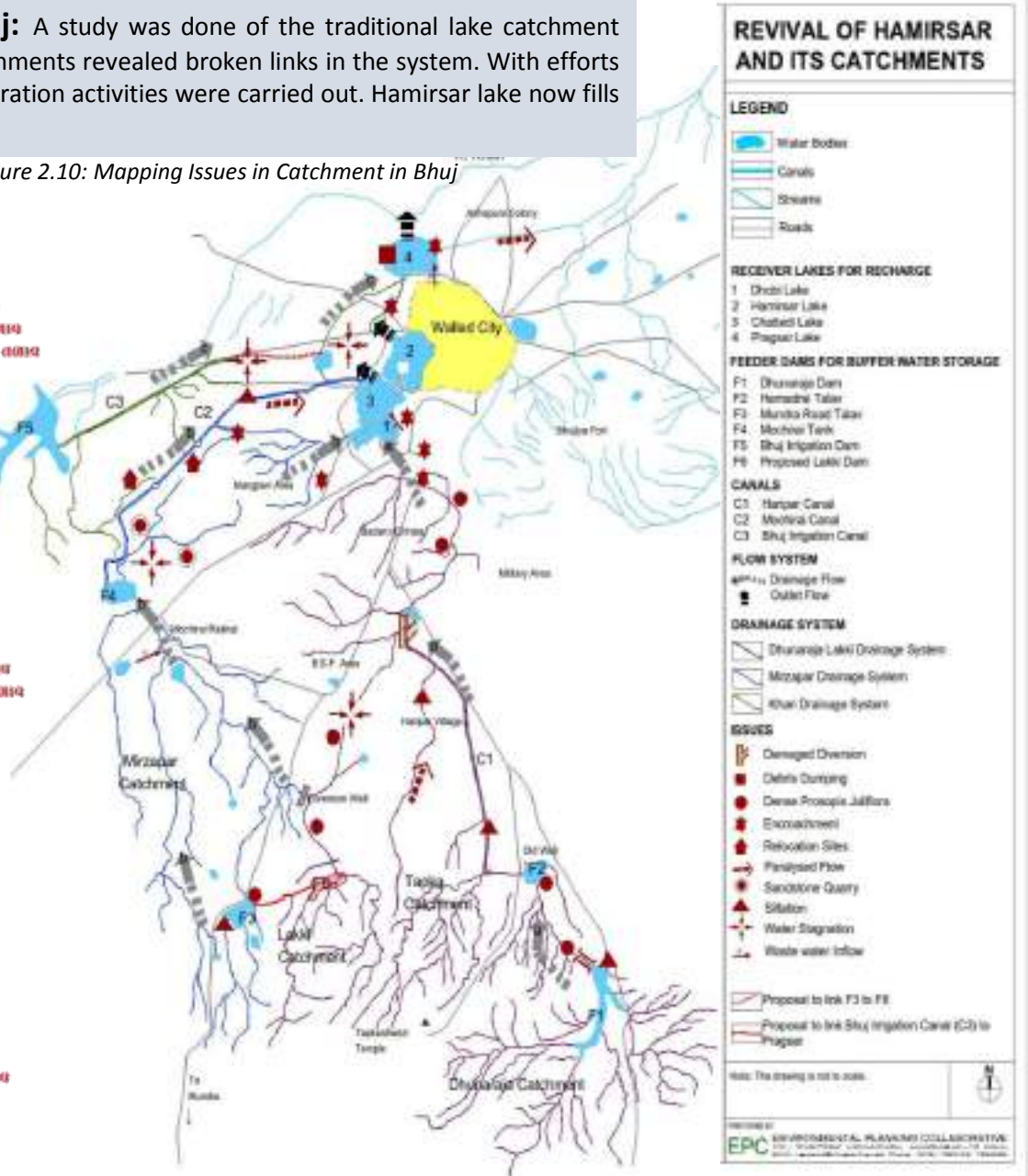


Figure 2.10: Mapping Issues in Catchment in Bhuj



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TOOLS

MODULE: 2

2.1 Template for Surface water inventory

This template can be used to conduct a surface water inventory in the city.

It provides a list of details to be collected in a survey format.

2.2 Protocols for Surface water quality monitoring

Quality monitoring requires careful sampling and testing.

This document lists protocols for sampling locations, ideal times and methods for obtaining reliable samples and parameters which must be recorded for water quality testing.

It has been compiled under CEPT University's PAS Project.

2.3 Template for Surface water quality monitoring

This template lists the details that need to be collected along with water samples for quality testing

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2.4 Water quality standards

This list gives acceptable standards for water quality parameters according to as per IS: 2296.

It classifies water into 5 classes according to their use -

- Class A – Drinking water without conventional treatment but after disinfection.
- Class B – Water for outdoor bathing.
- Class C – Drinking water with conventional treatment followed by disinfection.
- Class D – Water for fish culture and wild life propagation.
- Class E – Water for irrigation, industrial cooling and controlled waste disposal.

It also provides quality standards for treated drinking water according IS: 10500

2.5 Guide: How to mark watersheds?

This fact sheet provides the user the necessary skills to interpret topographic maps and successfully delineate a watershed boundary using a contour map

It is an excerpt from Appendix E of the Method for the Comparative Evaluation of Non-tidal Wetlands in New Hampshire, 1991. Alan Ammann, PhD and Amanda Lindley Stone.

2.6 Sample maps

This collection of maps can be used as examples of maps that need to be generated for land and surface water inventory

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2.4 Groundwater and Aquifer assessment

MODULE: 2


Source: ACT

Ground water is a major source of water for a large number of our activities. Any exercise in water resources planning and management must thus, include an assessment of groundwater and the aquifer.

An aquifer is an underground layer of water-bearing permeable rock, rock fractures or unconsolidated materials (gravel, sand, or silt) from which groundwater can be extracted.

The first step is understanding the aquifer. For Quick assessment and macro level information : Central Ground Water Board, India has published studies on aquifer systems of India-http://cgwb.gov.in/AQM/. The ministry of Drinking water and Sanitation also gives a compilation of Groundwater prospects maps - http://www.mdws.gov.in/hgm_maps

For more granular information, studies need to be conducted to understand the boundaries and characteristics of the local aquifer and groundwater contained in it.

The second step is monitoring the groundwater and trends over time. Changes in levels and water quality over seasons and even years need to be recorded and analysed.

It must be noted that aquifer mapping and GW monitoring are long term procedures taking up to 2 years in order to be able to get meaningful information and analysis.

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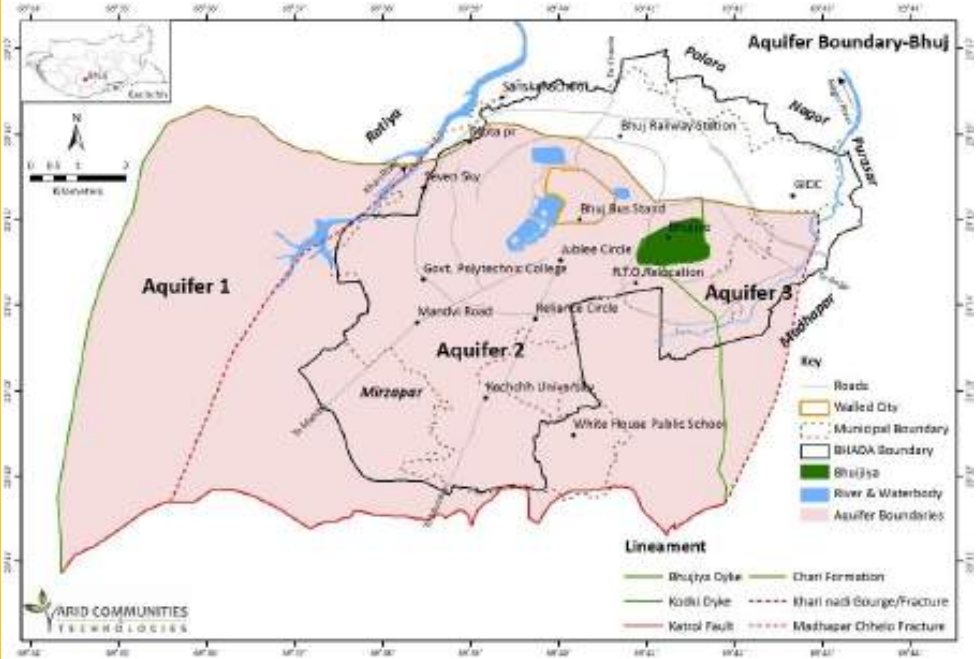
MODULE: 2

2.4 a) Aquifer Identification and Delineation: Producing a geology map and fence diagram

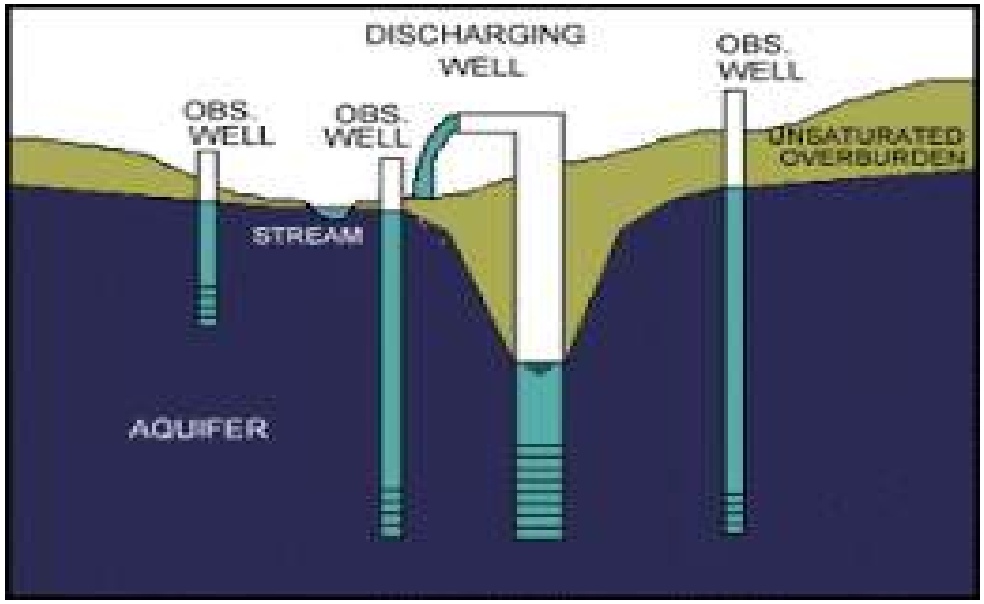
Figure 2.11: Mapping of Aquifer in Bhuj Region



1. Geological Mapping for surface
2. Tectonic – Lineament mapping for identification of aquifer boundaries, localized specific characteristic influencing groundwater levels and quality
3. Well inventory and litho-log mapping for sub-surface
4. Reduced water level maps for groundwater flow direction and to identify discharge area

2.4 b) Aquifer Characterization– hydraulic properties : Estimating storage potential

Figure 2.12: Pumping Test for Discharge Management



1. Pumping test for discharge measurement: A Pumping Test is a field experiment in which a well is pumped at a controlled rate and water-level response (drawdown) is measured in one or more surrounding observation wells; response data from pumping tests are used to estimate the hydraulic properties of aquifers, evaluate well performance and identify aquifer boundaries.
2. Groundwater replenishment / withdrawal estimation
3. To understand transmissibility – Permeability
4. Porosity test to estimate storage potential - Rock sample saturation method

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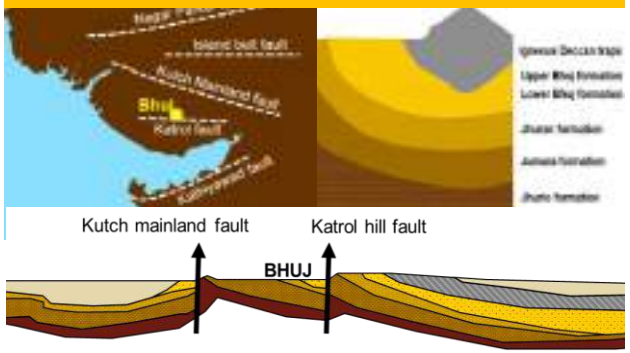
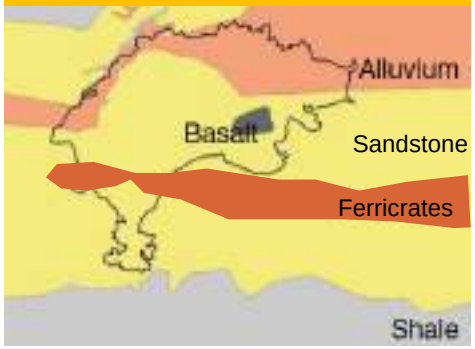
MODULE: 2

Figure 2.13: Process of Mapping of Aquifer in Bhuj

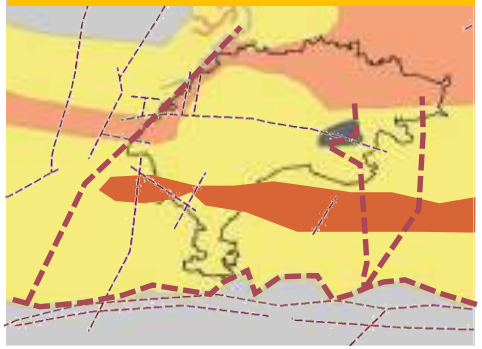
2.13 a. Macro geological context



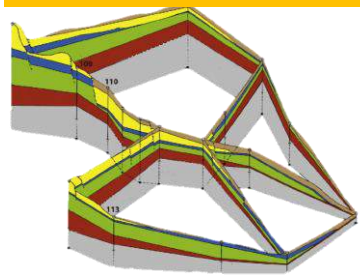
2.13 b. Geological Mapping



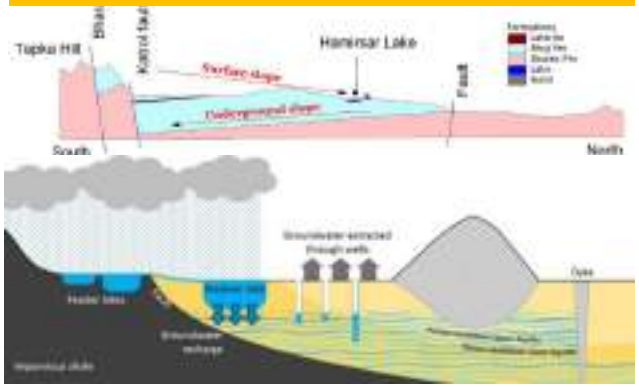
2.13 c. Lineament mapping



2.13 f. Aquifer fence diagram



2.13 d Conceptual diagrams

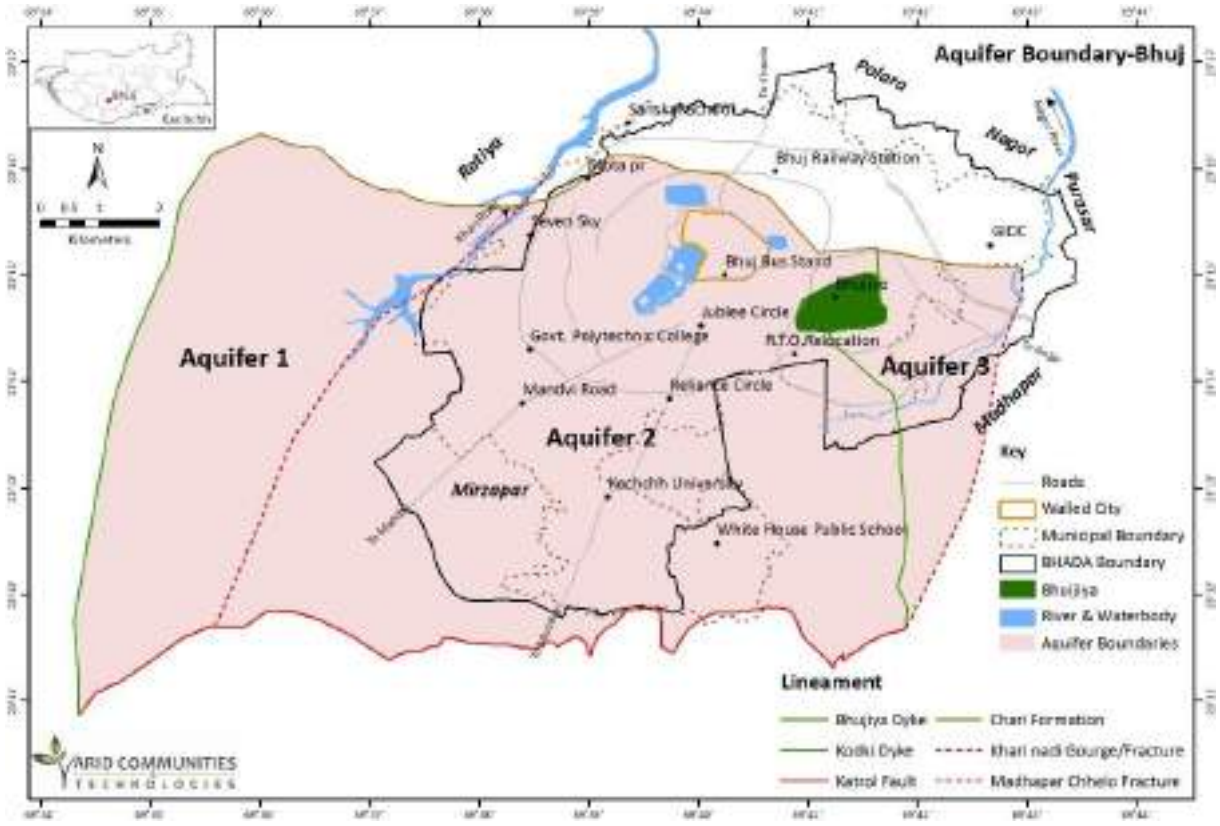


2.13 e. Well Litholog mapping

Source: ACT, CEPT

Aquifer Delineation

Figure 2.14: Aquifer Boundary of Bhuj



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MODULE: 2

Case Study

Aquifer mapping in Bhuj

ACT, a NGO in Bhuj has been studying the local geology of Bhuj. With the help of people in ACT with technical knowledge, a team of para-hydrogeologists called Parabs were trained. Since 2008 this team has been helping ACT map and monitor the aquifer and its groundwater. With years of experience and research, they have built up a rich geological database of the aquifer in Bhuj. Geological information, although available at a macro level, is very rare at this scale. It has been used in various revival activities, technological demonstration and proposals based on this database are now included in the Development Plan of Bhuj. Further, proposals for GW recharge an storm water drainage under AMRUT are also in the works.

Read more

Hydrogeological Action Research for Spring Recharge & Development And Hill-top Lake Restoration in parts of Southern District, State of Sikkim, India – ACWADAM

This study aimed at providing scientific inputs based on hydrogeological mapping and related studies, for spring recharge (Dhara Vikas) programme and hill-top lake restoration. Hydrogeological mapping of 15 springs and 3 lakes in South district of Sikkim was carried out by ACWADAM team along with the Field Facilitators. Capacity building of FFs in understanding hydrogeology was a continuous process even during the field visits to different springs. This study showcases hydrogeological layouts of the springs and lakes studied by ACWADAM and FFs. Each layout describes the local hydrogeology, spring type and recharge areas for the spring.

Read more

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MODULE: 2

2.4 c) Groundwater monitoring


Source: ACT


Source: ACT

Groundwater is a dynamic resource and its levels change from season to season and vary in different localities. Knowing the levels and quality of groundwater is important for understanding the health and potential of aquifer. It also helps in determining how the groundwater interacts with local surface water sources, and understanding how surface development has impacted the aquifer.

1. Establish a monitoring network based on aquifer and zones of influence
2. Regular monthly/seasonal monitoring of water levels in monitoring wells to record fluctuations. Recordings should especially be taken before and after monsoon season
3. Water level measurement should be accompanied by Quality tests for Drinking Water as well as Irrigation Water
4. Produce seasonal water level and quality contour maps
5. Trend assessment - Reduced water levels and TDS or any quality influence parameters
6. Identification of reasons for aberrations in levels, quality parameters and trends
7. Estimate yearly changes in storage - Compute changes in quantity in the form of increase or decrease levels and quality in different in areas of watershed
8. Identify vulnerable zones

Go to Contents

2.7 Template for Well inventory

This template lists details to be collected while doing surveys for a well inventory And lithology mapping.

It has been adapted from the templates used by ACT in surveys in Bhuj

2.8 Manual on Aquifer mapping - CGWB, GoI

The Central Ground Water Board (CGWB), under the Ministry of Water Resources, GoI has developed a manual on aquifer mapping as part of the national Aquifer Mapping Project to aid mapping and delineation of local aquifers of an extent of 50 to 100 sq.km, as a unit for water management in the country

2.9 Template for Well monitoring

This template lists details to be collected Regarding water levels water use and quality testing.

It has been adapted from the templates used by ACT in surveys in Bhuj

2.10 Smartphone app - Mera Bhujal

This Android app by Govt of India provides ground water resources information for users at current/desired locations.

- Annual ground water availability and withdrawal
- Stage of ground water withdrawal in color coded format
- Ground water quality

2.11 Protocols for GW monitoring

This document lists protocols for sampling locations, ideal times and methods for obtaining reliable samples and parameters which must me recorded for testing of groundwater. It has been compiled under CEPT University's PAS Project.

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MODULE: 2

Case Study

Including Hydrogeology in Land use Planning in Bhuj:

Bhuj Area Development Authority is in the process of preparing a new development plan. ACT's efforts and suggestions led to the Municipality paying special attention towards the subjects of ground water and storm water drainage. ACT compiled a set of suggestions and proposals which are now in the process of being incorporated into the Development Plan.

Explaining the geology of Bhuj and observations from their ground water monitoring system, ACT suggested that Bhuj adopt a plan for ground water recharge based on a grid. This is based on their ground water monitoring network model which works on a grid system. Each grid box contains at least one well that is already monitored in terms of Reduced water level and TDS and can hence be used to assess the effect of recharge activities. Assuming that each activity benefits an area of 300X300 sq. m around it, ACT has suggested the following recharge activity plan.

The plan proposes up gradation of several water bodies as well as the creation of a new lake with recharge borewells in all the lakes. Recharge pits are proposed every 60 m in existing water channels. To support this, another plan to maintain the channels was proposed. This is shown in Figure 34 . In addition to this, ACT suggested the use of common plots/ open grounds for collecting rainwater and using it for groundwater recharge.

MARVI : Managing Groundwater Use and Aquifer Recharge

MARVI is a project funded by the Australian Centre for International Agricultural Research (ACIAR) and it has been in operation in the States of Gujarat and Rajasthan since 2012.

The research on two multi-village watersheds, the Dharta watershed in Rajasthan and the Meghraj watershed in Gujarat. Both watersheds have hardrock aquifers. The main aims were to enable local villagers to monitor groundwater and establish a comprehensive database about groundwater level fluctuations, availability and river bed structures to augment recharge.

Water table fluctuations in 250 dug wells in the Dharta watershed and 110 wells in the Meghraj watershed were monitored by trained 'Bhujal Jaankars' and groundwater sensors over four years. A number of check dams were monitored to understand their recharge performance and effects on groundwater availability on nearby wells. An SMS based data collection system and a smart phone app called MyWell, for both Android and iOS platforms, was developed to assist in the easy collection of water table depth and rainfall data and to visualise data and make them available on the web. **Read more**

Figure 2.15: Proposed Groundwater Recharge Pits in Bhuj

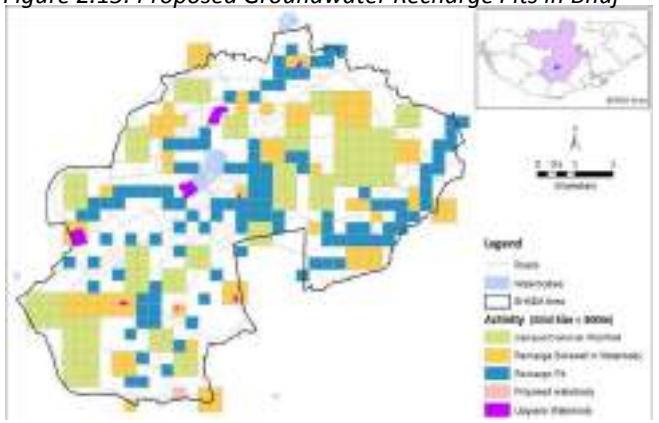


Figure 2.16: Proposed Water Channels and Water Bodies in Bhuj

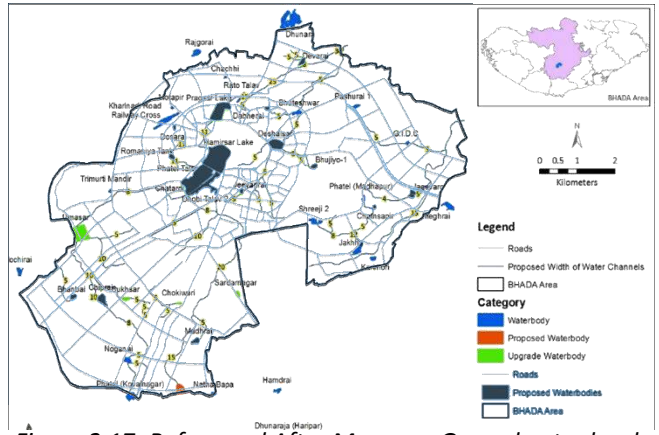
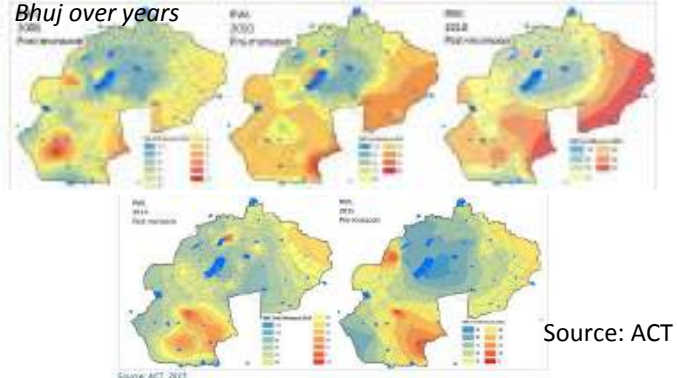


Figure 2.17: Before and After Monsoon Groundwater level of Bhuj over years



Source: ACT

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Output 2A: Land suitability and Vulnerability analysis

MODULE: 2

Based on assessments and mapping so far, users can compile a land suitability and vulnerability analysis. This will become basis for all future planning and development activates. Care must be taken to include the following points -

Disruption in natural water flow
- Encroachment
- Vegetation overrun
- Siltation
- Flooding
- Erosion

Structural damage

Polluted lakes, river stretches

Areas with drastic drop in water table

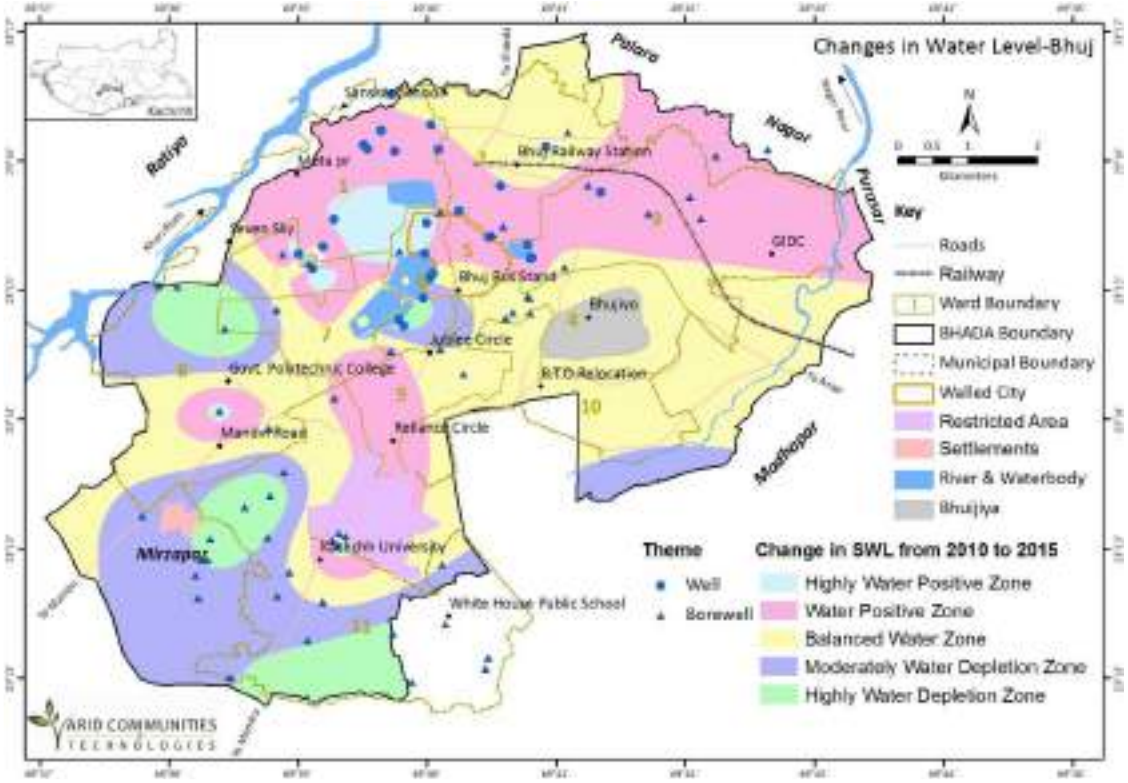
Low lying / Flood prone areas

Lakes running dry for consecutive years

Natural high recharge potential zones

Populations with low access to municipal supply e.g.: slums

Figure 2.18: Mapping of Changes in Groundwater Levels in Bhuj



Eco Sensitive Areas - Species Based (Endemism, Rarity etc.), Ecosystem Based (sacred groves, frontier forests etc.) and Geomorphologic feature based (uninhabited islands, origins of rivers etc.) (MoEF, GoI)

Areas with poor or undesirable quality of groundwater
- Due to human activities
- Due to aquifer characteristics - salinity etc.

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Output 2B: Water balance assessment

MODULE: 2

Figure 2.20: Inflow-Outflow Water Assessment of Bhuj

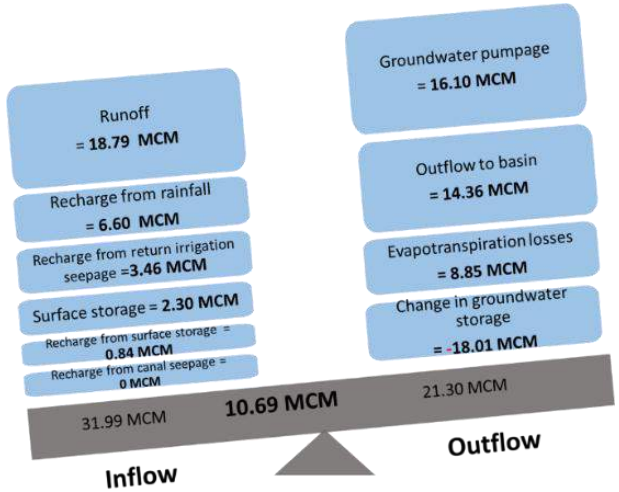
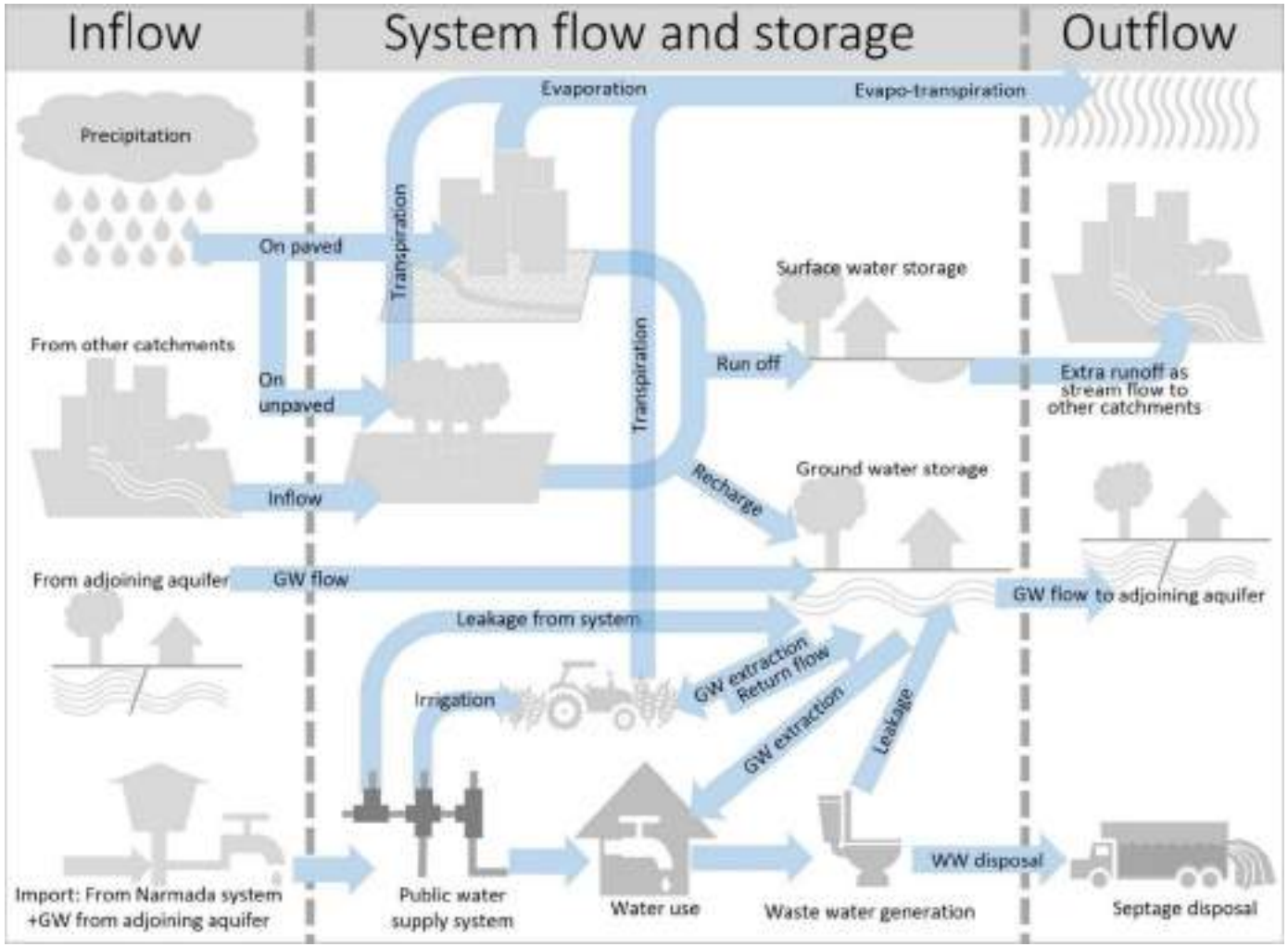


Figure 2.19: Schematic Diagram of Inflow-Outflow of Water



In hydrology, a water balance can be used to describe the flow of water in and out of a basin. It is an assessment of the various flow components of the hydrological cycle of a specific region, comparing precipitation and other inflows with outflows, and accumulation/storage changes over a certain time period.

Water Balance estimation of city helps to assess the current status and trends in water resource availability in an area. It also indicates if enough surplus are available for planning for future water demand.

Hydrological equation: Inflow = Outflow + change in storage

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TOOLS

MODULE: 2

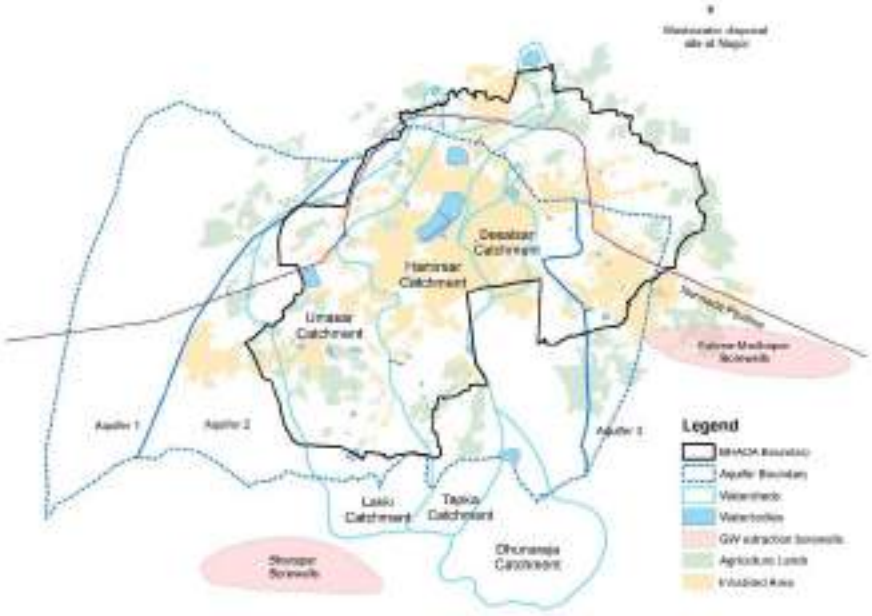
Case study

Water Balance in Bhuj area

Water Balance of Bhuj city was studied in detailed to assess the current status and trends in water resource availability in an area. BHADA boundary was defined as the study area for water balance of city for a period of one year.

Read more

Figure 2.21: Mapping of Various Catchments and Aquifers in Bhuj



Source: ACT

2.12 Template for Water Balance Assessment

This template assists users in conducting a water balance assessment in their delineated area
It provides users with a collection of thumb rules and methods in an excel based format for quick assessment

It has been developed out of the experience in Bhuj and can be modified to suit all cases

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2.5 Key issues and strategy: Interventions based on 2A, 2B

Combing suitability analysis and water balance, users can prioritize measures and interventions for water management. Each link in the urban water cycle must be examined to find ways for improvement. In addition, vulnerabilities must also be addressed as listed in land suitability assessment

Inflow		Natural Processes		Supply for Human use		Waste Water generation	
Rainfall on built up area	Roof RWH	Evaporation	Protect water reservoirs	Public water supply system	Demand management, Moving away from centralized systems Manage increased demand from covering unserved areas	Waste water Generation	Opportunities for reuse
Rainfall on unpaved areas	GW recharge	Keep in consideration Ecological water requirements		Leakage from water supply system	Minimize losses and ensure maximum efficiency Metering	Stream flow to downstream catchments	Ensure Safe WW disposal in rivers
Stream flow from upstream catchments	Surface water source – check pollution levels	Ground water storage	Monitor levels and quality regularly	Private GW extraction	Should be regulated to a sustainable amount	WW disposal on land	Potential GW pollutant, opportunities for reuse
Water Import	Minimize Inter-basin transfer Undertake special recharge activities if importing from aquifer falling outside city boundaries	Run off	Harness to increase GW recharge and surface storage	Return flow from Irrigation	Potential GW pollutant due to use of pesticides	Leakage from Sewer systems	Potential GW pollutant

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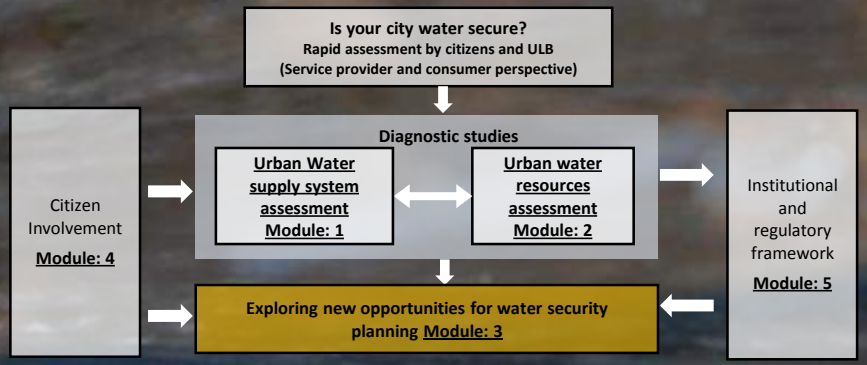
Module 3
Exploring new opportunities for water security planning

M3



Module: 3
Exploring New Opportunities for Water Security Planning

Source: http://www.dnaindia.com/mumbai/report-rainwater-harvesting-opt-for-the-greener-option-before-it-is-too-late-2092057

Introduction:

A resilient urban water management system makes cities water secure. By relying on a limited number of water sources, cities put themselves at risk of increased competition for water, climate variability, and political wrangling. In response to such threats, the water sector is revisiting the present practices as it searches for sustainable solution to safeguard the integrity of the resource base. Diversifying urban water sources helps secure ones water supply systems. In comparison, an alternative approach for providing water services to urban areas should be explored.

Module 3 explains how new opportunities other than the conventional water augmentation approach can be identified and implemented. It promotes different approaches which mainly focus on improving the efficiency of existing water supply systems and exploring alternate urban water sources in the city.

This module attempts to give an opportunity to the city to focus on its local water resources and culminate its search for endless new sources of water. It also provides case studies on various projects which will help both planner and CSO to understand it well.

Learning Objectives:

More specifically, the module will assist the users in:

- Identifying an integrated and more sustainable approach to water supply.
- Exploring the alternate sources of water for a city such as rainwater harvesting, groundwater recharge, local water sources revival and reuse of wastewater.
- Alternative measures and innovative technologies to improve efficiency of existing water supply systems .

Target Users:

Planners: This module helps the planners to identify measures to improve efficiency in the existing water supply systems and make improvements in it to enhance its performance. Moreover it also diverts the thinking of the planners towards adopting new approaches in the city apart from just focusing on bringing water from distant sources.

CSO: This module can be used by CSOs' to explore various technical projects which can be planned and demonstrated in a city to explore innovative technologies. It assists the CSO's on how to involve citizens and other stakeholders in its planning and implementation.

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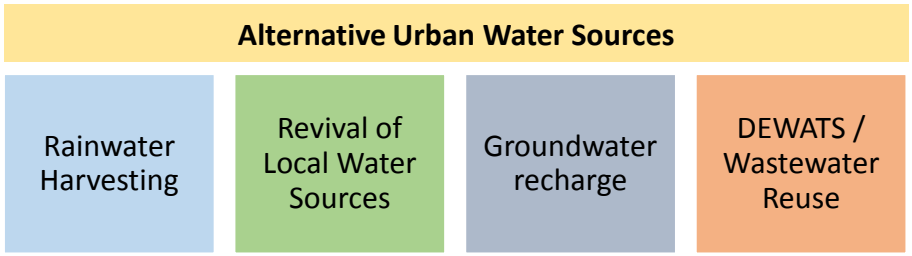
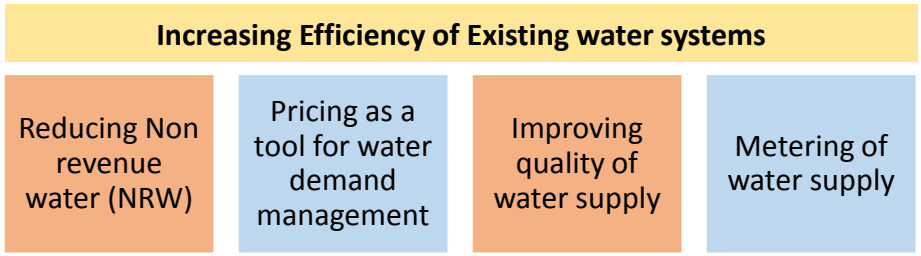
Module 3: Introduction

MODULE: 3

Most of the current strategies about water management are blindly focus on developing new sources to meet the constantly increasing demand of water. A paradigm shift is necessary for cities to manage local water sources sustainably.

Water management in urban area can be supported by both measures of increasing efficiency of existing water systems as well as water conservation practices as described below. Both these approaches can be implemented simultaneously. However, the feasibilities of these options need to be evaluated in the context of local conditions to achieve the larger goal of urban water security.





The approach in the urban context mainly constitutes of augmenting a city's water supply by bringing water from afar. One can increase water security through diversifying sources i.e. focusing on local water resources and culminating its search for new sources of water. Rainwater harvesting, groundwater recharge, reviving local water sources and wastewater reuse are the options a city can adopt as an additional or alternative water source of it. Physical factors such as hydrological regime, geological environment, climate, and topography will have a great bearing on adopting an option amongst it.

Rainwater Harvesting: Assessing RWH potential of city, Capturing the runoff as it forms the most suitable approach to manage water at household/society scale.

Groundwater recharge: Artificial techniques for augmenting groundwater and help improving groundwater quality.

Revival of Local Water Sources: Revival of lakes and water bodies to its original way.

DEWATS / Wastewater Reuse: Identifying potential of wastewater reuse in industries, agriculture, gardening, etc.

There are many steps that municipal water systems can take to increase efficiency without having to upgrade entire facilities and piping systems. Implementing a few initiatives can save utilities significantly. A city can implement efficiencies that will increase revenue and decrease water loss, all with the least capital expenditure possible.

The efficiency of the existing system can be increased through simple measures like leak detection, control and prevention of illegal connections, metering of water supply, appropriate pricing mechanism, etc.

Reducing NRW: Identifying areas of loss in the water network, prioritizing issues and taking appropriate measures for it.

Metering of water supply: Metering at both source level and user level can regulate the use of water and also account for the losses.

Pricing as a tool for water demand management: Well designed tariff structure for the achieving the benefits of reducing demand and improving financial sustainability of supply systems

Improving quality of water supply: Identify sources of water and treatment accordingly.

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3.1 Rain Water Harvesting

Source: http://www.marinebuzz.com/2009/09/22/india-depleting-ground-water-and-rain-water-harvesting/

Rain water harvesting is the technique of collection and storage of rain water at surface or in sub-surface aquifers, before it is lost as surface run-off. The augmented resource can be harvested in the time of need. Water harvesting means to understand the value of rain and to make optimum use of rain water at the place where it falls.

The factors affecting RWH system design are:

- Rainfall quantity (mm/year)
- Rainfall pattern
- Collection surface area (m2)
- Runoff coefficient of collection
- Storage capacity (m3)
- Daily consumption rate (litres/capita /day)
- Number of users
- Cost
- Alternative water sources

Source: ACT (2015),” RRWH concept and experience” A Presentation. Bhuj.

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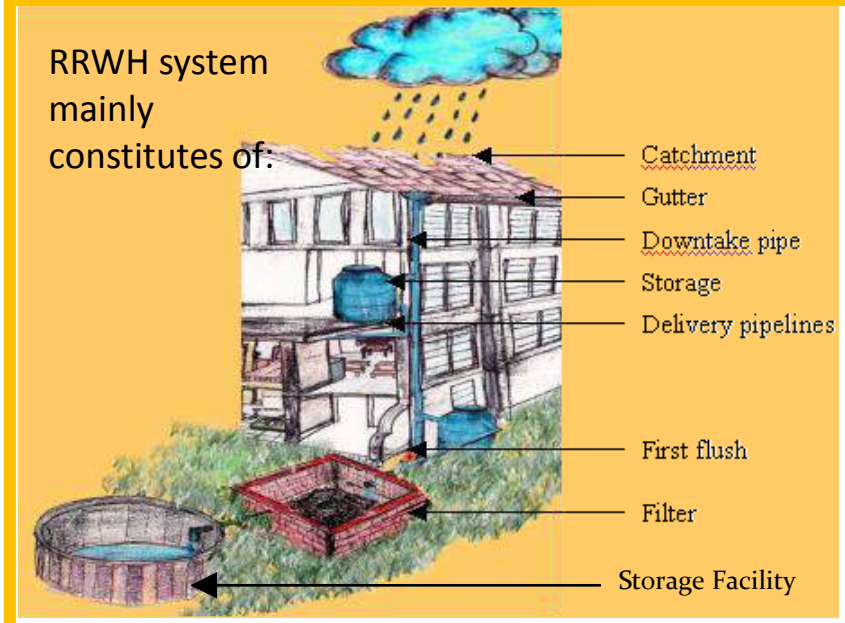
MODULE: 3

3.1 a) Rooftop Rainwater Harvesting (RRWH)



Source of picture- http://schools.indiawaterportal.org/principals/rwh

RRHW is a system of catching rainwater where it falls. In rooftop harvesting, the roof becomes the catchments, and the rainwater is collected from the roof of the house/building.

Illustration: Considering Rooftop rainwater harvesting in Bhuj

For a building with a flat roof of size 5 m x 8 m in Bhuj

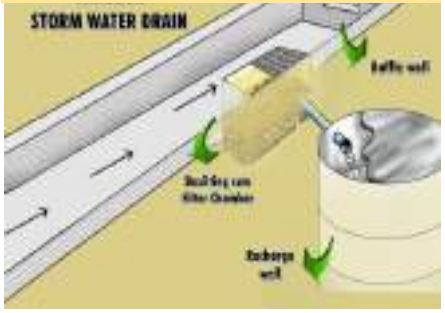
Average annual rainfall of Bhuj is 330 mm.

- Roof Area (A) = 5 x 8 = 40 m^2
- Average annual rainfall (R) = 400 mm = 0.33 m
- Total annual volume of rainfall over the roof :
  A * R = 40 m^2 x 0.33 m = 13.2 m^3 = 13,200 litres
- If 70% of the total rainfall is effectively harvested
- Volume of water harvested = 13,200 x 0.7
  = 9240 litres
- Average water availability = 9240 / 365 ~ 25 litres/ day

3.1 b) Surface run-off rainwater harvesting

RWH from run-off and storage in ponds

RWH from roads through storm water drains



In urban area rainwater flows away as surface runoff. This runoff could be caught and used for recharging aquifers by adopting appropriate methods. Surface run-off rain water harvesting system is also sometimes called as stormwater harvesting. Stormwater is generally harvested from roads, parks, garden, parking spaces, etc.

Water harvesting methods in parks and open spaces involve micro-watershed management methods that allow rainwater infiltration and percolation into the ground. The runoff has to be minimized by providing adequate number of percolation pits and dispersion trenches.

Rainwater run-off from open space and paved areas can be stored in underground sumps by filtering through sand-bed filters and guiding the filtered water through channels.

Rainwater harvesting from roads can also be explored as viable options. For this an infiltration trench could be built by the side of the drain all along the road, wherever possible. As the rainwater from the road flows into the infiltration trench, water percolates into the ground.

Source: ACT (2015)," RRWH concept and experience" A Presentation. Bhuj.

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3.1 Guidelines for Rain water harvesting

This document provides guidelines for technical details for rainwater harvesting and estimation of the potential of RWH in a city and it. It also discusses many case studies where RWH has been included in city regulations (DCR or by-laws).

It describes the following:

- Types of rain water harvesting system
- Technical details of Rainwater Harvesting system
- Case studies for Rain water harvesting systems
- Rain Water Harvesting Potential
- Enabling Environment for implementing Rainwater Harvesting system

3.2 RRWH Components

RRWH components tool explains in detail each of the component of Rooftop rainwater harvesting.

It also explains the design considerations for Rooftop catchment systems

3.3 Template for calculating RRWH

This tool helps one to calculate the potential of rooftop rainwater harvesting. It also helps in estimating the volume of storage tank required.
The information required in this tool are:

- Roof Area
- Average annual rainfall
- Coefficient of efficiency of collection

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3.2 Groundwater Recharge

MODULE: 3

3.2 a) Feasibility Analysis and Site Identification

Source: http://www.waterworld.com/articles/2017/01/

Areas suitable for ground water recharge are:

- Areas where ground water levels are declining on regular basis.
- Areas where substantial amount of aquifer has already been desaturated.
- Areas where availability of ground water is inadequate in lean months.
- Areas where salinity ingress is taking place.

Assessment Of Sub-Surface Potential For Ground Water Recharge

Based on the hydrogeological and geophysical surveys, the thickness of potential unsaturated zone for recharge should be worked out to assess the potential for artificial recharge in term of volume of water which can be accommodated in this zone vis-à-vis source water availability.
The studies should bring out the potential of unsaturated zone in terms of total volume which can be recharged.

Source: CGWB (2000), "Guide on artificial recharge to groundwater"

3.2 b) Identification of Required Recharge Structure and Technique

a. Direct surface techniques

- Flooding
- Basins or percolation tanks
- Stream augmentation
- Ditch and furrow system
- Over irrigation

b. Direct sub surface techniques

- Injection wells or recharge wells
- Recharge pits and shafts
- Dug well recharge
- Bore hole flooding
- Natural openings, cavity fillings.

c. Combination techniques

- Basin or percolation tanks with pit shaft or wells.

d. Indirect techniques

- Induced recharge from surface water source.
- Aquifer modification

Source: Guide on artificial recharge to groundwater, CGWB, New Delhi

A wide variety of techniques are available to recharge groundwater reservoir. Based on the different hydrogeological settings, suitable artificial structure must be identified.

Tool 3.6 helps to identify the technique suitable according to the hydrogeological strata present. These structures are also required to be selected based on the cost and economic benefits of the place as well.

Source: CGWB (2007), "Manual on artificial recharge to groundwater"

3.2 c) Enumerating required recharge structures

Example: Enumerating Groundwater Recharge Structures in Bhuj

Surface runoff (ML)	14599.0
Amount of water to be recharge (40% of surface runoff) (ML)	5839.6
Recharge rate of one structure (L/s)	18.0
Considering 15 days rainfall period of Bhuj	
Recharge by one structure (ML)	23.3
Recharge structure required	250
Area of Bhuj (sq. km)	56.0
Recharge Structures per sq. km	5
Cost per structure (in lakhs)	5
Total Cost (in lakhs)	1250

Source: CEPT analysis

After the selection of the area where artificial recharge is feasible and selecting the type of artificial recharge structure, next step is to calculate the numbers of recharge structure required. This step helps to calculate the number of recharge structures required in the selected area. Based on the numbers of recharge structures, the cost estimation can also be obtained which would in turn help in deciding the phasing of this project.

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3.4 Guide on Artificial recharge

This section from **Guide on Artificial Recharge to Ground Water** by CGWB helps in doing a feasibility analysis of a site for groundwater recharge. It explains in detail the steps and data required to execute:

- Hydrological Studies
- Hydrogeological Studies
- Soil Infiltration Studies
- Geophysical Studies

3.5 Template for Assessment of Sub-surface potential for GW recharge

This tool helps to estimate sub-surface water storage capacity based on hydrogeological-geophysical surveys and thickness of potential unsaturated zone for recharge.

The worksheet brings out the potential of unsaturated zone in terms of total volume which can be recharged.

3.6 Guide to Suitability of Artificial Recharge Structures for Different Hydrogeological Settings

This section from a previous draft of CGWB's **Guide to Artificial Recharge** helps one to identify the appropriate recharge structure according to the site conditions.
The artificial recharge structure will be mainly based on the hydrogeological settings of a city.

3.7 Template for Quantifying number of recharge structures required

This tool helps estimate the required quantity of recharge structures in a city.
It requires the recharge rate of site and structure and estimates the number of essential structures. This is useful to also carry out financial and economic estimates.

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3.3 Reviving local water sources

MODULE: 3

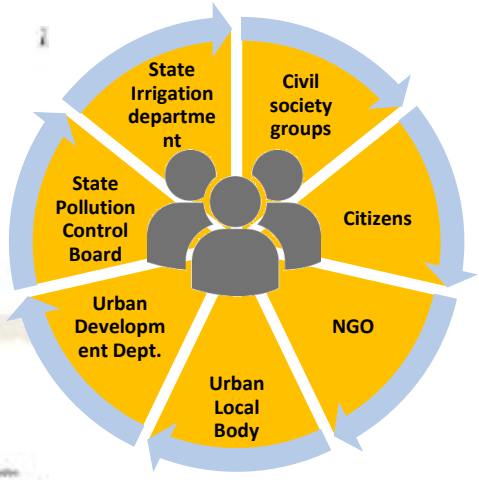
Most cities are grappling with the issue of balancing water supply and demand. The administrations look out for water outside its boundaries to augment the supply side in the city. An important aspect before planning any new projects to cater to future water demand is to assess the potential of its local water resources.

3.3 a) Mapping of catchments and lakes and other water bodies

Figure 3.1: Location of Water Bodies in Bhuj

For reviving the local water sources, the first step is to map and identify the catchment areas. Module 2 explains in detail the mapping process of the catchments and lakes and other water bodies in an area.

3.3 b) Identifying and bringing together all stakeholders



Bhuj Stakeholders and their actions

Stakeholder	Work
Forest Department	Tree plantation along the boundary of Hamirsar and Chhatardi, which now serve as a wetland for migratory birds.
Bhuj Municipality	Funded the repair and widening of the channel serving as overflow link between Hamirsar and Pragsar Lake thus fully re-establishing the old catchment system
Citizen groups	formation of lakes conservation committee to protect, conserve, restore and develop lakes.
Irrigation Department	Boundary wall surrounding Hamirsar Lake was also repaired
District Collector	Decision Making

Based on the mapping process, the second step is to identify the relevant stakeholders. Various state government agencies, city level officials and other civil society groups and citizens can be identified and grouped together for working on the revival of ones own water sources.

The example shows how ACT, an NGO was catalyst in bringing together various stakeholders like civil society groups, local government, the District Collector office, State Irrigation department and Forest department, for revival of the traditional catchment system and the steps taken by each of them.

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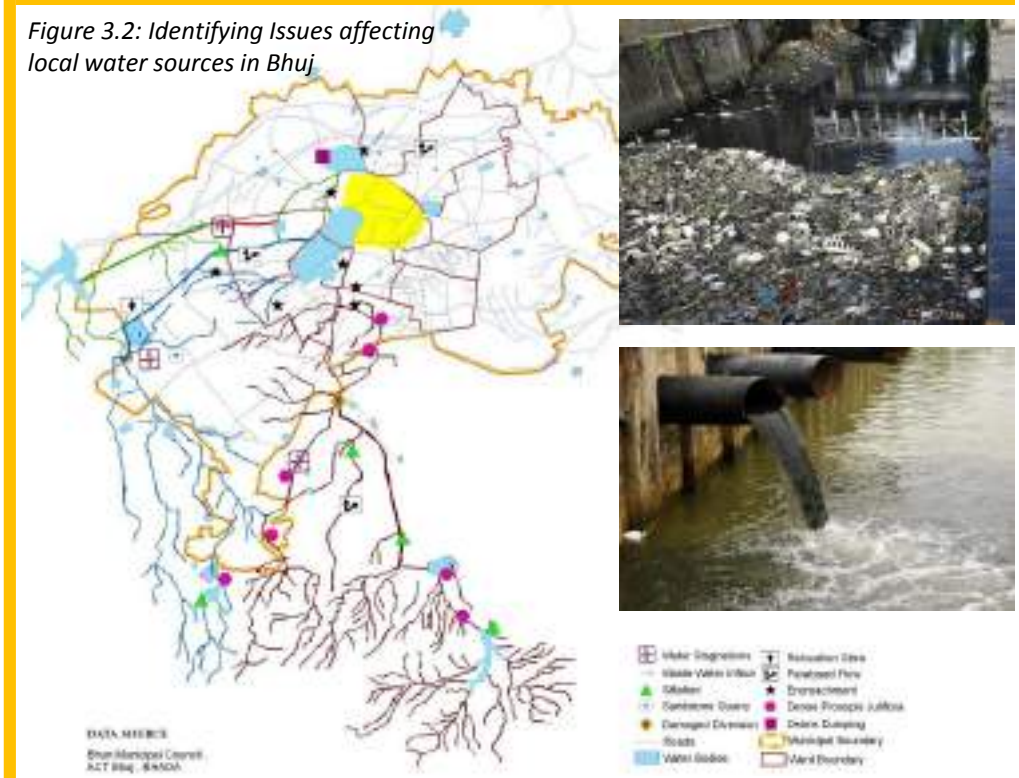
MODULE: 3

3.3 c) Identifying the missing links and issues affecting local water sources

Figure 3.2: Identifying Issues affecting local water sources in Bhuj



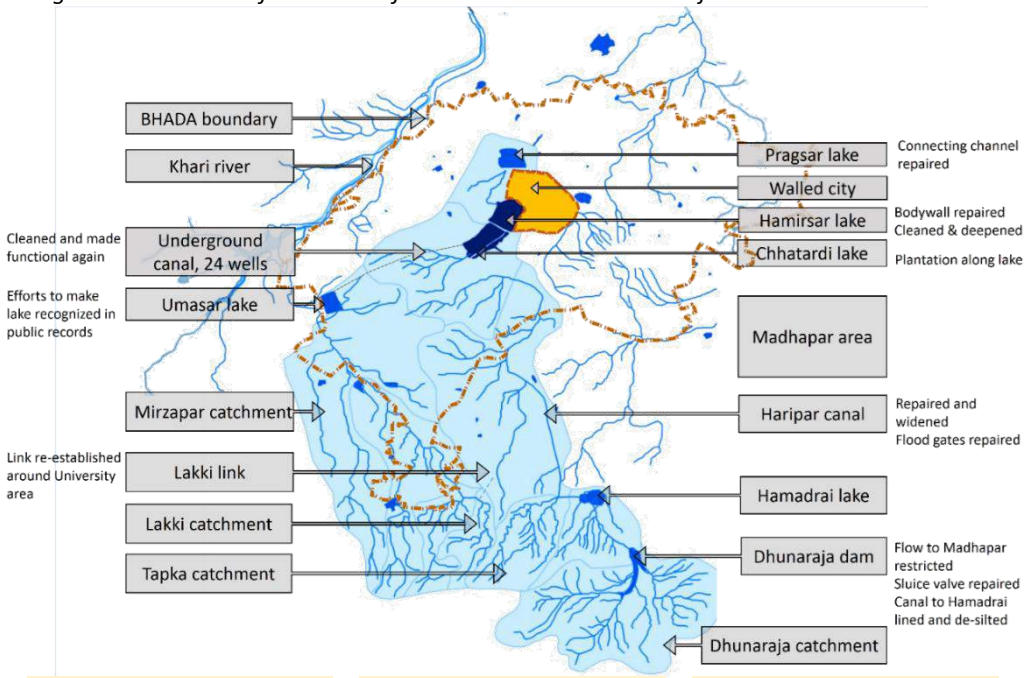
The third step is to identify the issues which are deteriorating the condition of local water sources. These damages could be mainly by anthropogenic activities which needs to be relooked on.

Based on the mapping and stakeholder involvement, issues catchment area can be identified as (examples):

- Water Stagnations
- Wastewater Inflow
- Damaged Diversions
- Paralyzed flow
- Encroachment
- Debris Dumping

3.3 d) Decisions regarding revival of local water sources

Figure 3.3: Decisions for Revival of Local Water Sources in Bhuj



De-silting Lakes, canals, streams, etc.	Repairing and widening canals	Cleaning of wells and removing debris
Streaming the natural flow if interrupted	Removing encroachment	

On the basis of the first three steps, decisions must be taken to revive the local sources. Along with the support of various stakeholders, decisions must be taken to make the catchment functional again and revive its local water sources.

Water supply system will depend on how city manages its water resource today and future perspective of its own resource. A city can become self-sufficient in water if it tries to sustain, recharge and develop its local water resources.

Source: MoEF (2008),” Guidelines for national lake conservation plan”

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3.8 Lake conservation guidelines

These guidelines prepared by Ministry of Environments and Forests under then National Lake Conservation Plan (NLCP) explain how to restore and conserve the urban and semi-urban lakes which are degraded, through an integrated ecosystem approach.

3.9 Advisory on Conservation and Restoration of Water Bodies in Urban Areas

This **Advisory on conservation and restoration of water bodies in urban areas** by CPHEEO explains the support of GOI for water body conservation under its various schemes.

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3.4 Wastewater treatment and reuse

MODULE: 3

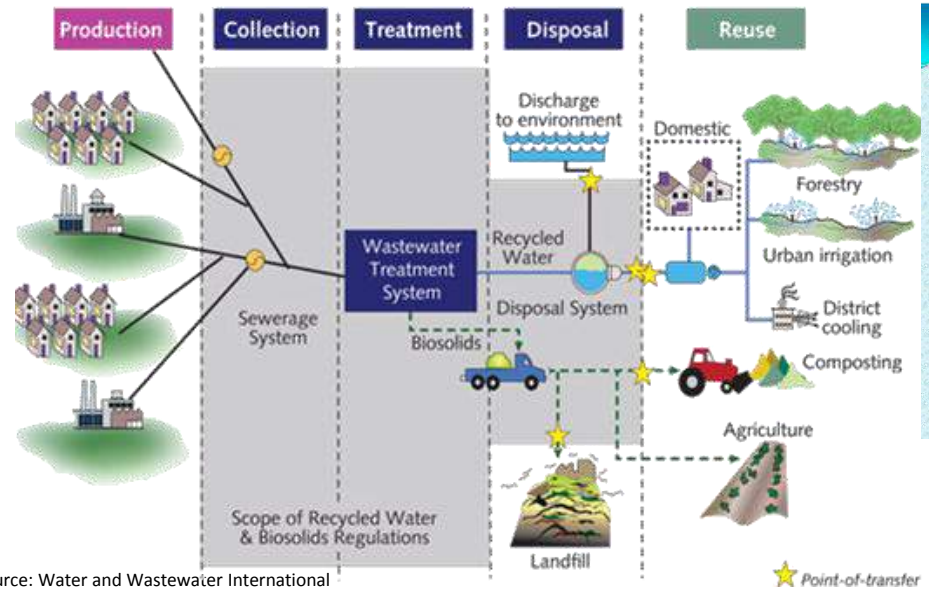
Conventional approach for wastewater can be viewed as a linear process where input is one part and output is the discharge of treated wastewater in the downstream. An alternative approach to it would be by managing the wastewater correctly and using it as a resource. Need is for looking at the appropriate wastewater treatment alternatives and applying more integrated approach for diverse ecosystems. Recycled water can satisfy most water demands, as long as it is adequately treated to ensure water quality appropriate for the use.

Reuse strategy:	Providing reliable treatment to meet water quality requirements	Protection of public health and the Environment	Gaining public acceptance	Economic viability

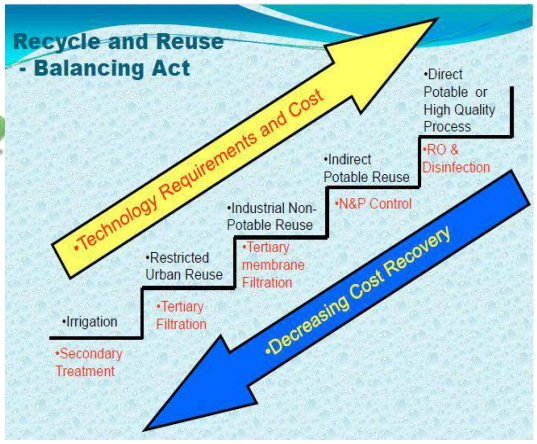
Wastewater chain and reuse options

The selection of wastewater reuse option would be affected by many factors such as public acceptance, terrain of the city, major land-use of a city (e.g. Water based industries, agricultural land, etc.), technology cost and cost recovery options. Each of the wastewater reuse areas can be explored through the case studies provided.

- Agriculture
- Landscape
- Public parks
- Golf course irrigation
- Cooling water for power plants and oil refineries
- Processing water for mills, plants
- Toilet flushing
- Construction activities
- Concrete mixing
- Artificial lakes

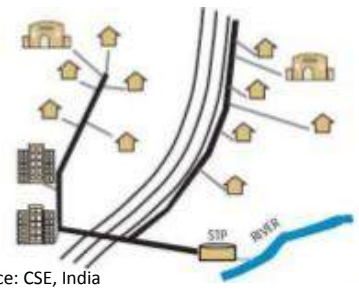


Source: Water and Wastewater International



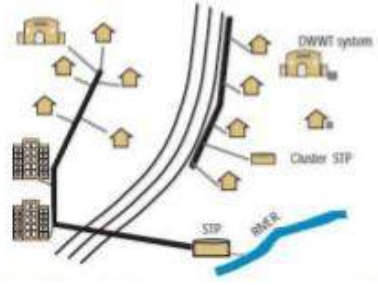
Source: CSE, India

Wastewater systems

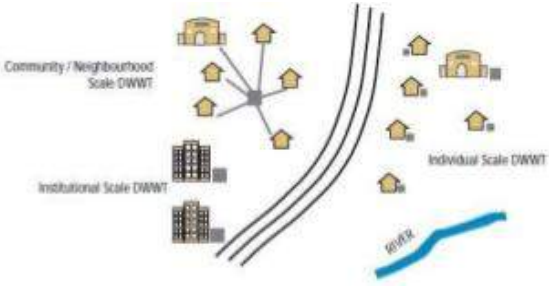


Source: CSE, India

Centralized wastewater system



Hybrid wastewater system



Decentralized wastewater system

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3.10 Resource Material for Waste water reuse by Ministry of Urban Development

The Ministry of Urban Development, Govt. of India has compiled various resource under the topic "Waste water recycle and reuse: Need of the hour".

Resources include technology evaluations, international as well as India case studies for successful reuse, international laws and policies, opportunities and cases for private sector involvement,

3.11 State Policies for Wastewater reuse

Rajasthan State Sewerage and Waste Water Policy

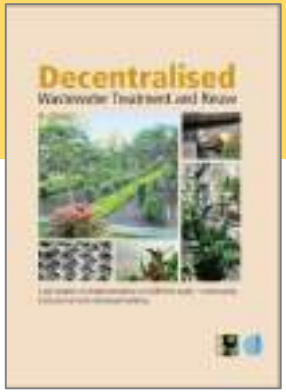
Madhya Pradesh State Policy for Waste Water Recycle & Reuse and Faecal Sludge Management

Gujarat State Waste Water Recycling Policy

3.12 Options for Wastewater reuse at 3 scales

This document by CSE explains three case studies of implementation of wastewater reuse systems at different scales – one each at community, institutional and individual household building.

All three case studies use natural technologies with minimal or no electricity requirement for treating wastewater and also locally reuse treated water.



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MODULE: 3

Case Studies

Rainwater Harvesting

Rooftop Rainwater Harvesting in Schools of Bhuj, Gujarat

To make the school 'self-sufficient' in respect to water a primary school in Bhuj adopted rainwater harvesting practice. Before its installation, a private tanker was needed every week to meet the water demand of the school. With installation of the rainwater harvesting system in the school, it solved the water problem. Active participation was observed from the students, parents and teachers donated their labor for this activity. With the joint effort, the model was implemented and the school has now become self-sufficient in terms of drinking water and does not have to depend on erratic and poor quality municipal water supply.

Read more

Groundwater Recharge

Groundwater Recharge Saving from Floods

Jubilee Colony of Bhuj made an attempt to recharge its groundwater with the help of recharge pits. It also stands as an example of citizen driven initiative for flood control measures. In 2011, a heavy downpour led to a flood in Jubilee colony of Bhuj. This prompted the residents to take steps for preventing flooding in their area. The solution was very simple but innovative. It was decided to recharge the ground with recharge pits which would help the water to permeate in the ground as well as solve the problem of water logging.

Read more

Reviving Local Water Sources:

Revival Of Ancient Water System Of Chitradurga City, Karnataka

The ancient water system in Chitradurga is unique in many ways. The engineering marvel, the skillful storage of water is astounding. Due to regular drought situations, the underground water has suffered severe stress as well as the grand neglect of the traditional water bodies has also resulted in fast depletion of it. The District Administration in association with Chitradurga City Municipality has made elaborate attempt to revive the ancient water bodies which are abundant and located within the city limits. The aim was to rejuvenate the Open wells, Kalyanis, Hondas etc. and make the local water supply system sustainable.

Read more

Wastewater Reuse

Wastewater Reuse in the colonies of Mumbai

Naval colony is a residential housing neighbourhood located in the suburb in eastern Mumbai. The residential housing colony treats domestic wastewater (both black and grey) using 'SBT (Soil Biotechnology) – natural wastewater treatment methods' and the treated wastewater is used for meeting the landscaping water requirements to maintain green areas. Prior to the implementation of the system the water requirement for maintenance of green area and landscaping was dependent on municipal water tankers.

Read more

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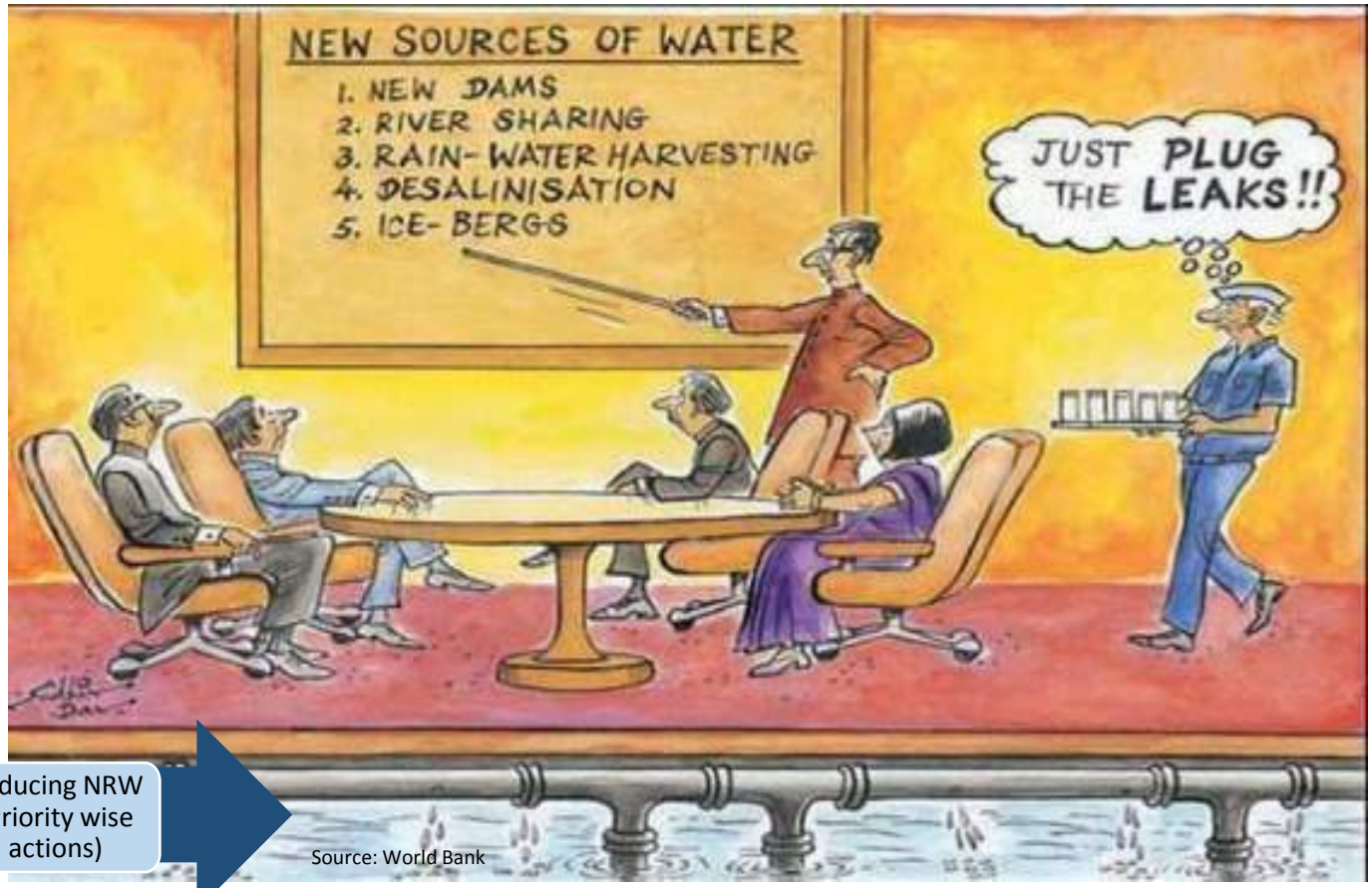
3.5 Reducing Non revenue water (NRW)

MODULE: 3



Measurement of NRW in the city → Identification of issues and prioritization → Reducing NRW (Priority wise actions)

Source: World Bank

Non revenue water (NRW) is water that has been produced and is "lost" before it reaches the customer. Losses can be real losses (through leaks, sometimes also referred to as physical losses) or apparent losses (for example through theft or metering inaccuracies).

Reducing the non-revenue water can help a city improve its services and also perform efficiently. It allows city to systematically reduce water losses, which will result in reduction of capital investments on augmenting new water sources.

Reducing physical losses will not only help postpone capital investments for developing new water sources, it will also help reduce a utility's electricity bill. Reducing water losses can also help water utilities ensure their financial viability and avoid a spiral of financial decline: Reducing the apparent loss component of NRW to the economic level minimizes the volume of water supplied to customers that is not paid for, thereby maximizing revenues, whilst reducing the real loss component of NRW to the economic level minimizes overall operating costs.

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MODULE: 3

3.5 a) Measurement of NRW

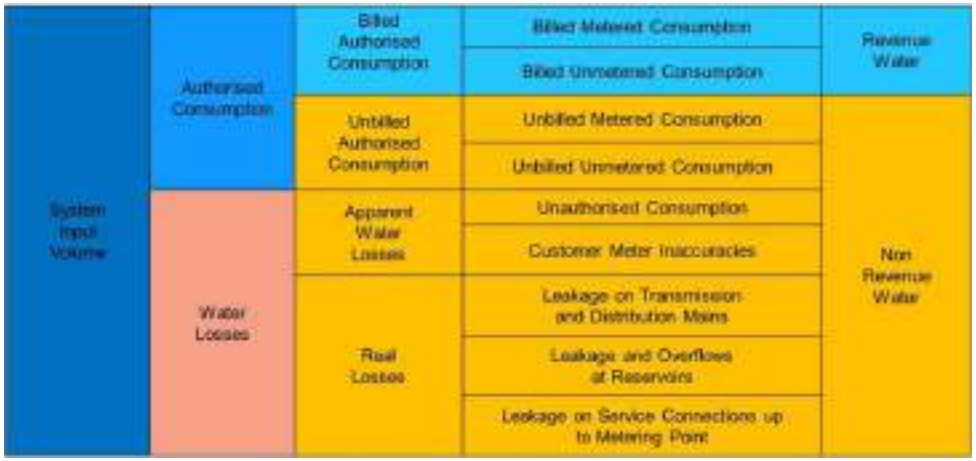
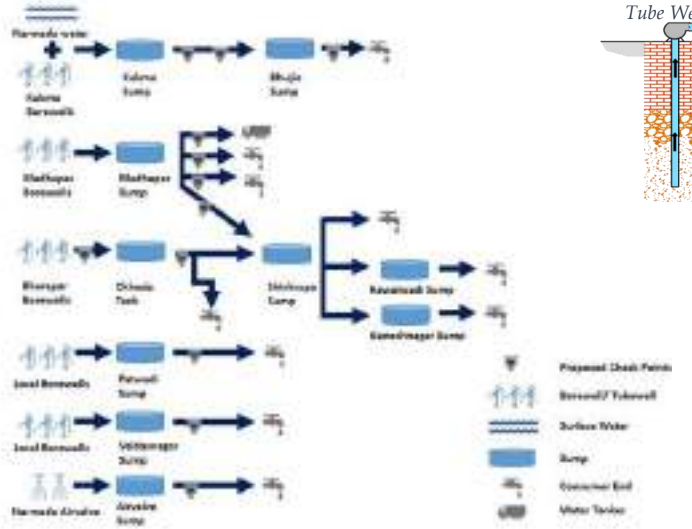
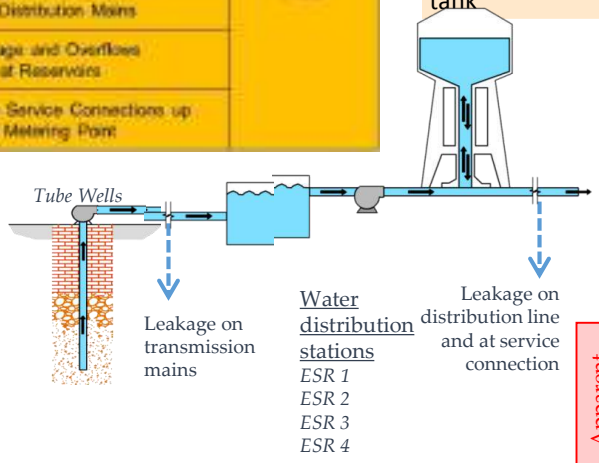


Figure 3.4: Identified Water Audit points in Bhuj





See tools

1.3 NRW calculation tool

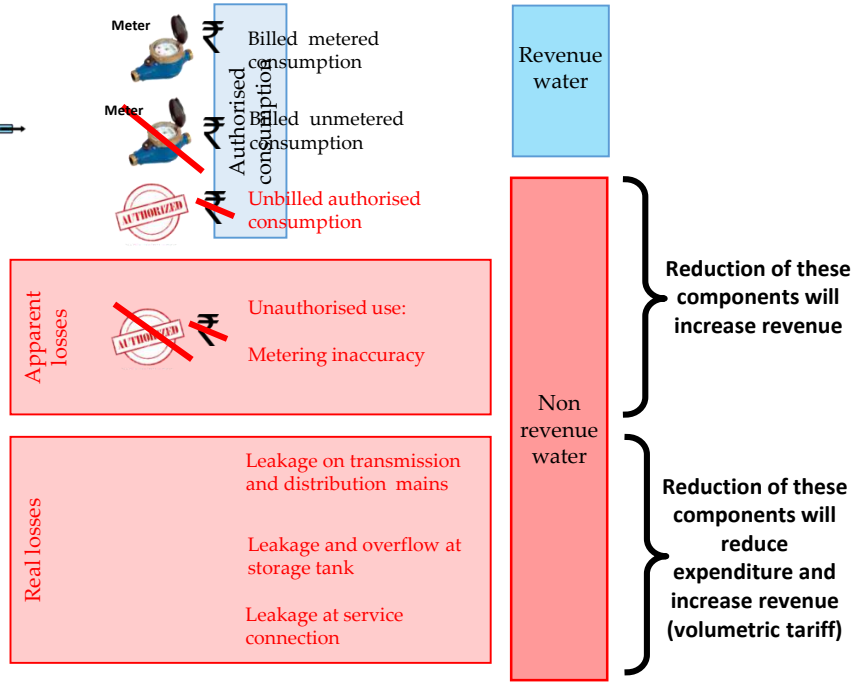
1.4 Water Audit Methodology

To track water losses, the city must carry out water audit. Water audits provide a decision making tool to ULB for quantification of water distribution system i.e. knowing where water is being supplied, where water is being loss, identify area of illegal extraction, leakages, which allows ULBs to take informed decisions about future investments to bring efficiency in water supply system.

3.5 b) Identification of Issues and prioritization

Cost and time requirements of NRW reduction measures

Short term - Low cost	Medium term - Medium cost	High cost – Long term
Reduction in free supply	Reduce customer meter inaccuracy	Replacement of pipelines
Regularization of illegal connection		Replacement of service connection
Repair valves and storage tank		Pressure management



After performing water audit and measuring NRW in a city, identification of all the issues and its prioritization is important. Based on the investment required and time required to resolve the issues, these could be prioritized.

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MODULE: 3

3.5 c) Priority wise actions

Measures to reduce NRW –Unbilled Authorized and Apparent Losses

Losses

- Unbilled authorized consumption
- Illegal consumption
- Meter inaccuracy or no metering

Improvement measures

- Start charging free supply
- Identify and then regularize illegal connection
- Install meters or Prepare meter replacement plan

Measures to reduce NRW – Real Losses

Losses

- Leakage in transmission and distribution main
- Leakage and overflow at storage tank
- Leakage at service connection

Improvement measures

- Repair leaking valves, Repair or replace leaking pipelines
- Create awareness in staff, Repair or rehabilitate storage tank
- Replace service connection
- Pressure management

Apparent losses and real losses must be tapped to reduce NRW. For each loss the improvement measures to be taken are mentioned. A single solution could also benefit in reducing losses at more than one end. Thus a city might adopt the improvement measures accordingly.

Monitoring of water flow through meters is required to get a true picture of the operation of the utility distribution system as well as a city's actual water consumption. Metering also enables ULBs to identify potential area of improvement and encourage taking up water conservation and efficiency measures.

Continuous supply of water also helps in reducing non revenue water and also in maintaining the quality of water.

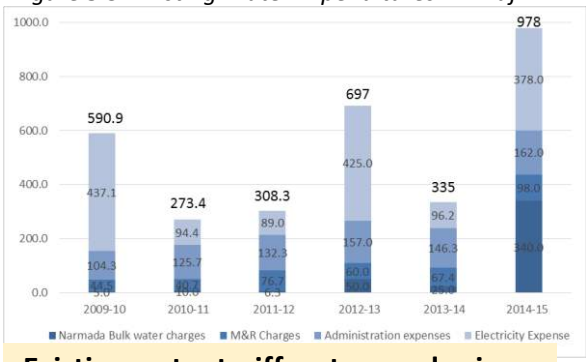
3.5 d) Pricing as a tool for water demand management

Types of water tariff system | **Fixed Tariff System** | **Volumetric Tariff System** | **Block Tariff System**

Existing water expenditures in Bhuj

Figure 3.5: Existing Water Expenditures in Bhuj

All values in lakhs



Existing water tariff system and prices in Bhuj

Category	Pipe Diameter	Tariff per Annum
Residential	15 mm	Rs. 900/-
	20 mm	Rs.1800/-
Commercial	15 mm	Rs. 3600/
	20 mm	Rs. 18000/-
Institutions	Meter Connection	Rs. 120/- per 5KL

Proposed water tariff system and prices

Particulars	Volumetric Water Tariff (Rs./ kl)*
Residential	21.4
Commercial	104
Institutional	125

Currently, water is supplied at a very subsidized rate. Water is treated as free commodity rather than a scarce resource. Pricing of water, as a tool for demand management, is expected to achieve the double benefits of reducing demand and improving financial sustainability of supply systems. A city can adopt different type of tariff system suitable to it. The tariffs would also depend upon the affordability of the people to pay and their willingness. Thus a city must adopt the tariffs for water accordingly.

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3.13: Maharashtra Government Resolution for Water tariff fixation

Marathi original English translation

The Urban Development Department, Government of Maharashtra had come up with a Government Resolution (GR) with guidelines for fixing water supply charges from the Point of View of Attaining Financial Sustainability in Water Supply & Sewerage Schemes.

3.14: PAS water Tariff model

This tool is to assist urban local bodies determine water tariff to recover 100% of cost of operations and maintenance.

The data required in this tool are:

- City details
- Type of connection and consumer consumption
- Water supply quantity and NRW
- Water expenditure
- Current tariff

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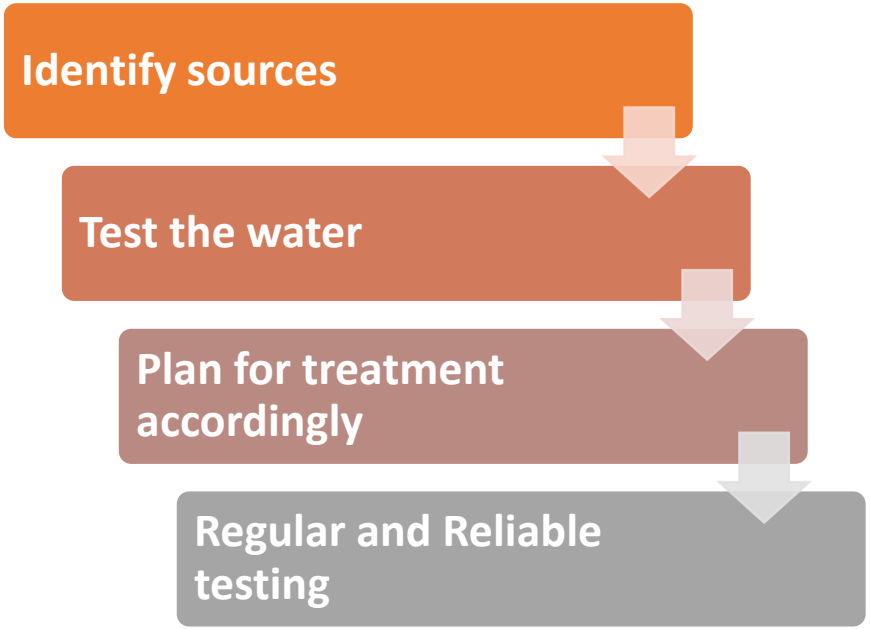
3.6 Improving quality of water supply

MODULE: 3

For the treatment of water, consideration must be provided towards its source. Also the impurities present in the water must be tested and accordingly the treatment water must be selected.

Poor water quality imposes indirect coping cost on households in terms of money spent on RO treatment or purchasing of RO bottle water.

See Tool 1.2 Water quality surveillance regime



Required level of treatment according to source of water

Source	Treatment required
1. Ground water and spring water fairly free from contamination	No treatment or Chlorination
2. Ground water with chemicals, minerals and gases	Aeration, coagulation (if necessary), filtration and disinfection
3. Lakes, surface water reservoirs with less amount of pollution	Disinfection
4. Other surface waters such as rivers, canals and impounded reservoirs with a considerable amount of pollution	Complete treatment

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MODULE: 3

Case Studies

Reducing Non-Revenue Water

Improving services by reducing NRW in Thane, Mumbai

To overcome the poor levels of service in respect to water supply, Thane took many measures to overcome it. The plans included forced billing and collection plan, converting illegal connections to legal connections and enter into billed system. Along with improving the collection efficiency, mapping of 670 km of main pipelines and distribution pipelines was also done to identify the areas of losses. This helped Thane in improving the poor levels of NRW and financial health.

Read more....

Metering of Water Supply

Bangalore: Bulk Metering with Intelligent Operating System

Bangalore Water Supply and Sewerage Board (BWSSB) had undertaken several initiatives for improvement of water supply infrastructure. However, in order to effectively manage the system it was necessary to do proper control and management of water flows. Thus BWSSB installed bulk water meters at strategically important locations and developed an ICT application to capture information from these bulk meters and use the same for analysis and decision making.

Read more....

Pricing as a Tool for Water Demand Management

Using a tariff structure for water demand management: the case of Kampala, Uganda

Kampala, with an estimated population of 1.45 million, is the capital city and industrial hub of Uganda. About 45% of the city residents live in low-income informal settlements, with limited infrastructural public services. The city used demand-responsive tariffs as an economic instrument to encourage existing consumers to conserve water, and hence reduce the pressure placed on the infrastructure and the water resources and be water secure. As a result, the tariff structure was evolved over time, and the current tariff has a built-in indexation formula applied on an annual basis, to protect it from being eroded by inflation. The tariff structure was differentiated in increasing blocks according to the type of connection (i.e. public standpipe, household connection, institutional/government, commercial/industrial) with further block structures for industrial/commercial connections. The model derived an optimal tariff which will not only conserve water, but will promote the equity objective based on the household affordability criteria

Read more....

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Output 3A: Comprehensive urban water scenario

MODULE: 3

A city can adopt one or more options for water security planning

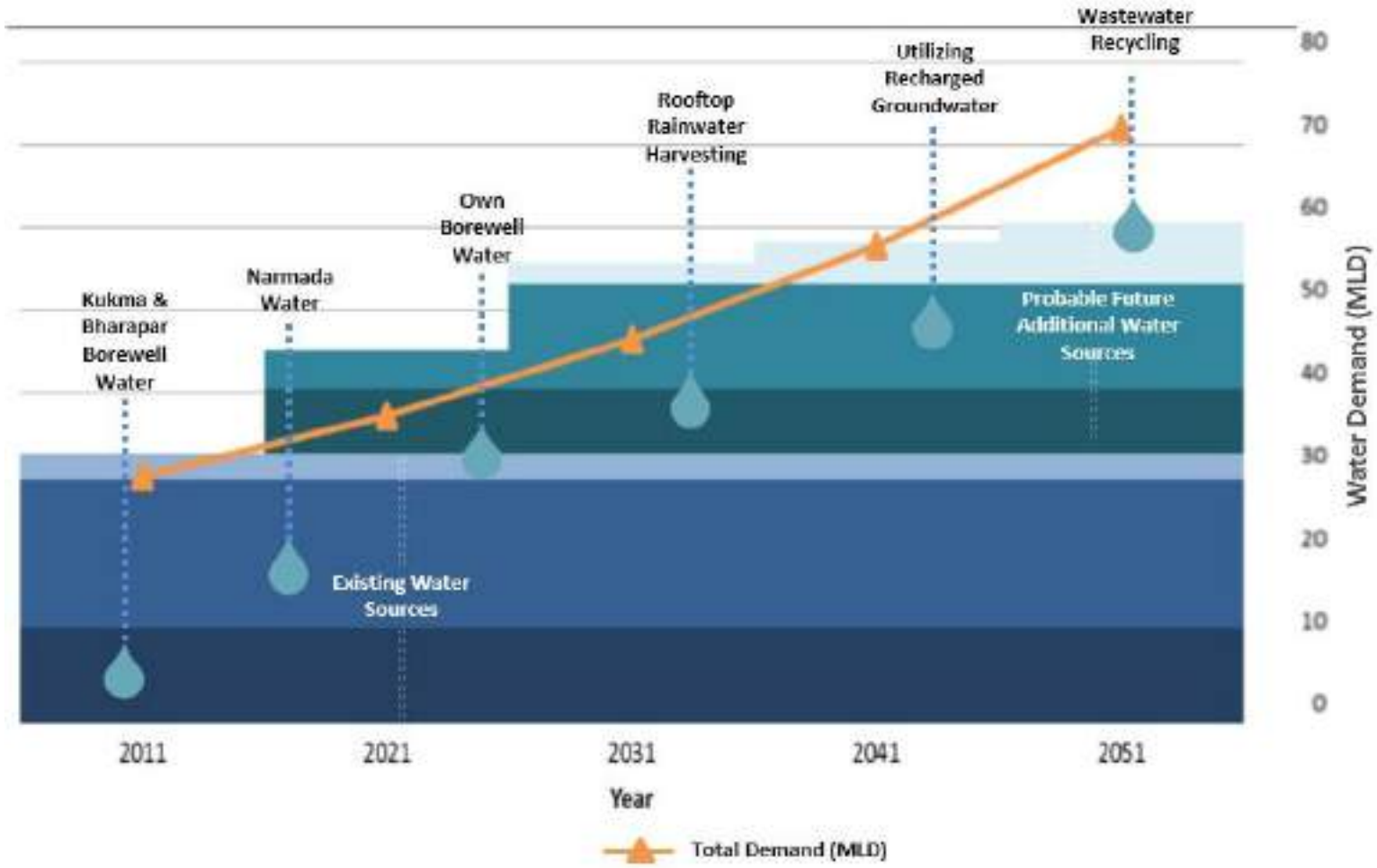
With the assistance of these approaches, a comprehensive scenario can be developed. The alternative practices can help in addressing the increasing demand of the city in the future.

The options adopted can be quantified at city level.

Thus for future, comprehensive urban water scenario can be developed against the demand for water.

A co-governing mechanism to incorporate these practices follows in the next modules.

Figure 3.6: Comprehensive Urban Water Scenario of Bhuj



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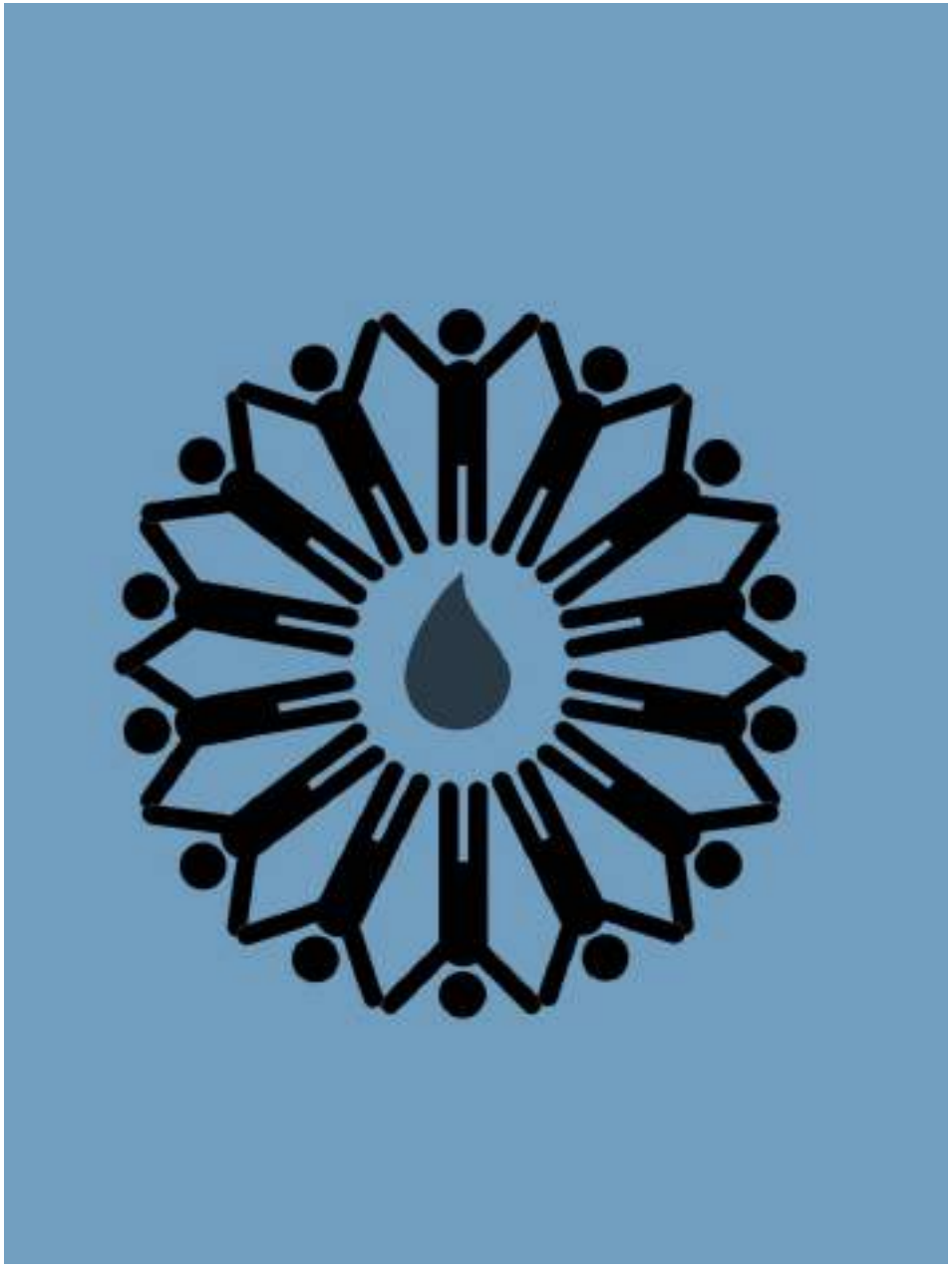
Module 4
Citizen involvement in water resources management

M4

Module 4
Citizen involvement in water resources management



Introduction:

Water as a common resource where everyone is a stakeholder, requires a participatory approach in its management and planning process.

The concept of IWRM as "a process which promotes the coordinated development and management of water, land and related resources in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital eco-systems" (GWP 2004) highlights a participatory approach as one out of five principles.

In addition, stakeholder participation is part of many formal planning processes in the water sector, as well as a pre-condition of many international development agencies and donors providing financial assistance (GWP, 2015).

This module enables citizen involvement in water resources management. The degree of involvement may range from basic IEC to direct and firsthand involvement in decision making and implementation.

Learning Objectives:

This module will guide users in –

- Information, Communication and Education campaigning
- Involving citizens in decision making, assessment and implementation

Target Users:

Planners: This module acts as a bridge for planners to involve the citizens in assessment and decision making process starting with awareness generation to training and involving para-hydrogeologists in the process thus easing the time and manpower consuming nature of assessments and monitoring .

CSOs: For CSOs, this module presents a starting point getting involved in the planning and management process through the creating of a citizens' forum and then conducting awareness generation and advocacy activities through it. CSOs with technical experience can also support training of para-hydrogeologists and technical demonstrations.

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Module 4: Introduction

Ways for citizen involvement in water resources management may vary depending on the degree of involvement. The first and easiest is awareness generation and Information. This may include general campaigns for water conservation, information about local water resources and education about government policy, schemes and relevant projects. The second is method is supporting the creation of a Citizens' forum for water related advocacy amongst other citizens and decision makers. Finally, citizen involvement in the planning process and range from assisting in assessments and monitoring, to decision making through a public consultation. Self managed water supply systems and labor donation drives can also be a form of involvement in implementation.

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4.1 Awareness generation and information

MODULE: 4

The first step in a participatory approach to water management is generating awareness amongst the citizens. A successful IEC Campaign should inform, educate and persuade people to realize their roles and responsibilities, and benefits from investing in the right practices. It should take into account the barriers and variables related to infrastructure, socio–cultural practices and traditions.

What topics can the campaign include?	What modes can be employed?	Who to Target?
Campaigns for Water conservation- e.g. "save water"	Media spots- TV / Radio / Newspapers / Magazines	High Multiplier Effect Group: School / college students & through them their parents, teachers. Women Households through RWAs
Familiarizing with local water resources and water use in the city	Posters in prominent spots, Mass transport	Sector-wise Group: Industrialists Agriculturalists Mass transport users Cinema / TV / Radio Visitors to prominent places/exhibitions/fairs Readers of newspapers/magazines
Campaigns for Environmental conservation – "Save the lakes" "Clean up our river"	Activities for school children	Decision makers, influencer: Policy makers / Leaders Government Officials (i)Engineers (ii) other functionaries (iii) WUAs, PRIs, Local Urban Bodies, RWAs etc. Media
Rallying Around common interest point - Lake/River, Festival	Rallies	Innovators, knowledge creators and disseminators: Research Students Professionals / Experts in water management Delegates at conferences etc. Professional Bodies / Associations
Information disbursement regarding policy and planning of Government towards Water Resources	Presentations, Seminars, Information stalls	

Source: Adapted from IEC Strategy, Ministry of Water Resources, River Development & Ganga Rejuvenation, Government of India

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MODULE: 4

Case study

Awareness generation for water conservation in Bhuj

In Bhuj the water security movement revolved around a strong and robust Campaign involving awareness generation and advocacy.

1. Jalgatha and Talav parikrama : '*Hamirsar Ek Jal Gatha*' are heritage as well as educational walks along Hamirsar Lake and its catchment to help people understand the system as a water source for Bhuj
2. Jalpedi : *Jeth sud ekadashi* is an auspicious day in Kutch at beginning of monsoon - associated with "water holders" – vessels, tanks etc. On this day a festival was organized including stalls for awareness and coming together of citizens to de-silt local water bodies
3. A Music Festival near lake was organized to emphasize the cultural and traditional aspects of Hamirsar lake
4. Meeting decision makers for advocating inclusion of hydrogeology in mainstream planning
5. A Lake protection Rally was organized to bring attention to the condition of dying lakes and encroachment on them
6. Talks and movies were organized in schools and community meeting
7. A Monthly Magazine called *Hamirsar no Saad* is published with updates about water conservation in Bhuj
8. Programmes targeted at children were organized in schools including Drawing/ photography/ essay/ model making/ drama competitions. A children's wing of the water committee has been formed to encourage the concept in children. Read more










Source: ACT

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4.1 IEC guidelines

These guidelines by the Ministry of Drinking Water, GoI, although designed for rural areas, provide useful insights for developing an IEC strategy to enable the community and CSOs play their rightful role.
It helps bridge gaps in knowledge and information – both thematic and programmatic on various aspects of drinking water and in creating an enabling environment.

4.2 Know your water legislation

An informed user is a smart user!
This except from a Policy Paper on Water Efficiency And Conservation In Urban India by the Centre for Science and Environment (CSE) gives a compilation of legal and institutional provisions, policies and plans relating to water in India

4.3 IEC resources

Videos:

- Water cycle
- Jal hi Jivan hai (Hindi)
- Water Conservation: TV Advert
- Keeping Water Sources Clean: TV Advert
- Understanding groundwater Part 1 (English)
- Understanding groundwater Part 2 (English)
- Simple steps to achieve water sufficiency - Constructing a recharge well
- Simple methods to achieve water sufficiency - Recycling greywater

Posters

- Save water - 1 , Save water - 2
- Water conservation is important
- Clean drinking water
- Arsenic contamination
- Identifying fluoride patients

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4.2 Creating a Citizens' forum

MODULE: 4

An active citizen forum provides a center point for organizing a participatory approach for water resources planning. A "water committee" may be formed

- at the city level
- at watershed/ localized aquifer level
- for smaller catchments/lakes
- for special "intervention areas" e.g.: Decentralized water supply schemes

4.2 a) Ensuring equitable representation

"Water committees" have been successful in rural areas. However, in urban areas, the scale is huge and the community is heterogeneous and dispersed across the entire city. Grouping them is a challenge as they had different needs and were not bound by common interests or problems. Paradoxically, owing to the higher levels of education and awareness among urban citizens, acceptance of change was more difficult (Ghanashyam & Jatkar, 2015).

In such a case , to develop participation. understanding of various communities and societies of working area is an important aspect. Further, it is important to ensure adequate and equitable representation of stakeholders in a "water committee" form of citizens' forum.

- Residents in catchments of all water bodies in the city
- Areas based on water distribution esp. Slums and areas not covered under municipal water supply
- Residents from "vulnerable zones" identified in module 2
- Committees from areas where decentralized and self managed water supply systems are installed
- Academic institutions
- Women
- Children
- Religious communities and castes
- Water dependent livelihoods e.g.: fishery, irrigation based farming etc.

4.2 b) Capacity building of citizen forum for advocacy

Once citizen forum and water committees have been formed they must be sensitized towards water resources management with an objective of making them autonomous and capable of collaboration and coordination with government organizations and educational institutions.

- Understanding Local water resources and local landscape
- Understanding Local communities and their relation to water
- Identification of active members
- Municipal water supply
- Vision building
- Understanding Government schemes, institutions and policies
- Training of trainers for awareness activities

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MODULE: 4

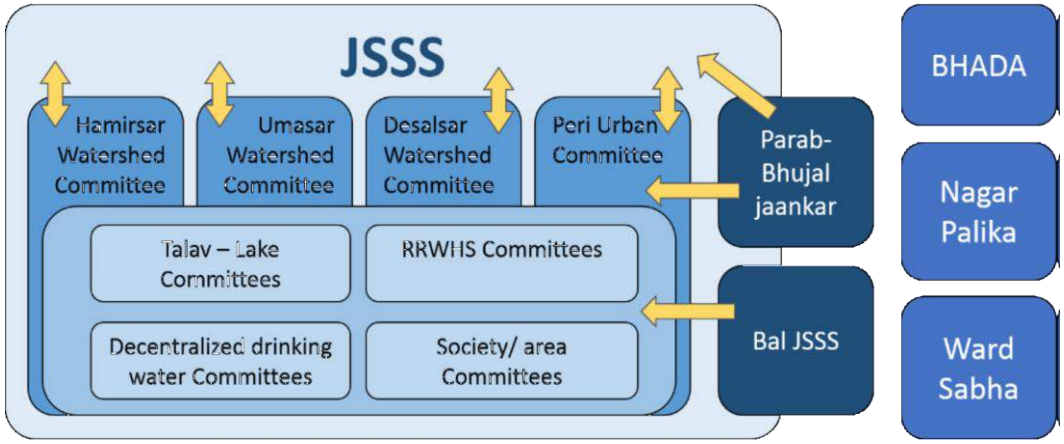
Case study

Citizen involvement for water conservation in Bhuj

Citizen forum

In Bhuj, Hamrisar lake became a rallying point for citizens for its traditional and cultural significance. To combat degradation of Hamirsar lake, *Hamirsar Sneh Samvardhan Samiti (*Hamirsar Care and Conservation Committee) was formed. Later it was recognized that all water resources must be conserved and it was renamed to *Jalstrot Sneh Samvardhan Samiti (JSSS,* Water resource Care and Conservation Committee*).* JSSS is comprised of extremely dedicated senior citizens, retired bureaucrats and elected representatives. From a single entity, JSSS has slowly branched out into different watershed committees and a Children's wing. With the support of local technical institutions, JSSS members carry out restoration activities, awareness and advocacy with decision makers.
Read more

Figure 4.1: JSSS committee arrangement and Stakeholder Involvement in Bhuj



Jala Poshan and Jakkur lake

Jakkur Lake situated in the North-Eastern outskirts of Bangalore has been a hotspot for biodiversity and water based livelihoods.

It was fenced and developed by the Bangalore Development Authority (BDA). The Bangalore Water Supply and Sewerage Board (BWSSB) then set up a Wastewater Treatment Plant upstream of Jakkur Lake, with a constructed wetland next to it to which further purifies the treated wastewater through natural processes, before letting the water flow into the main Jakkur Lake.

With the purpose of preserving the Jakkur Lake, a citizens' group called Jala Poshan, comprised of residents around Jakkur Lake, have joined hands with Satya Foundation, (a trust that works for community development). They have adopted Jakkur lake to nurture its beauty, maintain its positive aspects and preserve its eco-system.

Formed by citizens in the vicinity, Jalaposhan tracks the sewage inflow, water quality and also forces institutional intervention. They also help build a vibrant community around the lake. Read more

Source: Surekha

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4.3 Involvement in planning process

4.3 a) In assessment and decision making

Para-hydrogeologists for assessment and monitoring

Hydro-geological assessments are time consuming and require a large amount of skilled manpower. With basic training of hydro-geology, citizens can be involved in assessments such as aquifer assessment and groundwater monitoring thus expediting a time consuming process and also harnessing traditional knowledge of local residents in water resources and geology of the area.

Public consultation

Public consultations is part of many formal planning processes in the water sector and is also a pre-condition of many international development agencies and donors providing financial assistance.

Notification: Involves the communication of information on regulatory decisions to the public. It is a one-way process of communication in which the public plays a passive role. Prior notification allows stakeholders the time to prepare themselves for upcoming consultations or projects affecting them.

Consultation: Involves actively seeking the opinions of interested and affected groups. It is a two-way flow of information, which may occur at any stage of the planning process, from initial assessments, strategy formulation to actual implementation.

4.3 b) In implementation and management

Community managed water supply systems

Decentralized drinking water supply systems as mentioned in Module 3 can be community managed, thus reducing burden on the Municipality and also providing better coverage of water supply.

Example:

Rooftop rainwater harvesting for drinking water supply in school – managed by student body and school neighbors

Piped water supply through local well for slum community – pumping operated and financed through community contribution

Labor donation drives

Voluntary drives for lake cleaning, de-silting, stream restoration builds ownership of water resources.

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MODULE: 4

Case Study

Citizen involvement for water conservation in Bhuj

PARAB – Para hydrogeologists

"Parab" in Gujarati is one who manages the water hut that provides free water to thirsty travelers. Taking inspiration form the "Pani thiye Panjo" programme in rural Kutchh, para-hydrogeologists called "parab" were trained in Bhuj They are drawn from local communities and trained in basic hydrogeology to assist in aquifer mapping and groundwater monitoring. They are also trained to develop technical plans for water management and irrigation. Initially supported by technical institutions, Parabs have now become self-reliant and generate income through external consultancy projects.

"Shram-daan" – Labour and cleanliness drive for lake restoration

Citizens participated in a drive for lake restoration and desilting.

Technical demonstrations: Self reliant decentralized drinking water schemes

- Self managed and self financed Roof Rain water harvesting in Schools: Finance was raises by contribution of students and teachers. It is managed through a committee of students and school neighbors.
- Revival of old well for drinking water scheme for slum: slum residents participated in cleaning and reviving an old well for supplying piped supply to their homes. Pump for filling supply reservoir is managed by a water committee composed by slum dwellers who also pay for the electricity consumed.
- Flood control and GW recharge for residential society

Read more




MARVI : Managing Groundwater Use and Aquifer Recharge

MARVI is a project funded by the Australian Centre for International Agricultural Research (ACIAR) and it has been in operation in the States of Gujarat and Rajasthan since 2012.
The research was on two multi-village watersheds, the Dharta watershed in Rajasthan and the Meghraj watershed in Gujarat. The study's main aim was to educate these communities through an intensive capacity building of (mainly) rural youth, called *Bhujal Jaankars (BJs)*, a Hindi word meaning 'groundwater informed'. The BJs were trained in their local settings through relevant theory and practical exercises, so that they could perform a geo-hydrological evaluation of their area, monitor groundwater and share their findings and experiences with their village community. The BJs went through a training program of a series of sessions totalling 45-days that covered mapping, land and water resource analysis, geo-hydrology, and water balance analysis, and finally groundwater management strategies. Read more

Hydrogeological Action Research for Spring Recharge & Development And Hill-top Lake Restoration in parts of Southern District, State of Sikkim, India – ACWADAM

This study aimed at providing scientific inputs based on hydrogeological mapping and related studies, for spring recharge (Dhara Vikas) programme and hill-top lake restoration. The project included capacity building of "field facilitators". The FFs participated in a 15 day training course on 'Groundwater' held at Pune. This included various classroom sessions on different topics such as hydrogeology, drainage analysis, water balance, water quality, sanitation, climate change etc. and its importance in groundwater management. Fieldwork in different areas involving activities designed to relate theory and practice, mainly in the form of 'simplified field hydrogeology' was also an integral part of the training programme. Hydrogeological mapping of 15 springs and 3 lakes in South district of Sikkim was carried out by ACWADAM team along with the Field Facilitators.
Read more

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4.4 Sample reports: Water committee training workshops

a) Bhuj citizen forum for water (JSSS) vision building and training workshop

b) Bhuj Lake committees training workshops

In Bhuj, a citizen forum was formed for water related issues. Subsequently separate committees were formed for each lake catchment.

Reports of workshops conducted for orientation, training and vision building of these committees are useful guides for citizens groups trying to replicate the model in their areas.

4.5 Training modules for Community based Water management

a) Basics of Water supply system

b) Operation and maintenance of water supply system

These training modules are formulated for capacity building of community groups in small urban areas for operation and maintenance of water supply in their town.

"Basics of Water Supply System" provides insights on basics component of water supply system, installation and distribution of water supply systems, estimation and measurement of components of water supply system and drinking water quality control.

"Operation and Maintenance of Water Supply System" provides insights on methods for O&M of water supply system for its effective functioning.

These modules were prepared by CEPT at the request of Maharashtra Jeevan Pradhikaran (MJP) for use in their training programmes.

4.6 Sample Course outline for training for para-hydrogeologists

ACT runs programmes for training para-hyrogeologists - a cadre of barefoot hydrologists who are local resources to help develop water security plans.

These people who are local youth undergo training courses course that teaches them about geology and aquifers.

This excerpt from the Arghyam report “Para- hydrogeologists bloom in the desert” gives an outline of the syllabus for the training course.

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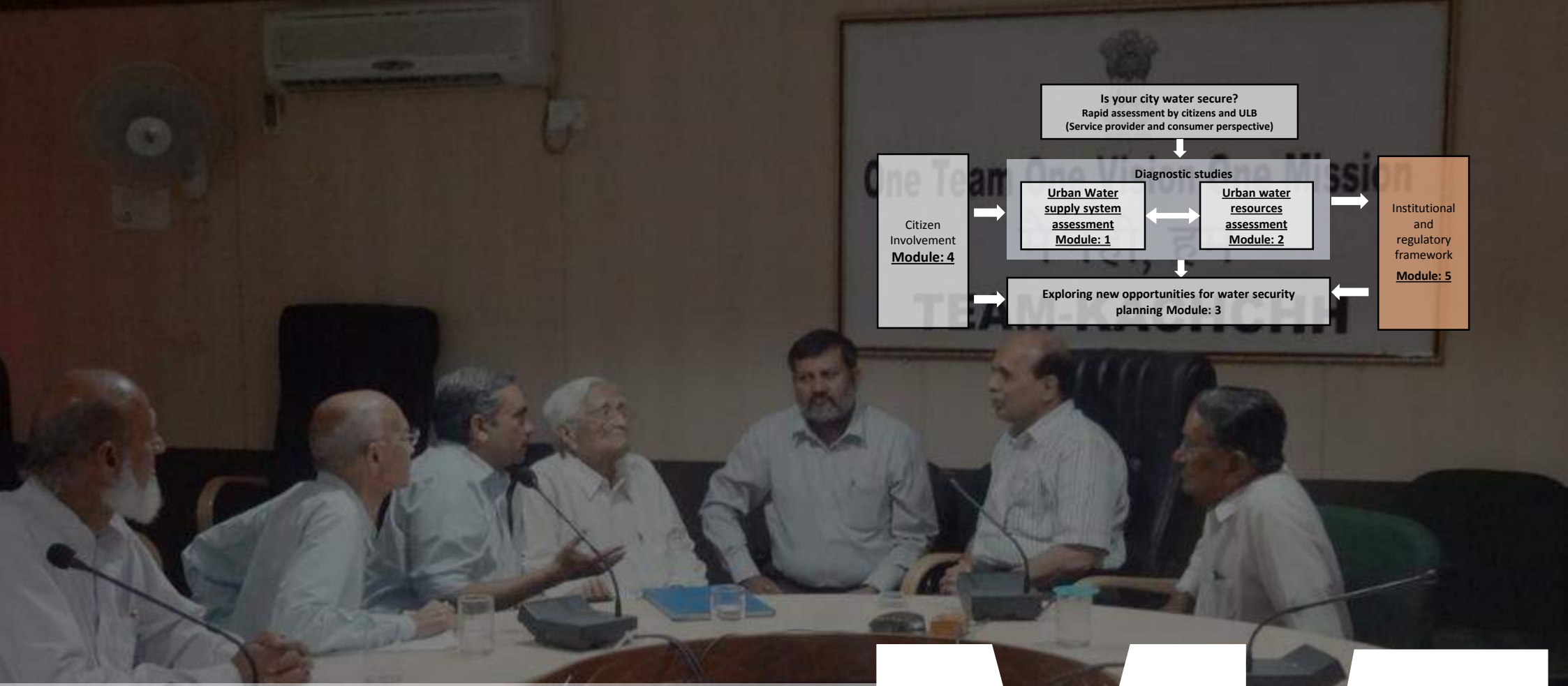

Module 5
Institutional and regulatory framework

M5

Module 5
Institutional and Regulatory Framework

Introduction: Implementing integrated approach for water services requires a favorable institutional context supported with coherent legislative and policy frameworks. Managing urban water all together, it would require strong policies and/or regulations support which would provide a framework to a city to carry out relevant actions.

Capacity building in urban water sector should go beyond institutional reforms. The ULBs are not equipped with the organizational, managerial, and technical resources to deal with the growing urban challenges. Strengthening of ULB with the support through policies and regulations as well as from the local community would aid in running them efficiently.

Module 5 helps in assessing the existing institutional framework in relation to urban water. It also provides methodology to landscape **water institutions.** The tool helps users to analyze the institutional arrangements and their performances to identify gaps and/or overlaps in the institutional set-up and spot where changes could be made to improve their cities' water governance system.

Learning Objectives: More specifically, the module will assist the users in:

- Assessing institutional and policy structure for urban water systems.
- Identifying the gaps and overlaps in the institutional structure and policy for urban water systems.
- Capacity building and learning alliance.

Target Users:

Planners: This module will help the planners to gain the understanding of the existing policies and regulations. Apart from this the inter-linkages as well as roles and responsibilities of every stakeholder involved. It would thus help the planners to identify the missing links and will guide them to strengthen the existing condition. The module provisions capacity building and targets towards strengthening of institutional framework.

CSO: From this module, the CSO can understand the existing policies and regulations under which it can perform its activities for water security. Moreover the CSO can understand the roles of every institution and cogitate the relevant institutions for their help.

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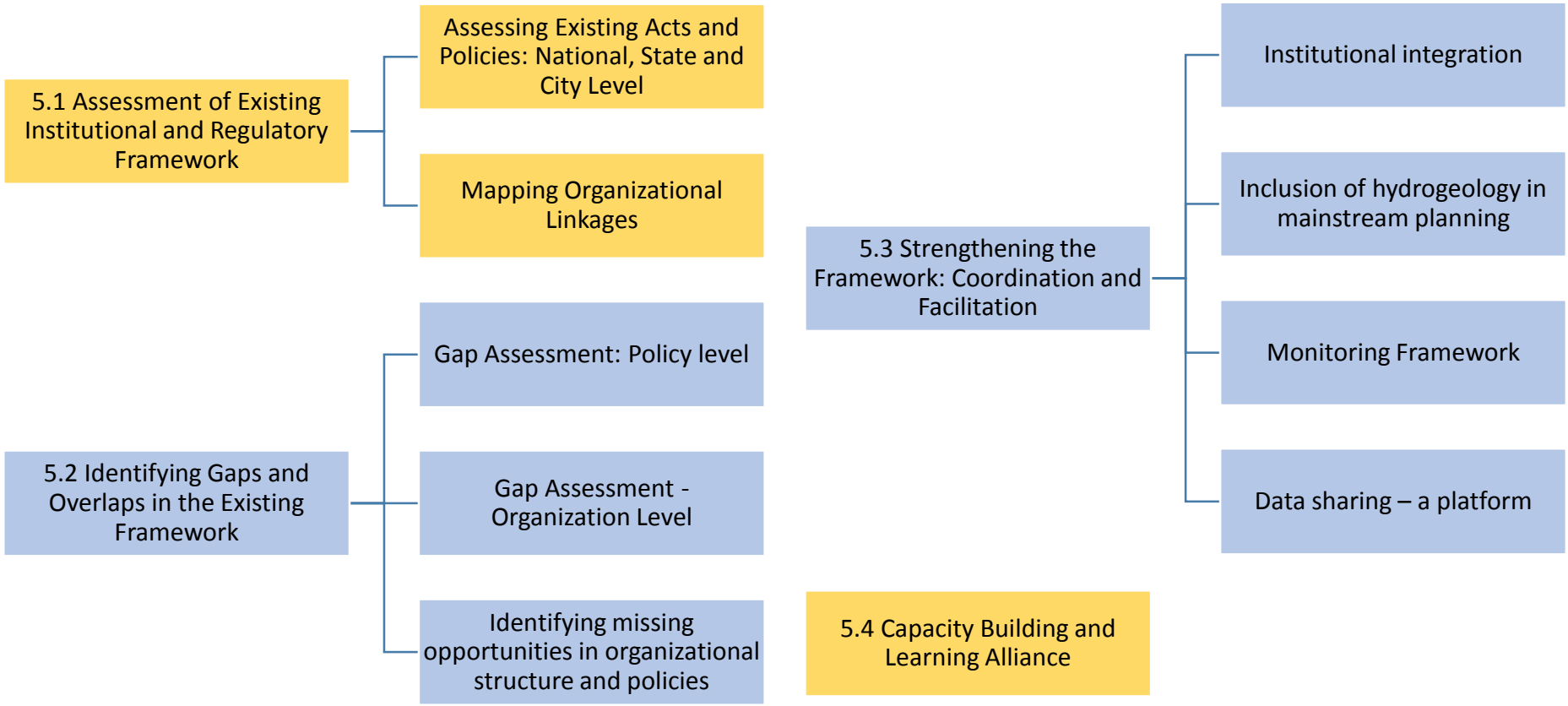
Module 5: Introduction

MODULE: 5



Institutional framework can be defined as a combination of policies, regulations, administrative arrangement and organizational arrangements.

The institutional context acts as a backbone to the sustainable management of urban water services.

There is a need for building a strong institutional framework to implement the activities related to water security in the city.

Water management in the urban areas can be supported by the policies and regulations and the administrative back-up. While general responsibility of provision of water services in a city is that of municipality, there are various other agencies that have a role in water management. It thus follows that for co-governing alternative services, accountability and responsibilities given to be clearly defined. Thus having an appropriate institutional framework would cater to the needs of keeping the city water secure.

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5.1 Assessment of Existing Institutional and Regulatory Framework

MODULE: 5

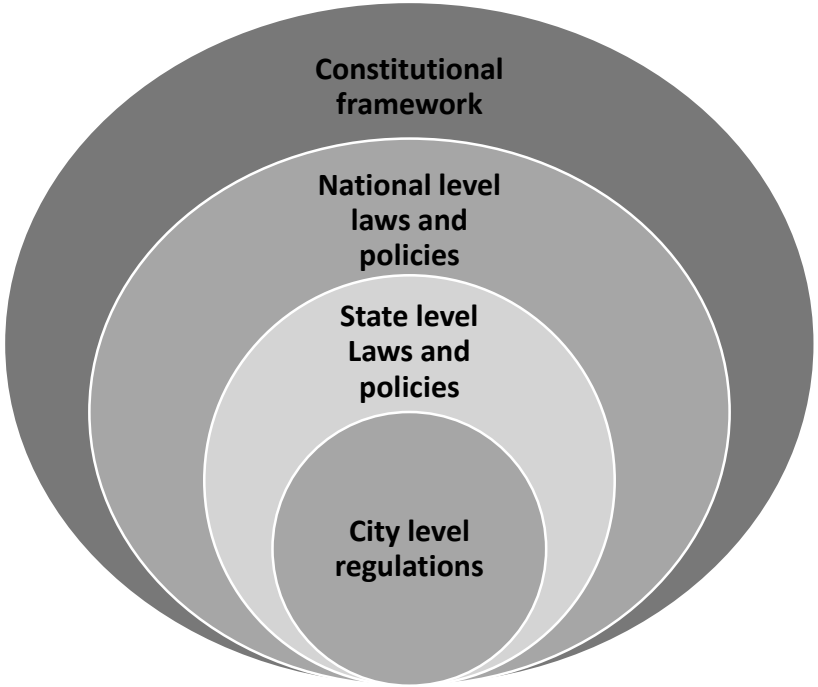
Legal Laws and policies

Development control regulations and bye-laws

Stakeholders

Quality and discharge standards

Tariff and Pricing



Many different types of institutions take part in water related decisions, ranging from national to local and regional governments, civil society groups and citizen groups. All these levels have an impact on the development and management of urban water. Thus to assess the current institutional and regulatory framework, it must me mapped and analyzed.

Assessment must be done for all the aspects of policies, regulations, norms and standards, tariff and pricing, etc. as everything holds an equivalent importance on implementing various activities to make a city water secure. However, at the same time the organizations whose primary function is not related to water may also have an influence on developing water security in a city.

Apart from this, the institutional framework also decides the sustainability of the activities carried out under water security.

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MODULE: 5

5.1 a) Assessing Existing Acts and Policies: National, State and City Level

National Level	State Level	City level
National Water Policy (2012)	**State Water Policy**	**In Development Plan / Master plan**
Water prevention and control of pollution Act (1974)	**Policies related to Pollution Control of water resources**	**In city GDCR**
Environment Protection Act, 1986		**Policy resolutions by ULB**
National Environment Policy, 2006		

There are many policies, acts and regulations present at National level which has an impact on urban water management.

Since water being a state's subject, reviewing state level policy is a must. The influence of these policies would prioritize the actions taken by the local governments. Thus the planners and civil societies need to review these policies.

After reviewing the national and state level policies and regulations, local level policies and regulations must be assessed. Many cities have formed regulations in regards with the urban water management. These regulations could be a part of their GDCR's or policy resolutions. Cities could have also taken special measures in the master plan to enhance the water sources of it by creating a sensitive zone or ecology zone etc.

Thus these regulations and policies at city level must be assessed to understand in which of these the actions for water security would fall.

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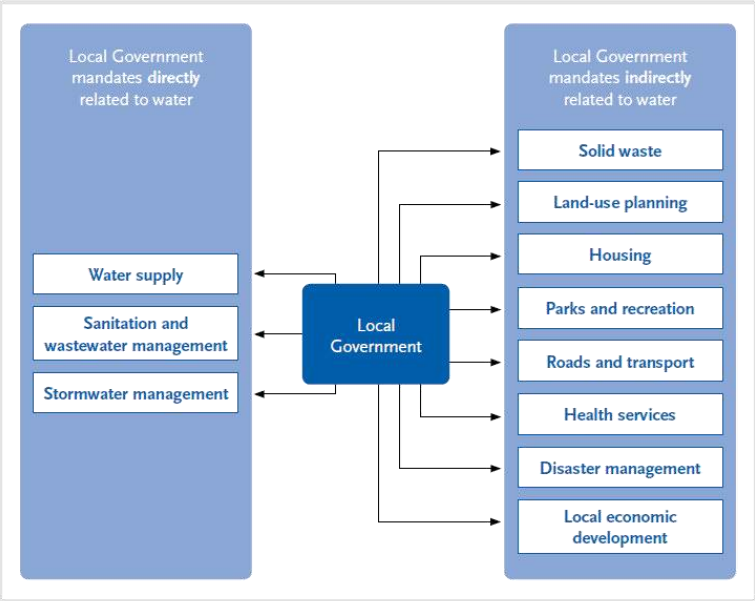
MODULE: 5

5.1 b) Mapping Organizational Linkages

Intra Organization Linkages



Source: Philip R. et al., Local Governments and Integrated Water Resources Management, Part III: Engaging in IWRM – Practical Steps and Tools for Local Governments (2008)

Inter Organization Linkages

The example shows the roles of various organization for water supply system in Bhuj

Agency/ Authority	Jurisdiction	Category
Department of Narmada, Water Resources, & Water Supplies	State level	Administration and regulation
Gujarat Industrial Development Corporation (GIDC)	State level	Administration and regulation
Gujarat Water Supply and Sewerage Board (GWSSB)	State level	Implementation and capital works
Gujarat State Drinking Water Company Limited		Implementation and capital works
Sardar Sarovar Narmada Nigam Ltd.	State level	Implementation and capital works
Bhuj Municipal corporation	Local level	Operation and maintenance
Bhuj Urban Development Authority	Local level	Operation and maintenance

It would help in developing a complete list of participants who would play different roles in the water security planning of a city.

One of the activity would be to identify the inter linkages amongst various departments of the local government. It is very important as it assesses the roles and responsibilities at each level of the hierarchy within the local government. It also helps in understanding existing institutional setup for water supply & water resource management.

A range of stakeholders (different organizations) amongst the institutional environment would be found. Since all the members of the local government as well as the civil societies do not have information about the roles and responsibilities of different organizations mapping them has an important role. Mapping out the key decision makers within the system for various activities also helps. A stakeholder mapping should be done on the basis of the influence of each stakeholder and their interest in the IUWM related activities.

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MODULE: 5

5.2 a) Gap Assessment: Policy level

After the assessment of the existing policies and regulations, it is important to identify prevailing gaps and overlaps in it.

This quick assessment tool helps to identify whether similar policies or regulations are present to enable various steps towards water security in the city.

Policy / Regulations

1 Household level metering ☐ Yes ☐ No

2 100% cost recovery of water supply systems ☐ Yes ☐ No

3 Regulations to implement rain water harvesting measures in the city. ☐ Yes ☐ No

4 Conduct water audit at regular interval ☐ Yes ☐ No

5 Waste water reuse ☐ Yes ☐ No

6 Pro-poor water policy ☐ Yes ☐ No

7 Encourage runoff reduction ☐ Yes ☐ No

8 Monitoring of water quality in water bodies ☐ Yes ☐ No

9 Protection of water bodies ☐ Yes ☐ No

10 Monitoring of Groundwater extraction ☐ Yes ☐ No

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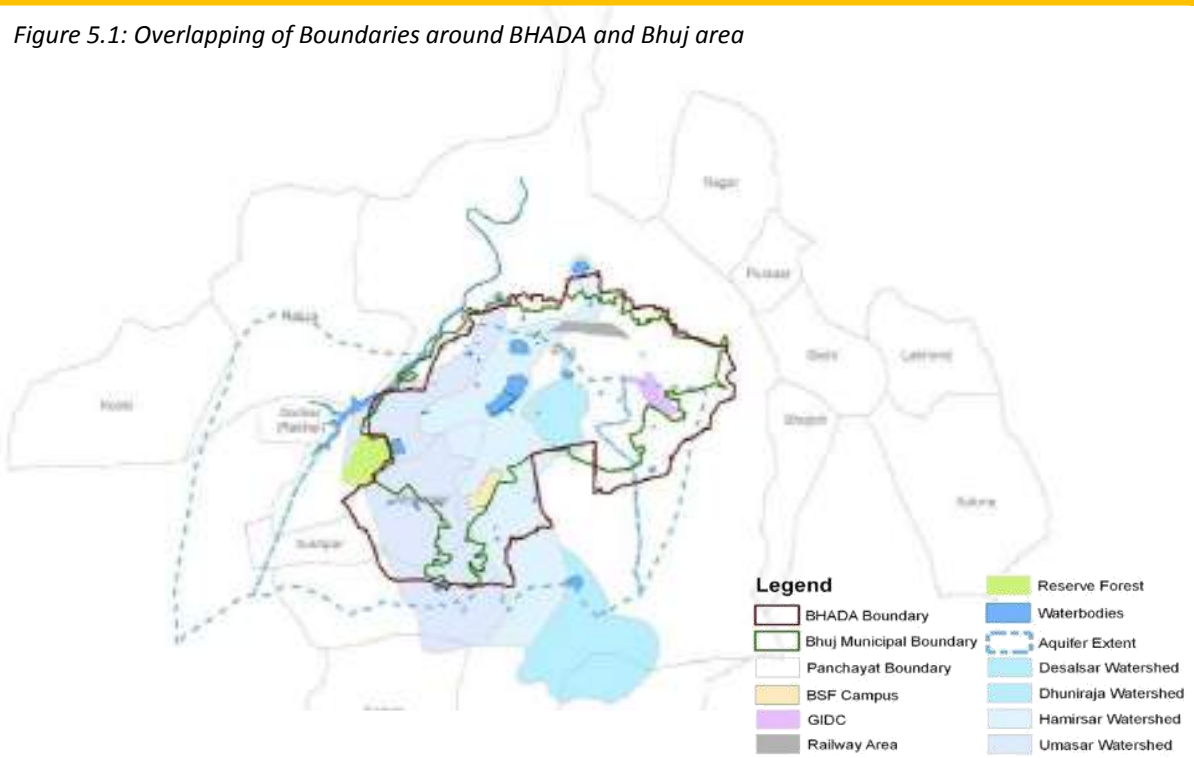
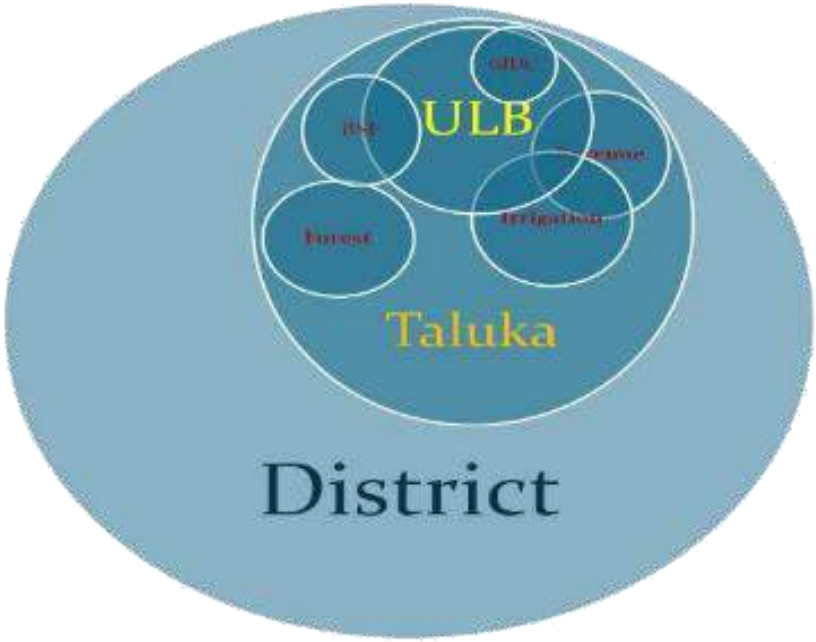
MODULE: 5

5.2 b) Gap Assessment - Organization Level

Figure 5.1: Overlapping of Boundaries around BHADA and Bhuj area





A lack in existing institutional structures, makes implementing water security approach difficult. The approaches then become often uncoordinated and unaccountable.

At present, multiple stakeholders and government entities are working in isolation. This assessment would help one to understand the weak links in the institutional structure. The overlaps and gaps in this working system needs to be integrated properly to implement and sustain water security approach.

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MODULE: 5

5.2 c) Identifying missing opportunities in organizational structure and policies

> "Coping with future water challenges raises not only the question of ***what to do?*** but also ***who does what?***, ***why?***, ***at which level of government?*** and ***how?***"
>
> **- OECD Principles on Water Governance**

Based on:
Water Efficiency And Conservation In Urban India, CSE, 2016; Water security and governance in India, Baby K., 2013.

Multi-level Governance Framework: Mind the Gaps, Bridge the Gaps

Source: OECD (2011), Water Governance in OECD: A multi-level approach, OECD Publishing, Paris

Policy Incoherence	Existing policies were formulated with water as a subject, they did not incorporate a holistic approach to water management.
Lack of Binding Laws	Absence of Water conservation and efficient usage at National level
Organizational/ Departmental Fragmentation	Lack of coordination amongst the departments for
Lack of cross sectoral linkages	Most of the times, all the sector plans are planned in silos.
Lack of Integrated planning	Landuse and water resources planning not yet carried out on the same page.
Lack of importance to local resources	No promotion to look into ones own sources.
Participation of communities and citizens	Lack of involvement of citizens during the decision making process. People's participation can be meaningful when informed discussions take place during consultations.

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5.3 Strengthening the framework: Coordination and Facilitation

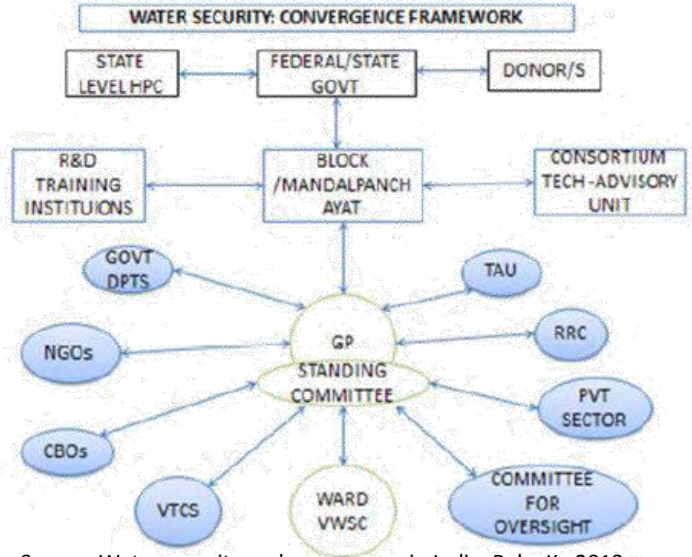
MODULE: 5

5.3 a) Institutional integration

Making a city water secure will require more than just implementation of few projects. There is therefore a need to stimulate changes in policy and practices of urban water management.

Institutional integration would be one of the first step to make the organizations and administration work in coordination. It would assure coordination amongst all the activities.

Defining Roles and responsibilities at each administration level



Source: Water security and governance in India, Baby K., 2013.

Defining level of involvement and
Roles and responsibilities
E.g. Formation of Water shed Committee

Level of Involvement	Policies and Regulations	Planning and Decision Making	Implementation and Monitoring
State Level	Land and Revenue Department Department of Agriculture Forest Department State Irrigation Department Urban Development Department Rural development Department		
	State Pollution Control Board State Ground Water Authority		
District/ City/ Gram Panchayat Level	District Magistrate		
			Urban Local Bodies Gram Panchayat Urban Development Authority
Local Community Level			Water User Associations NGOs Other Local Communities

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MODULE: 5

5.3 b) Inclusion of hydrogeology in mainstream planning

A water security plan must focus on attaining safe water for life and sustainable livelihoods and ensuring water security even in times of emergencies like droughts and floods. It should be made at the lowest possible administrative level as the lowest level administration knows the ground reality. It must contain, besides a description of water sources, catchments and groundwater aquifers, a statement of rights, duties, management responsibilities, and priorities of use.

Strategies for water security plan	
Water Recharge Programs	Community based monitoring
Groundwater prospecting and aquifer management	Promotion of making use of less water intensive technologies
Water source audit and protection	Accommodate local historical water management practices
Rejuvenation of water bodies	Measures for conjunctive use of surface and groundwater
Efforts for improving water services efficiency	Other measures as may be appropriate to the specific aquifer, watershed and/or River Basin
Demarking water sensitive zones	

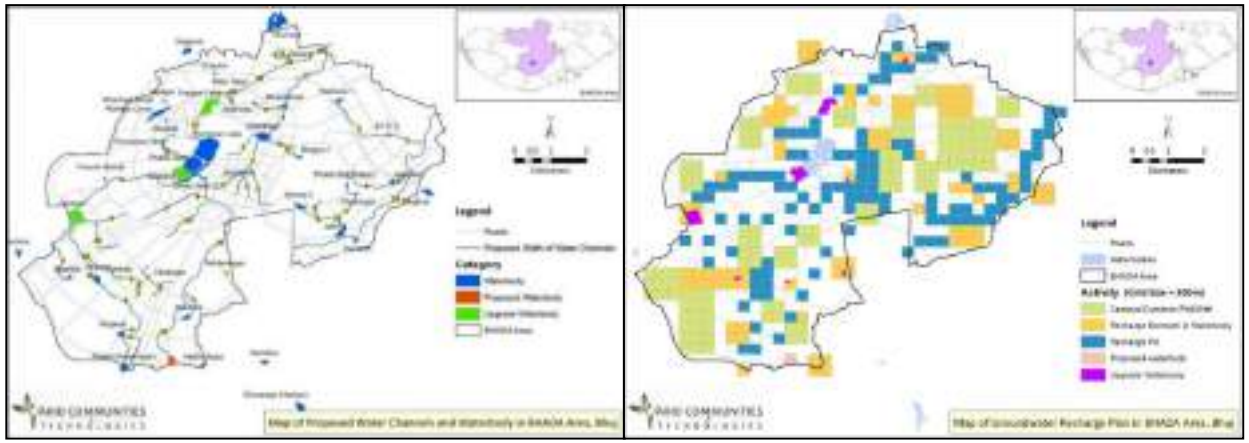
The plan must be integrated with other plans as well and may be required under other laws and government schemes.

Based on: Draft National water framework, 2016

One way step to facilitate this is by involving hydrology as a part of landuse planning and city development plans. The steps which can be taken are as follows:

- Provision of green buffers around water bodies in Development plan.
- Consideration of natural watersheds and pathways in storm water planning
- Identification of groundwater recharge zones
- Delineation of “sensitive” zone to protect water sources
- Developing “Zero runoff zone”
- Consideration of soils, topography, water availability in urban expansion and infrastructure planning.
- Consideration of water security projects in grant based infrastructure schemes

Figure 5.2: Proposal of Groundwater Recharge Pits and Water Channels for Bhuj DPR



Source: ACT

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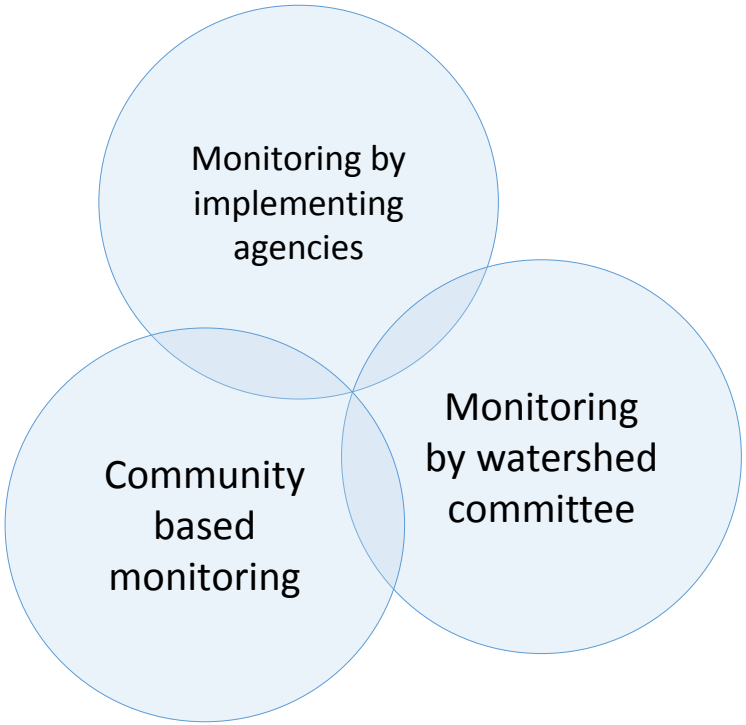
MODULE: 5

5.3 c) Monitoring Framework



Developing monitoring framework:

- Identify activities/indicators/outcomes to be monitored.
- Decide how the findings will be acted on.
- Identify sources for monitoring data and data collection methods.
- Schedule monitoring.
- Design forms/ questionnaire for recording information.*Based on WSP framework.

With the development of this monitoring framework, participatory monitoring must be promoted which would help in knowing the actual ground situation as well as keep the citizens aware and concerned about water security. .

Monitoring by implementing agencies: Will be done in regards to the decided water security plan and targets to be achieved.

Monitoring by Watershed committee: Monitor the outcomes after implementation and help in evaluating the outcomes.

Community based monitoring: Involving citizens and community to monitor water quality, groundwater levels, etc. Training must be given to the citizens to make them understand the evaluating and monitoring criteria.

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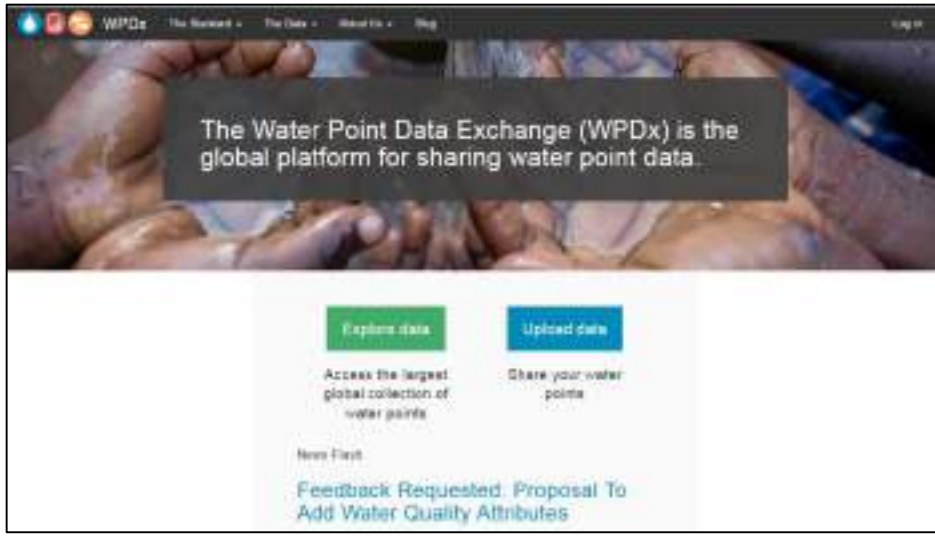
5.3 d) Data Sharing: A platform

Data Sharing

Groundwater Board	Details regarding groundwater levels and groundwater quality
Pollution Control Board	Quality and details of surface water sources and groundwater sources.
Other Organizations (Public or Private)	Details in relation to water which it came across during their own projects.
Water Users	Provide groundwater related data to the appropriate Government, such as new tubewell, deepening of tubewell, dug well, pumps, and any water quality issues.

Global Platform for sharing water data



A common public domain must be created where everybody can put all water and water related data. The data must not be restricted to rainfall. Humidity, temperature, wind velocity, etc. but shall also include details such as groundwater levels, groundwater quality, details about surface water sources, irrigation details etc.

The data must be available on an interactive platform which is simple to access. A unique ID system must be adopted to identify the locations. A unique village ID to all the villages in the country to make data easily accessible to the rural population. Similarly, a unique ID system needs to be generated for the urban areas as well.

The Central Government shall develop and maintain a publicly available web based Water Resources Information System (IndiaWRIS) on Geographical Information System Platform, integrating water resources and other related data with satellite imageries through use of state-of-the-art Information Technology.

* Based on Draft National Water Mission.

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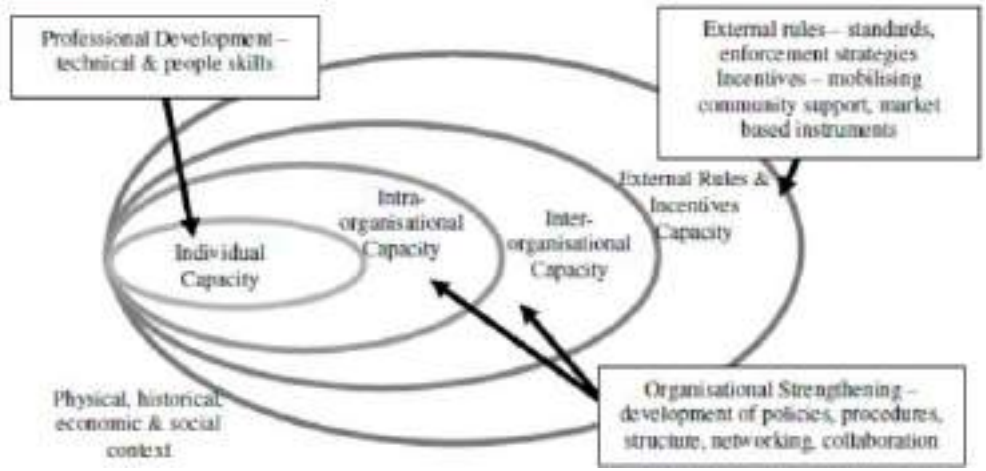
5.4 Capacity Building and Learning Alliance

MODULE: 5



Source: Harvey, L. et al., "Organizational Capacity in Integrated Urban Water Management: The Art of Being Undisciplined"

The multi disciplinary nature of water security approach and the number of stakeholders involved in its planning presents a significant need to identify, understand and address its capacity building.

- Undertake capacity building need assessment study across various stakeholders
- Design of appropriate training and capacity building module and compilation of relevant case study
- Identify local individual or local institutions in the city, who can play a role of champion for learning alliance
- Learning Alliances for action research and scaling up innovation

Gujarat: Gujarat Jal Sewa Training Institute

Key Institute for imparting training at state and national level in drinking water supply and sanitation sector. Institute organizes training programmes, seminars workshops on water & sanitation related issues to facilitate sharing of knowledge amongst various stakeholders and functionaries.

Academic institutions play a key role in scaling up

CEPT UNIVERSITY

Gujarat Technical Universi

THE MAHARAJA SAYAJIRAO UNIVERSITY OF BARODA

सत्यं शिवं सुन्दरम्

SPA

teri university

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MODULE: 5

Case Studies

Strengthening Institutional Framework

Redeveloping Institutional Framework and Policy Making for Water, Myanmar

Myanmar faces a number of water challenges, with rapid development of special economic zones and agriculture expansion, water and energy demands are increasing in an unprecedented manner. This led to development of new institutional framework and policy measures to sustain its water resources. Based on the four pillars of sustainable water use – standards and compliance; information and decision making; services and products; and education and training – several policies were drafted, supported by a number of capacity development programmes. Decision support systems enabling people-centered approaches to policy development and decision-making through engagement with civil society are being formed, in part through the support of the World Bank. NGO participation is to be used to promote a neighbor-watch-system for monitoring, policing, enforcement and sanctioning with the objective to improve gross national happiness

Read more

Capacity Building and Learning Alliance

Concept of Parab in Bhuj: Involving the citizens

Parabs are drawn from local communities. With the intensive training and on-field experience, the parabs have now become para-professionals on Participatory Ground Water Management in Bhuj. The entire capacity building of parabs is a collaborative initiative between ACT and the trainees and training consists of a 45-day course that is a combination of technical information, and traditional wisdom. The curriculum includes knowledge of geology, know-how about locating water harvesting structures, working with communities and basic knowledge of government programmes. The programme is broken into a good mix of classroom sessions, backed by field work, in order to give a holistic experience to the trainees. At the end of the training, the parabs have the ability to conceptualize and plan for water resources.

Once the training is complete, parabs are encouraged by ACT to be self-reliant and practice their skills independently by providing consultancy services. They are now becoming local champions and an important link in participatory ground water management. People are slowly beginning to trust their skill and are seeking their help. A separate entity, Parab Water Management Pvt. Ltd. has now been set up and registered to further cement their credibility. Their initial breakthrough came when engineers from WASMO crosschecked their database for a project and endorsed its authenticity. Now, parabs from Parab Water Management Pvt. Ltd. also work as Resource Persons for Reliance Foundation and have been involved in CSR projects from IL&FS.

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Quick achievable things a city can start with?

Urban Planners

Civil society & NGOs

Solution to water crisis through Rainwater harvesting structure for residential/ institutional properties!!

Improve efficiency in existing water supply services; Conduct Preliminary water audit studies !!

Protection, conservation and rejuvenation of urban lakes!!

Water conservation through groundwater recharge, wastewater reuse !!

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Key Messages!!

Improve efficiency in existing supply system

Carefully manage your Ground Water

Bring back traditional knowledge of water management

Promote participatory approach in water planning

Advocate, collaborate, participate

Harvest rainwater, recharge ground water, Protect urban lakes, Recycle wastewater

Diversify Water sources

Regulate Private water vendors

Create an open data platform for water

Plan at watershed level, integrate hydro-geology in land-use planning

At End…..
Don't think its too complex…. Lets start…This is doable!!

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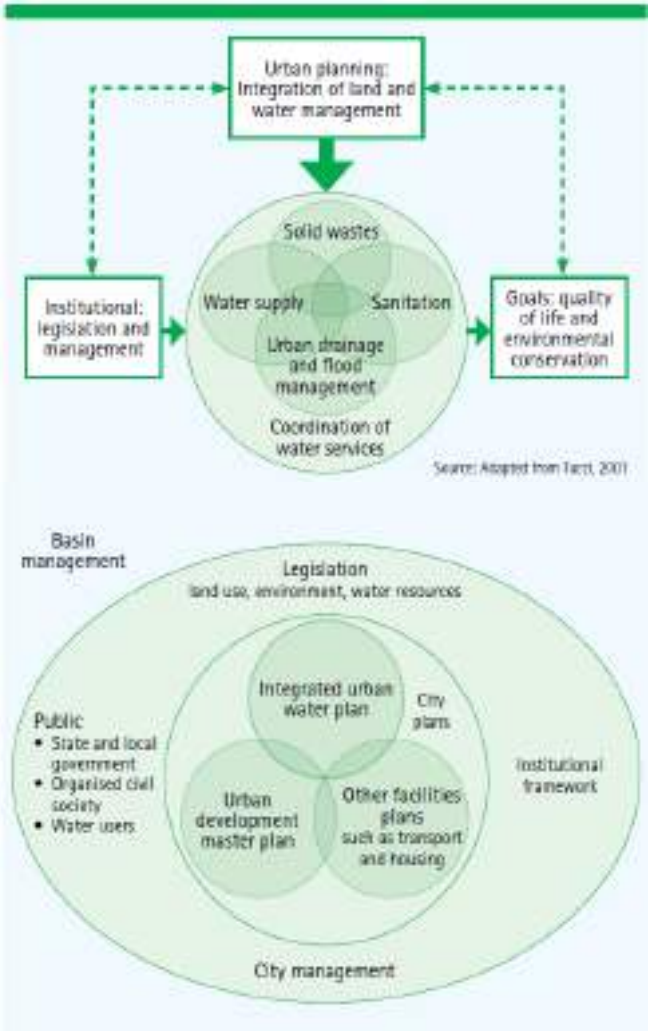
Annexure

Integrated Urban Water Management (IUWM)

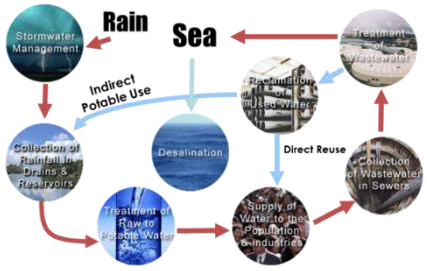
- Integration of urban development and basin management to achieve sustainable economic, social, and environmental goals.
- Integrated Urban Water Management (IUWM) brings together water supply, sanitation, storm- and wastewater management and integrates these with land use planning and economic development.
- A successful approach requires engaging local communities to solve the problems of water management.



Application of approach

Singapore : Diversifying water sources for water security

Windhoek – Direct wastewater reuse to address scarcity



Applicability in India

- Tested in Mulbagal city
- ICLEI is testing in four cities (2 in Rajasthan and 2 in Maharashtra)
- Can be adopted under smart city framework

Source: Policy Brief: IUWM Towards Diversification and Sustainability; GWP; August 2013

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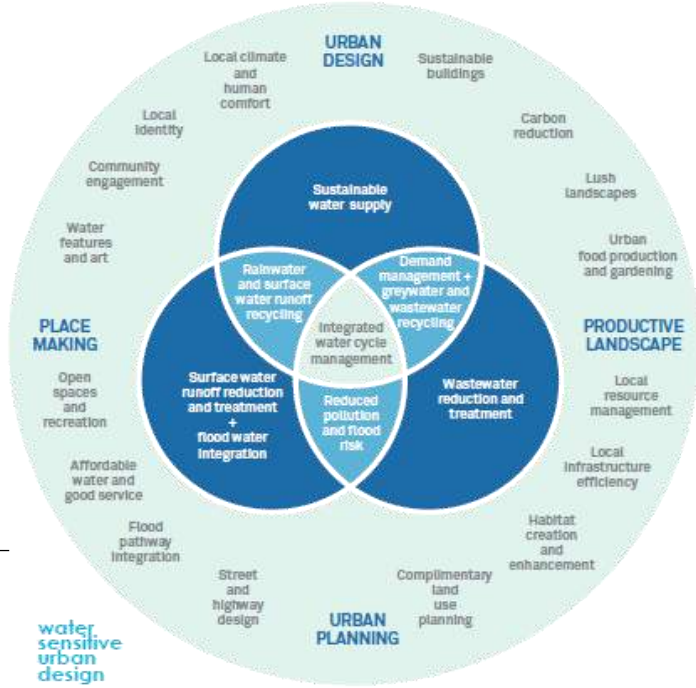
Annexure

Water Sensitive Urban Design (WSUD)

- Water Sensitive Urban Design is a philosophical approach to Urban Planning and design that aims to minimize hydrological and water quality impacts of urban development.
- It is the process of integrating water cycle management with the built environment through planning and urban design.



Application of approach

Portland, Oregon, USA: From Grey to Green
Lodz, Poland: Blue-Green Network
Melbourne, Australia: Green field residential development, stormwater and waterways design

Applicability in India

- Already applied at Property scale in India
  - IIM, Kozhikode
  - Jamia Hamdard University, Delhi

Source: WUSD in UK, Ciria (http://www.ciria.org/Resources/Free_publications/Water_Sensitive_Urban_Design.aspx)

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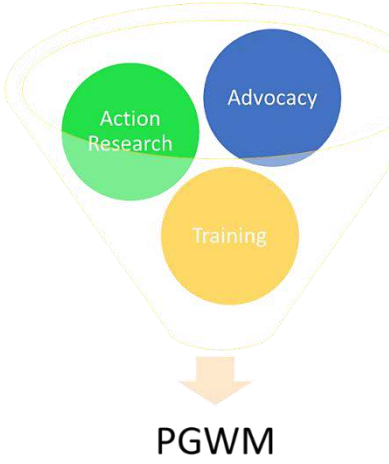
Annexure

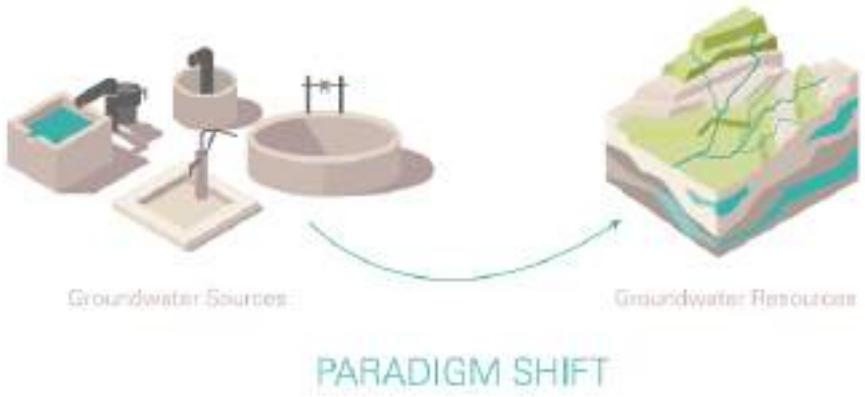
Participatory Ground Water Management (PGWM)

- Groundwater is a common pool resource and therefore participation of stakeholders is key to sustainable and effective management of groundwater.
- Effective participation of stakeholders relies on awareness raising and sustained information sharing.
- Participation brings a discipline into this process of management.
- It brings users together to arrive at mutually agreed decisions on usage and recharge



Application of approach

- **Well tested in rural area-** APFAMGS (Andhra Pradesh Farmer Managed Ground water System) Project, Randullabad in Maharashtra, Himachal Pradesh, Takarwan village of Beed district, Maharashtra
- **Exploring in urban areas**



Source: *(2015), Arghyam, Participatory Groundwater Management: A collective effort towards addressing India's water security*

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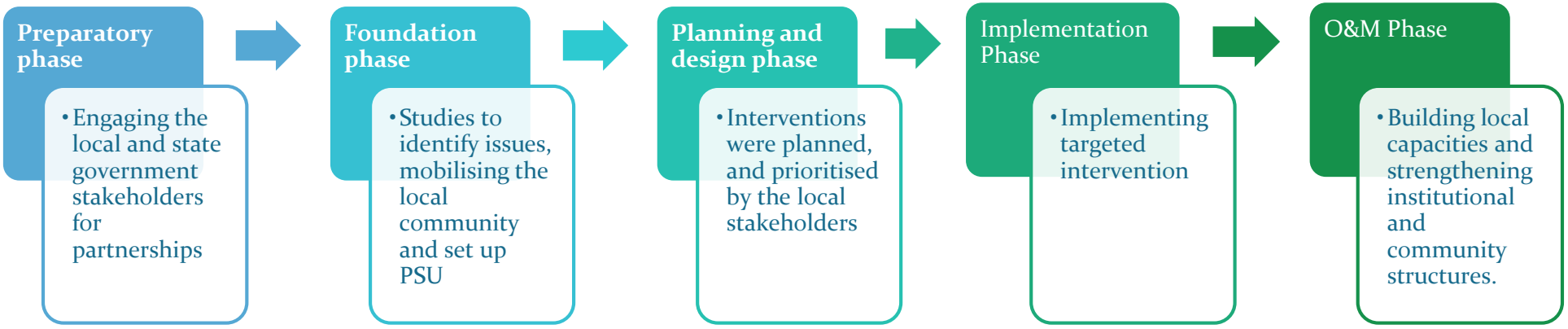
Mulbagal Experience

- Integrated urban water Management (IUWM) was studied for town of Mulbagal in Karnataka started in 2008 over the duration of 5 years
- It involved 5 phases:



Interventions made:

Energy efficiency in pumping stations, rainwater harvesting in schools, community toilets, individual toilets under GoI Integrated Low Cost Sanitation (ILCS) scheme, and solid waste management.

Lessons learned:

- **IUWM approaches** to conjunctive use of water allowed the citizens to be a part of the planning process.
- **Water Resources of town:** Need to undertake technical studies. Issues like pump efficiency improvements, fixing systems losses, getting experts to address design flaws in new schemes etc. need to be addressed
- Must give **incentives** for adopting sustainable measures to local communities and elected wing
- **Change Management Approach** offered a rational and feasible way to help small towns move incrementally towards IUWM.
- **Attitudinal changes** among stakeholders.
- **Technical support** is must.

Source: Sunita Nadhamuni, 2012; An Approach to Integrated Urban Water Management (IUWM); The Mulbagal Experience Arghyam, Bengaluru

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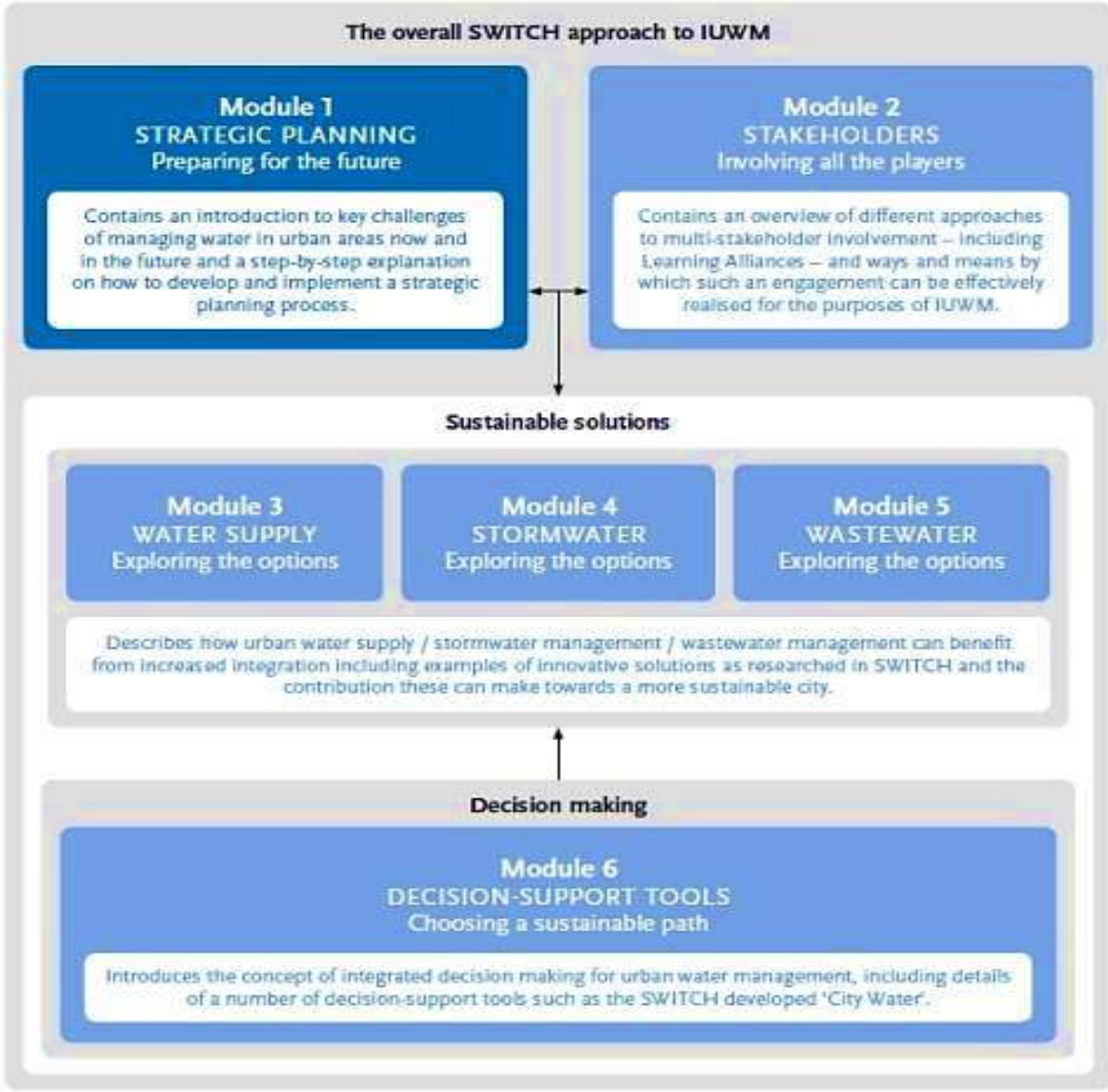
Annexure

SWITCH toolkit for IUWM

- SWITCH was an action research programme funded by the European Union that was implemented and co-funded by a cross-disciplinary team of 33 partners from across the globe, including 17 from Europe and 12 from South America, Asia and Africa.

- SWITCH developed a training toolkit to maximize the utility and impact of the SWITCH approach.

- The toolkit includes 6 modules to help practitioners including city staff and utilities to work through a strategic planning process and to increase their knowledge and capacity in different aspects of urban water management.



Source: http://www.switchtraining.eu/

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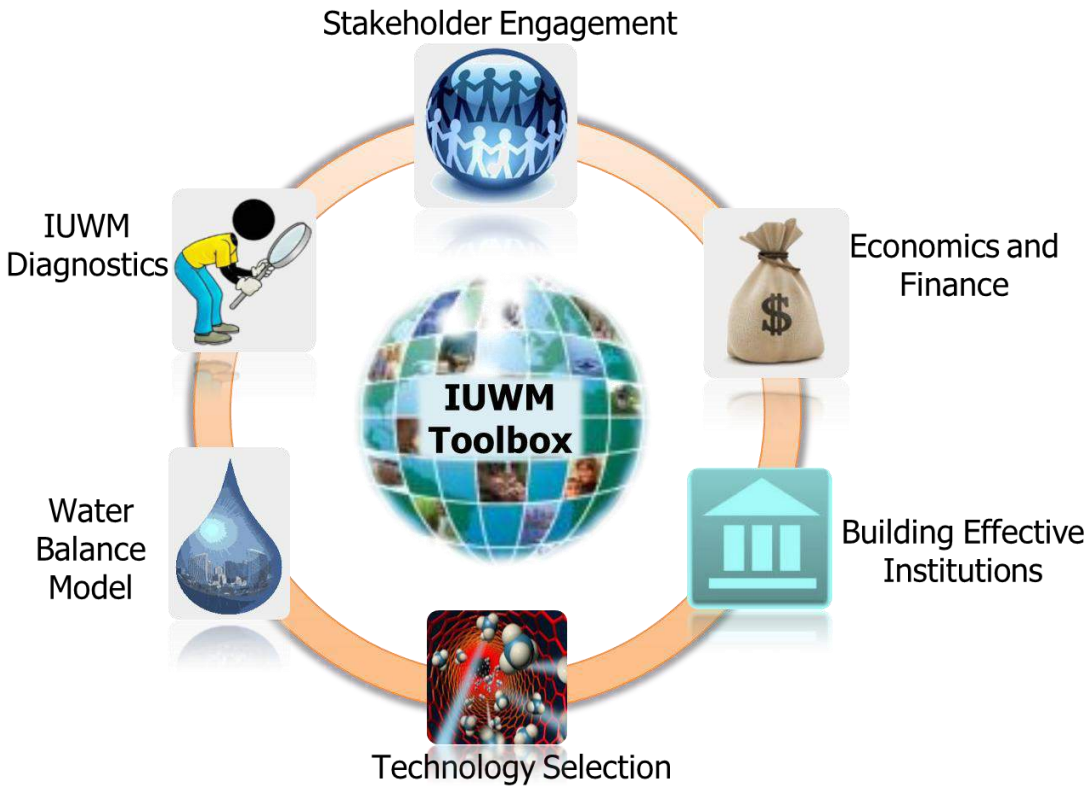
GWP IUWM toolkit

- GWP along with Patel College of Global Sustainability (PCGS)has developed IUWM toolkit

- The purpose of the toolkit is to assist the decision makers and key stakeholders in understanding the principles and applications of IUWM.

- The tools include: i) a diagnostic tool, ii) resources flow balance model, iii) technology selection tool, iv) stakeholder engagement guidelines, and v) institutional arrangement tool.



Source:

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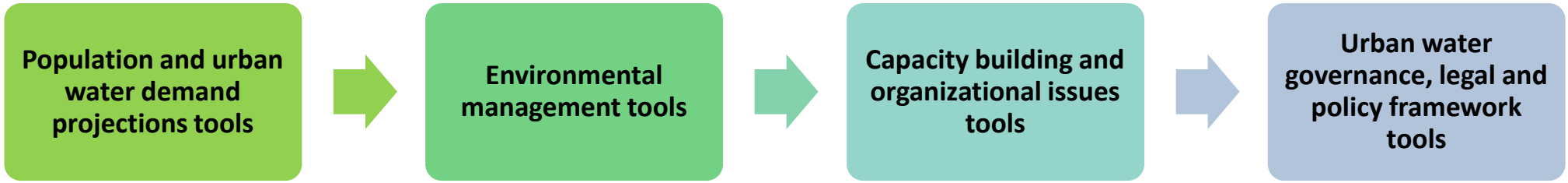
IRAP toolkit on IUWM

Toolkit on integrated urban water management in different urban typologies of India

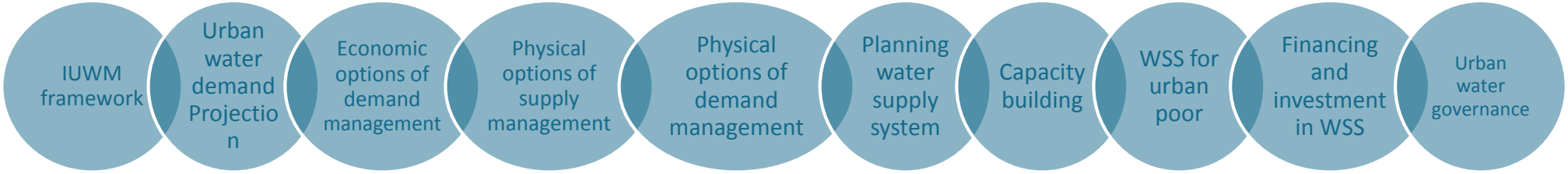
- **Initiated in 2008**
- **It involved Exhaustive review of research undertaken in urban water management**
- **Includes** urban hydrology, management of water resources, groundwater management, technical and economic instruments for water management

Target Audience: Water Managers, senior policy makers, scholars and practitioners

Volume-1 (Brief background, need for toolkit and details of four set of tools)



Volume-2 (Technical report, background literature and details of IUWM)



Source: Institute for Resource Analysis and Policy (IRAP), Hyderabad; Toolkit for IUWM Vol-1 &2; Oct 2010

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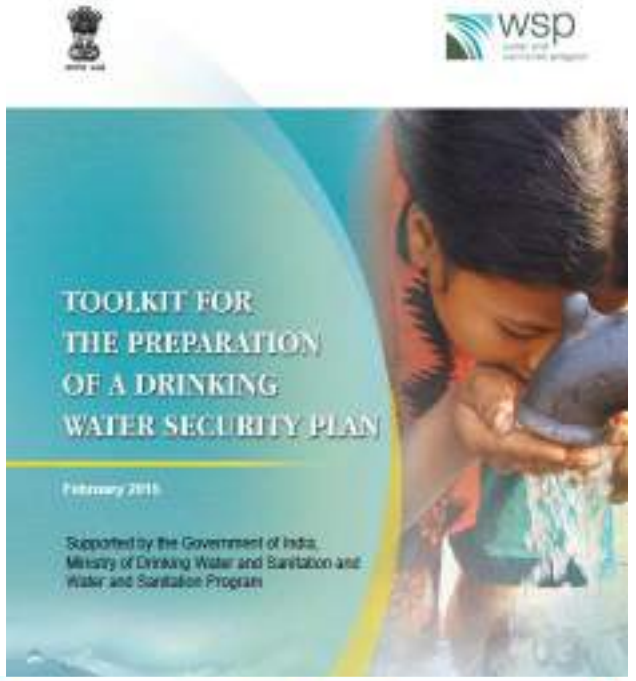
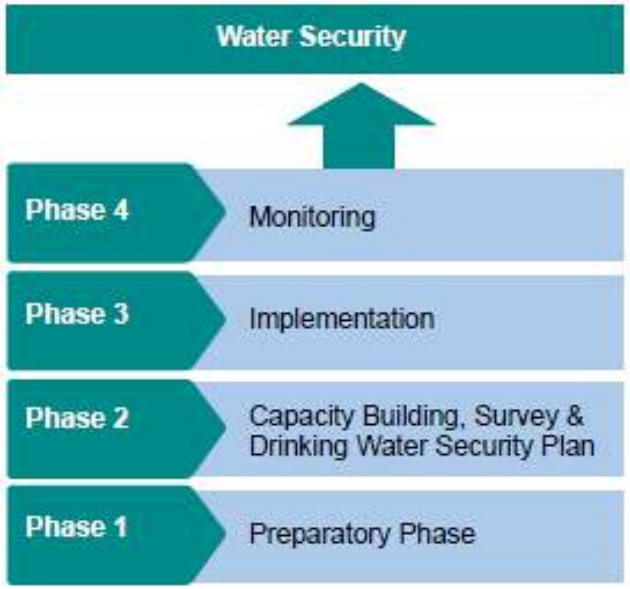
Toolkit for the preparation of a drinking water security plan in rural areas GOI

- Water and Sanitation Program (WSP) and MDWS have developed the Toolkit for the Preparation of a Drinking Water Security Plan.
- It provides a model for taking a Gram Panchayat/Support Organisation through an action planning process.
- It is a step-by-step process, covering practical guidelines and a water security plan template.
- It focusses on the planning and community mobilisation as well as the institutional and financial aspects of implementing a drinking water security programme in pilot blocks.





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Knowledge Management and Advocacy Partnership for Participatory Ground Water Management in Bhuj

Centre for Water and Sanitation (C-WAS) at CEPT University is the Knowledge Partner to Arid Communities and Technology (ACT) for ground water management activities in the city of Bhuj, Gujarat. CEPT supports ACT in documentation of processes related to Participatory Ground Water Management (PGWM) in Bhuj. The project is being funded by Arghyam.

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