Unnat Bharat Abhiyan 2-Day Web-Seminar on Water Resources Management

14th - 15th MAY 2020

IIT Delhi, the National Coordinating Institute of MHRD's flagship programme Unnat Bharat Abhiyan organised a 2-day Web Seminar on **14th and 15 May 2020**. The seminar was conducted by the experts from **IIT Kharagpur & SGSITS Indore** - the **Water Resources Management Subject Expert Group** of Unnat Bharat Abhiyan through the Cisco Webex virtual meeting platform for two consecutive days from **2:30 PM to 5:30 PM**.

Integrated water resources management is vital for poverty reduction, environmental sustenance, and sustainable economic development. In view of the rapid increase in population, urbanization, and industrialization, the demand for water for meeting various requirements is continuously increasing. Since water management is a composite area with linkage to various sectors of Indian economy including the agricultural, industrial, domestic and household, power, environment, fisheries and transportation sector, this UBA webinar was centralised on the fact that water resources management practices should be based on increasing the water supply and managing the water demand under the stressed water availability conditions.

The purpose of this webinar was to encourage the Regional Coordinating Institutes of Unnat Bharat Abhiyan to address relevant issues pertaining to the development and management of water resources in India through sustainable technologies. The role of water conservation, water harvesting and water management was broadly discussed in this web seminar. The experts also discussed how to prevent water contamination from Coronavirus during COVID-19 crisis.

The webinar was attended by 70 Coordinators of the Regional Coordinating Institutes and field experts from across the nation.

The seminar included the presentations by famous researchers, scholars, and innovators across this field followed by an interactive question and answer session.

SESSION 1: 14th MAY 2020

The session one of this UBA seminar was inaugurated by Prof. Manoj Kumar Tiwari, IIT Kharagpur, and Prof. Milind Dandekar, SGSITS - the two Subject Experts of the Water Resource Management SEG-UBA). Prof. Vivek Kumar (SEG Coordinator, NCI-UBA) welcomed everyone. The session began at 2:30 PM and continued till 5:30 PM.

The major areas covered during this session were -

1. **Water Sources and Water Budgeting Concept** by *Dr. Manoj Kumar Tiwari* (Professor, IIT Kharagpur)
2. **Estimation of Water Availability at Village Scale** by Prof. *Shishir Gaur*, IIT BHU
3. **Agriculture Water Demand Management** by *Dr. Ashish Pandey* (Professor, IIT Roorkee)
4. **Rain Water Harvesting and Water Conservation in Rural Areas** by *Dr. Sandeep Narulkar and Dr. Milind Dandekar* (SGSITS, Indore)
5. **Role of Community in Rural Area Water Supply: UBA Partnering with NJJM** by *Dr. Vivek Kumar* (Professor, IIT Delhi)

SESSION 2: 15th MAY 2020

Session 2 of this seminar was inaugurated by Prof. Manoj Kumar Tiwari, IIT Kharagpur and Prof. *Ashish Pande*y, IIT Roorkee. Attended by 60+ experts and regional coordinators of UBA, the session was very helpful in disseminating knowledge on water resources and discussing solutions on various water-related issues. The session began at 2:30 PM and ended at 5:30 PM including the question-answer session.

The major areas covered during this session were -

1. **Water Quality Monitoring and Treatment** by Prof. Manoj Kumar Tiwari, IIT Kharagpur
2. **Indigenous and Traditional Technologies of Rainwater Harvesting** by Prof P.K. Singh, MPUAT, Udaipur
3. **Rejuvenation of Ponds, Lakes and Canals** by *Dr. Sandeep Narulkar and Dr. Milind Dandekar* (SGSITS, Indore)
4. **Potential and Methods for Groundwater Recharge** by Prof. *Shishir Gaur* IIT BHU
5. **Water Use Efficiency Enhancement in Agriculture** by Prof. *Ashish Pandey* , IIT Roorkee.

The PowerPoint presentations of all the experts in this seminar have been attached below.

UNNAT BHARAT ABHIYAN

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UBA Web-Seminar on Water Resources Management

May 14-15, 2020

Water Sources and Water Budgeting Concept

Manoj Kumar Tiwari

School of Water Resources

Indian Institute of Technology Kharagpur

Outline…

- Motivation
- Present Status (as per NJJM)
- Water Stress and Water Scarcity
- Conventional and Non-Conventional Sources or Water
- Surface and Groundwater Available in India
- Water Budgeting
- Accounting of Water Supply and Uses
- Key Remarks

The First Question: Why Are We Here ?

- We all acknowledge that people in many parts of India are facing challenges with ***too little and too polluted*** water.
- We are willing to contribute to society for resolving al least part of these challenges.

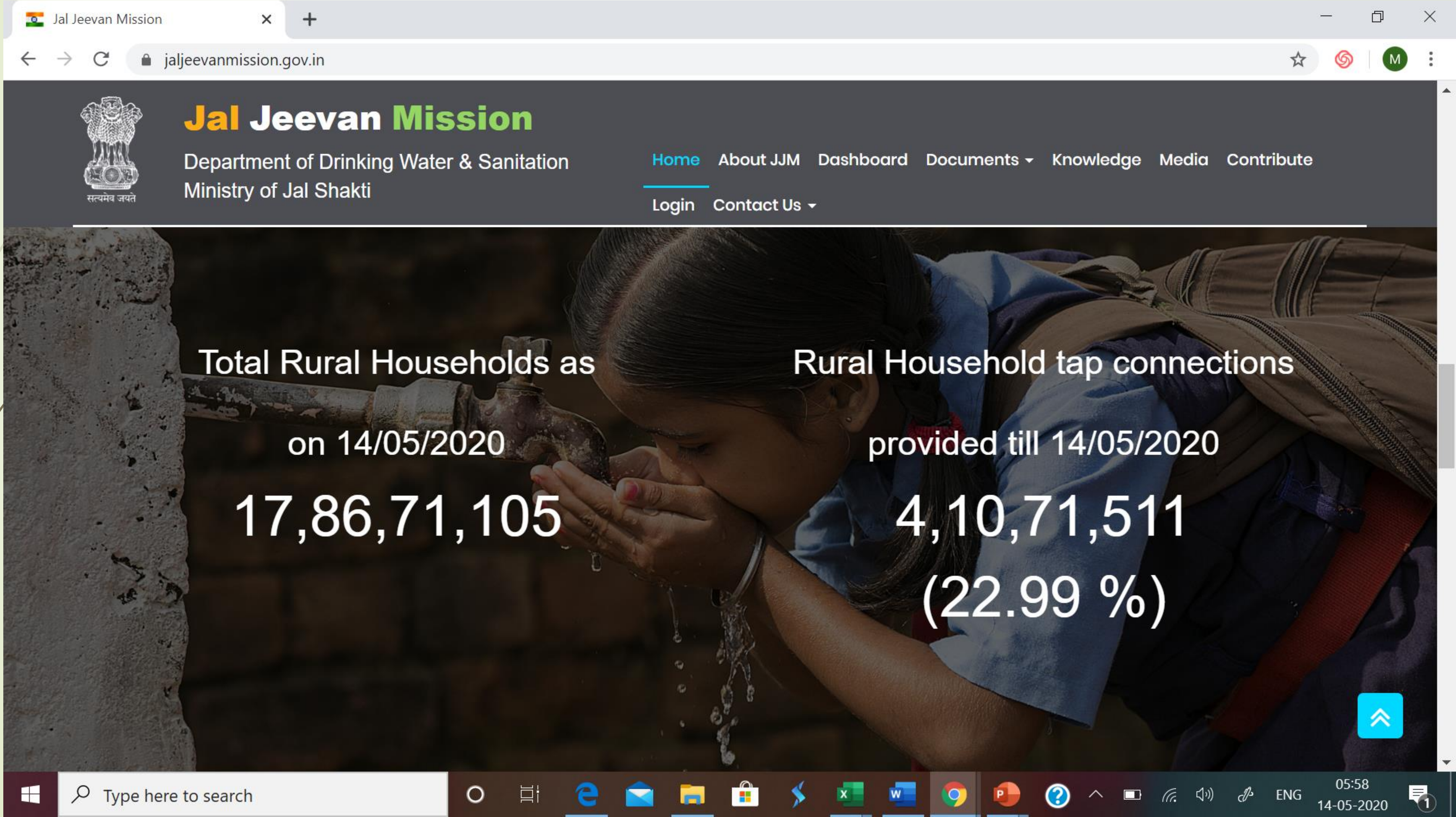
Where We Can Help ?

- **Judicious Supply and Uses**
- **Protection of Resources**
- **Effective and Efficient Management**
- **Be a Responsible Citizen**

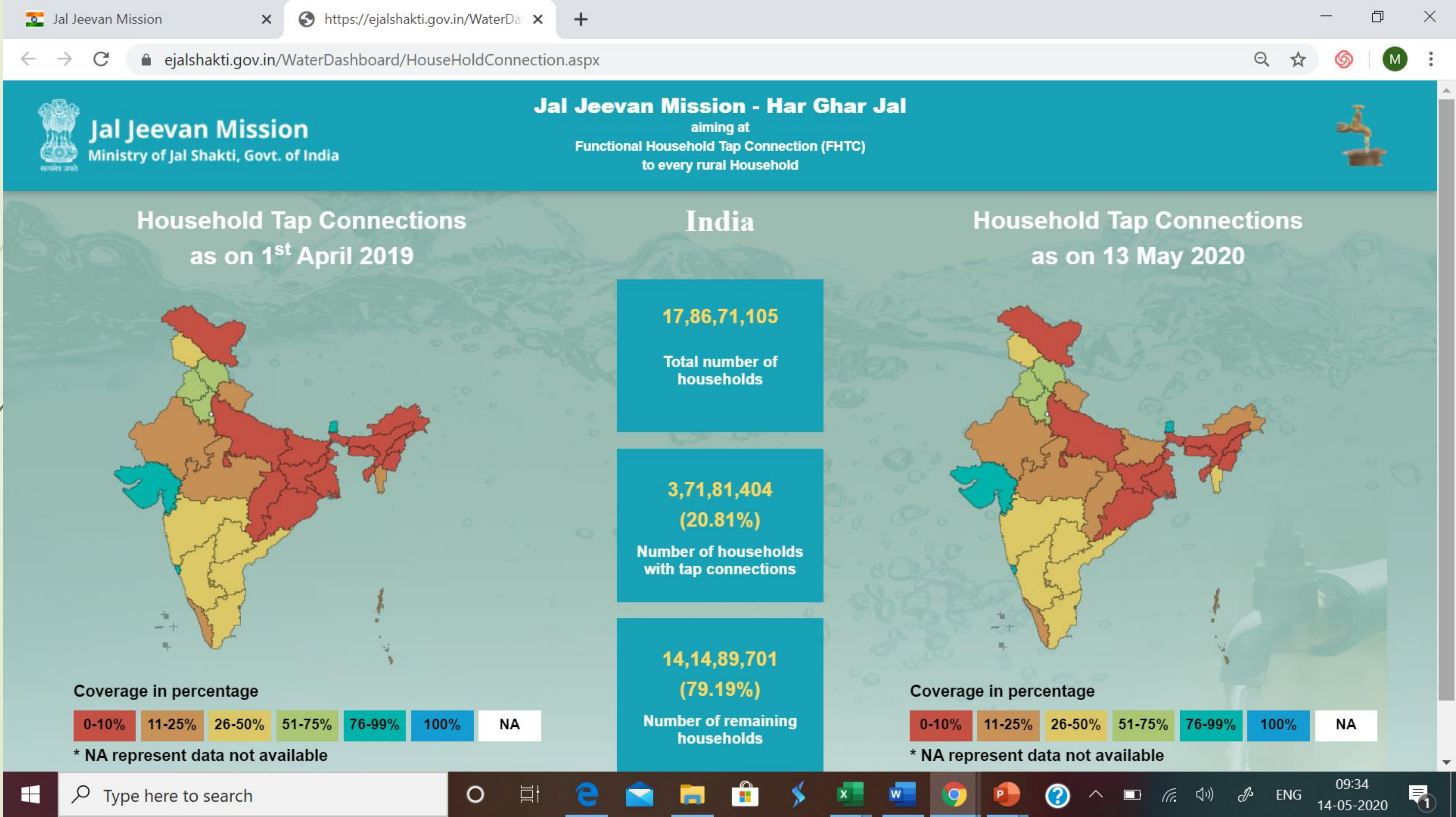
Acquire awareness and knowledge about water sources, sectoral demands, availability, supply systems and governance.

Image Source: https://www.mrgscience.com/ess-topic-42-access-to-fresh-water.html

Present Status



Present Status



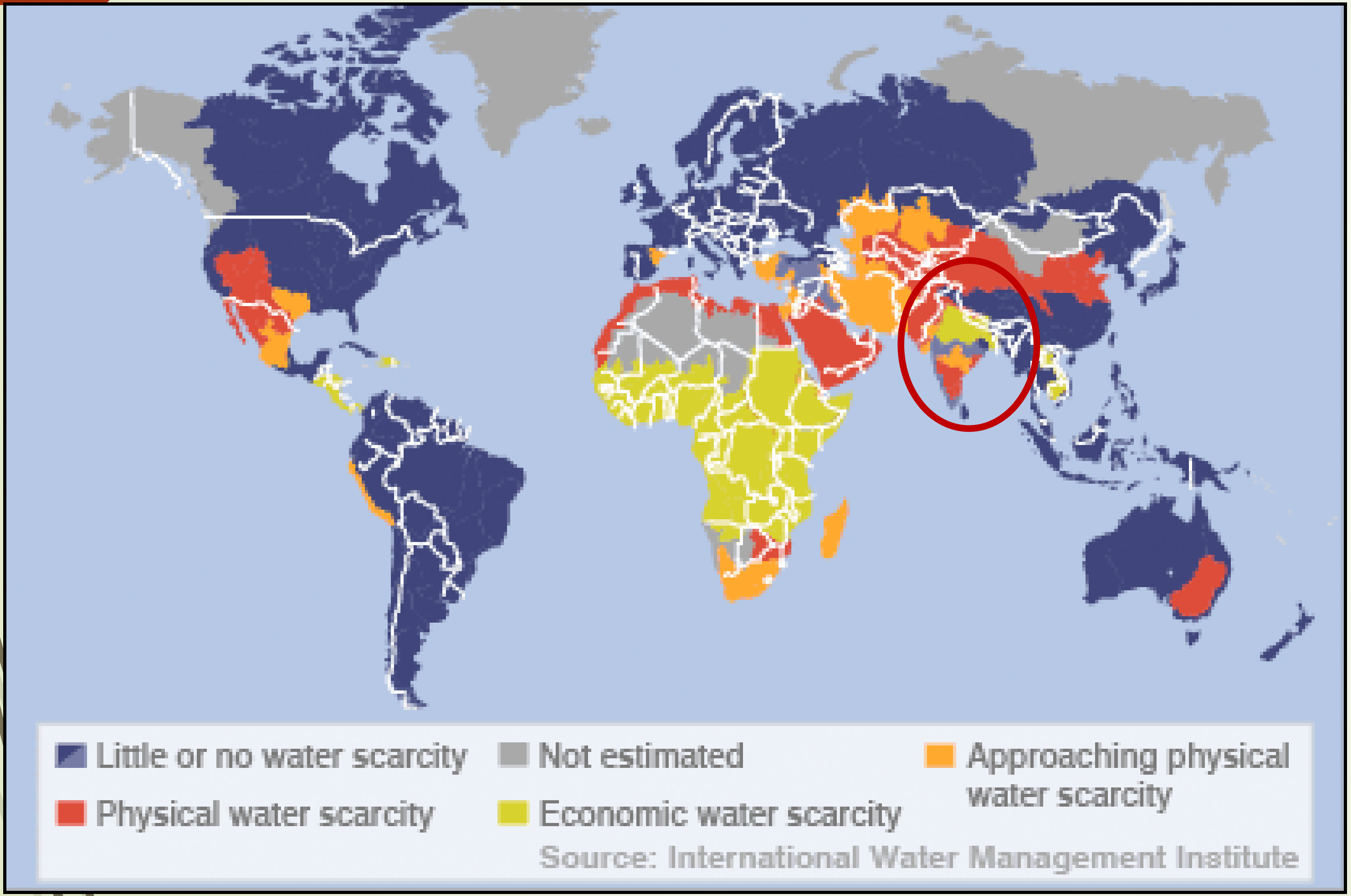
Water Stress and Water Scarcity

- **As per international norms:**
  - Per capita availability <1700 m^3 per year: Water stressed country
  - Per capita availability <1000 m^3 per year: Water scarce country

Water scarcity can mean:

- Scarcity in availability due to physical shortage, or
- Scarcity in access due to the failure of institutions to ensure a regular supply, or
- Scarcity due to a lack of adequate infrastructure.

Water Stress and Water Scarcity



Physical Scarcity

Physical access to water is limited.

Economic Scarcity

Population does not have the necessary monetary means to utilize an adequate source of water. (unequal distribution of resources for many reasons, including political and ethnic conflict).

Image Source: https://thewaterproject.org/water-scarcity/water_scarcity_2

What Do We Need for Setting-up a Water Supply System

- ***Water Demand*** – How much water to extract from source
- ***Water Source*** – What are the sources available
- ***Water Intake*** – How to withdraw water from the source
- ***Water Quality*** – What treatments are required
- ***Spread of the Users*** – Where to distribute and how to distribute

Conventional Water Sources

Conventional

- Surface Waters: Rivers, Lakes, Canals, Ponds *- High Turbidity, Pathogens*
- Groundwater *- Iron, Arsenic, Fluoride, Nitrate*
- Rainwater (unregulated) *- Clean but too little*

Non-Conventional (Alternate)

- Harvested Rainwater *- Requires collection and storage system*
- Stormwater *- Similar to surface water source, --"--*
- Reclaimed Water (Reuse and Recycling) *- Requires high degree treatment*
- Seawater *- Requires desalination and transport*

Spatial and Temporal Distribution of Rainfall

Annual Mean Rainfall in India

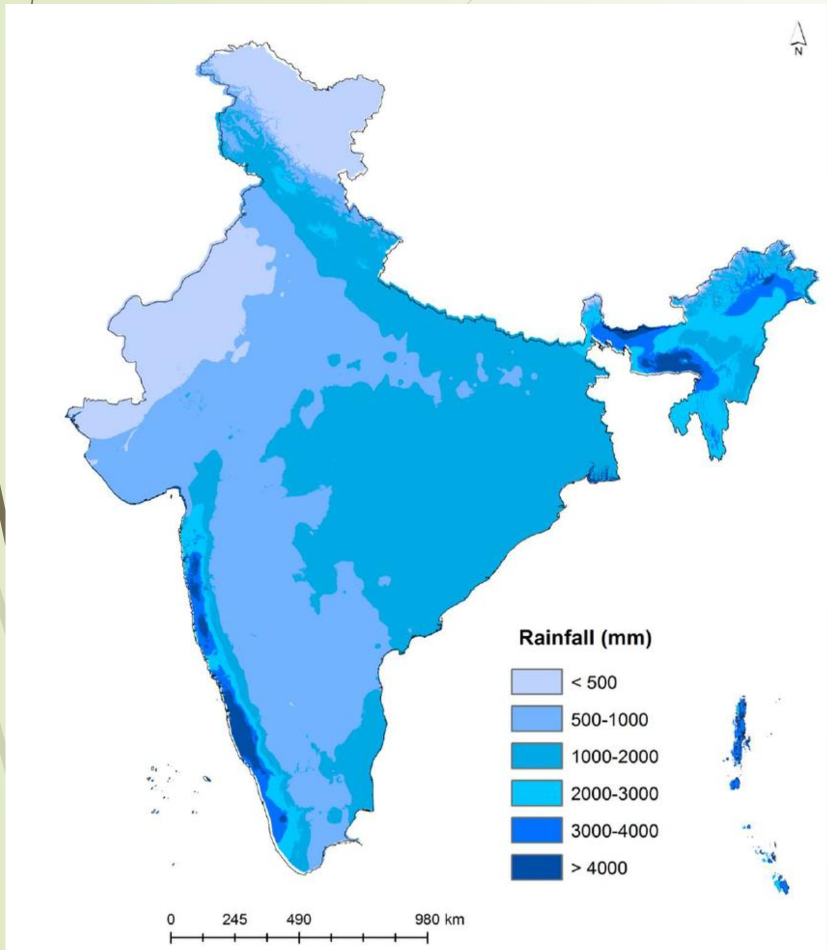


Image Source:
Nationwide classification of forest types of India using remote sensing and GIS, Environmental Monitoring and Assessment 187(12).

Temporal Distribution of Rainfall in India (2000-2014)

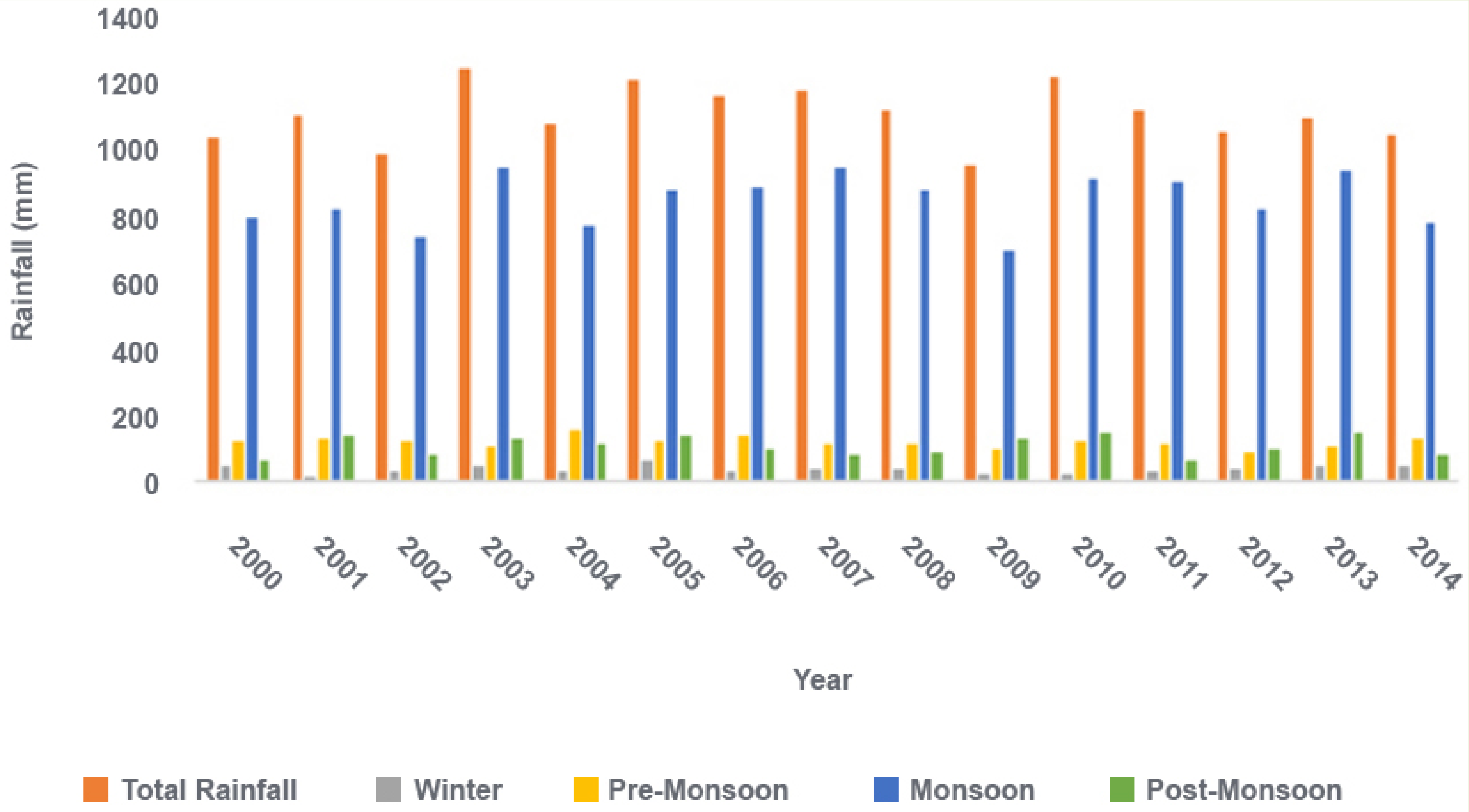


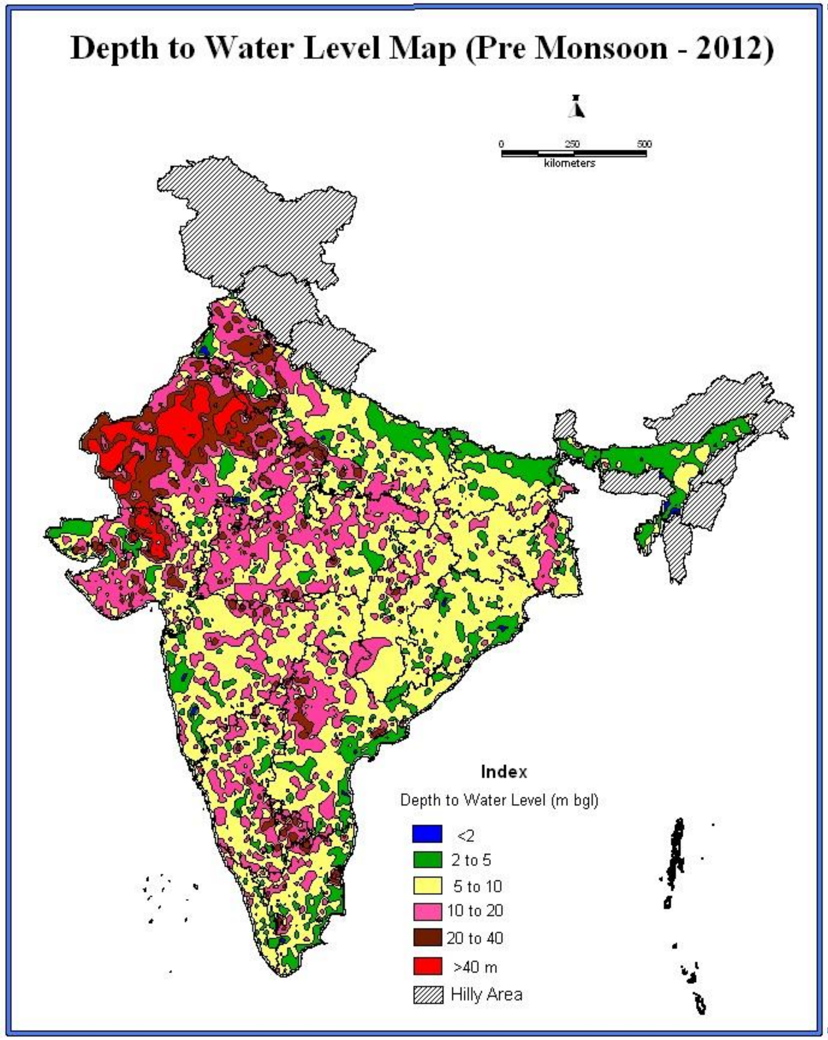
Image Source: https://www.adriindia.org/adri/india_water_facts

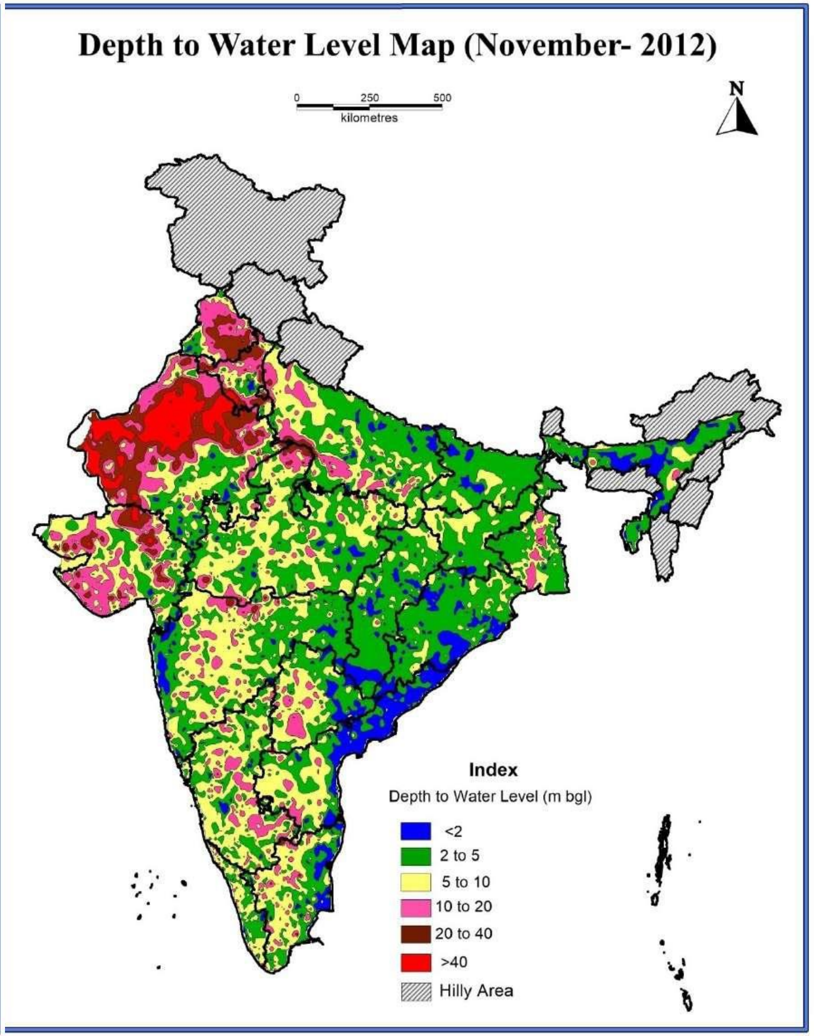
Major River Basins of India

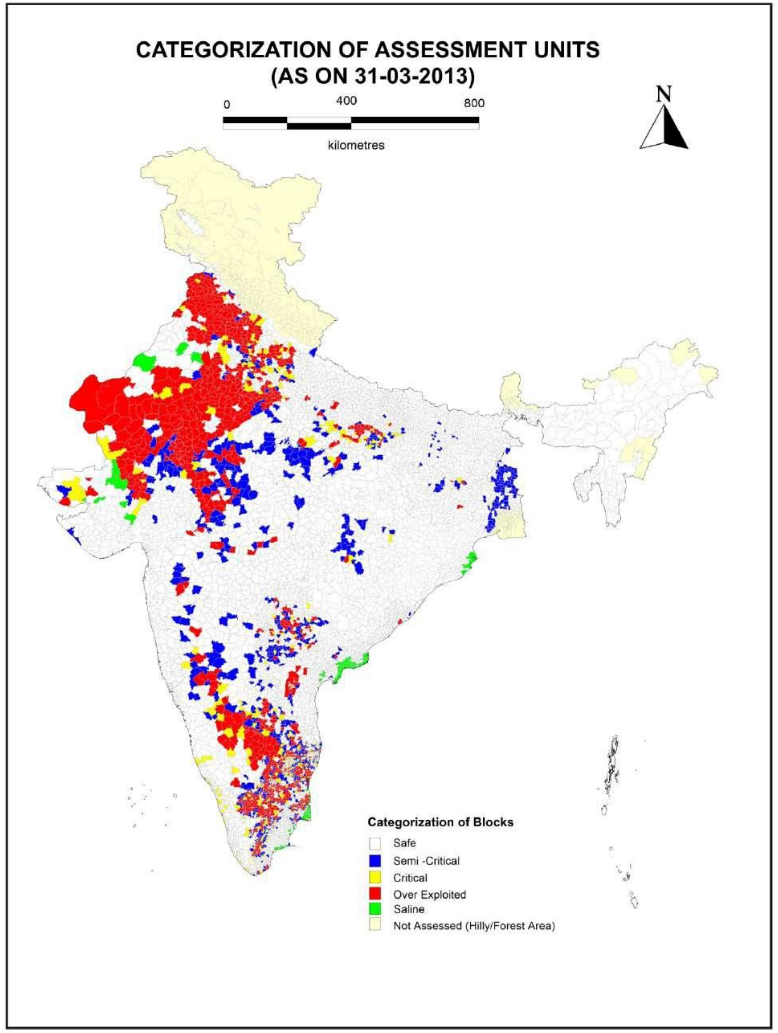
Sl. No.	River Basin	Catchment area (sq.km)	Avg. Water Resources Potential (BCM)	Utilizable surface water resources (BCM)
1	Indus (up to border)	321289	73.31	46
2	a) Ganga	861452	525.02	250
	b) Brahmaputra	194413	537.24	24
	c) Barak & Others	41723	48.36	
3	Godavari	312812	110.54	76.3
4	Krishna	268948	78.12	58
5	Cauvery	81155	21.36	19
6	Subarnarekha	29196	12.37	6.8
7	Brahamani & Baitarni	51822	28.48	18.3
8	Mahanadi	141589	66.88	50
9	Pennar	55213	6.32	6.9
10	Mahi	34842	11.02	3.1
11	Sabarmati	21674	3.81	1.9
12	Narmada	98796	45.64	34.5
13	Tapi	65145	14.88	14.5
14	West flowing rivers From Tapi to Tadri	55940	87.41	11.9
15	West flowing rivers from Tardi to Kanyakumari	56177	113.53	24.3
16	East flowing rivers between Mahanadi & Pennar	86643	22.52	13.1
17	East flowing rivers between Pennar and Kanyakumari	100139	16.46	16.5
18	West flowing rivers of Kutch and Saurastra	321851	15.1	15
19	Area of inland drainage of Rajasthan	36202	0	NA
20	Minor river basins draining in to Myanmar & Bangladesh		31	NA
	Total		***1869.35***	***690.1***

Source: Central Water Commission (2010)

Groundwater Resources of India







Images Source: http://nwa.mah.nic.in/sdmc/availability/groundwater.htm

Water Budgeting

- **Based on law of mass conservation**

- Within a confined domain: **Water In = Water Out ± Change in Storage – Water Losses**

- General Hydrological Water Balance:
  Precipitation = Runoff + Evapotranspiration + Change in storage in soil or bedrock

- In simpler terms:
  Rainfall = Surface Water Stock + Infiltration + Evapotranspiration + Runoff Flowing Out

  - ***Water In*** → Rainfall, River/Canal water flowing in, Groundwater in
  - ***Water Out*** → Evapotranspiration, River/Canal water flowing out, Groundwater recharge, Used water discharged out

Water Budgeting: Sustainable Withdrawal Limits

- **For Source Sustainability: Water Withdrawal = Water Recharged**
- Water Recharge to surface water resources (lakes, ponds, rivers) takes place through through either runoff or from groundwater (for gaining streams or lakes)
  - There are various standards methods and models to estimate runoff, depending on rainfall intensity and frequency, catchment area, land used classes, type of subsurface soil and rock matrix, surface topology etc.
- Recharge to groundwater is through infiltration/seepage.
  - Infiltration can also be measured (using infiltrometers) or estimated through models, and depends on similar factors listed above.
- Groundwater volume monitoring is difficult and complicated. Often groundwater table is taken as proxy measure of the groundwater quantity. The rise and fall in the groundwater table indicates the groundwater recharge or groundwater depletion.

Accounting of Water Supply and Uses

In a given time frame:

Source Stage		Supply Stage		Uses Stage		Post-Uses Stage
Water withdrawn from surface water Source + Groundwater pumped in + Recycled wastewater + Harvested Rainwater pumped in + Other Sources	=	Supplied to households (domestic consumption) + Supplied for irrigation (agri. consumption) + Other consumptions (Industrial/Institutional/ commercial/public places) + Water loss in treatment (if any), and supply	=	Total water consumed + Total wastewater generated + Water infiltrated (prominent for irrigation) + Water loss during uses + Water loss in treatment (if any), and supply	=	Treated wastewater recycled + wastewater discharged + Losses during wastewater treatment + Water loss during uses + Water loss in treatment (if any), and supply

Water Audit of Piped Water Supply System

International Water Association (IWA) and American Water Works Association (AWWA) Approach

<table>
<tr><td rowspan="8">Volume from Own Sources (corrected for known errors)</td><td rowspan="11">System Input Volume</td><td>Water Exported (corrected for known errors)</td><td colspan="3">Billed Water Exported</td><td>Revenue Water</td></tr>
<tr><td rowspan="10">Water Supplied</td><td rowspan="4">Authorized Consumption</td><td rowspan="2">Billed Authorized Consumption</td><td>Billed Metered Consumption</td><td rowspan="2">Revenue Water</td></tr>
<tr><td>Billed Unmetered Consumption</td></tr>
<tr><td rowspan="2">Unbilled Authorized Consumption</td><td>Unbilled metered Consumption</td><td rowspan="8">Non-revenue Water</td></tr>
<tr><td>Unbilled unmetered consumption</td></tr>
<tr><td rowspan="6">Water Losses</td><td rowspan="3">Apparent Losses</td><td>Systematic Data Handling Errors</td></tr>
<tr><td>Customer Metering Inaccuracies</td></tr>
<tr><td>Unauthorized Consumption</td></tr>
<tr><td rowspan="3">Water Imported (corrected for known errors)</td><td rowspan="3">Real Losses</td><td>Leakage on Transmission and Distribution Mains</td></tr>
<tr><td>Leakage and Overflows at Utility's Storage Tanks</td></tr>
<tr><td>Leakage on Service Connections up to the point of Customer Metering</td></tr>
</table>

NOTE: All data in volume for the period of reference, typically one year.

Water Budgeting: Key Remarks

- Different uses of water have different priorities, and basic minimum domestic demand is the most indispensable (top priority).

- Where water is in sufficient supply, all classes of demand may be satisfied (though keeping resource sustainability intact). However, a more careful and judicious water allocation is needed in water stressed regions.

- It is very important to carry out water budgeting before allocating water to different user classes, so that stakeholders have overall idea of available water, and demand and supplies may be managed to oversee the future sustainability.

- Although its difficult to have precise estimate of various water budgeting components for small catchments (like village), simple monitoring and calculation may provide a fair idea of water availability at various resources.

- In order to avoid additional stress on natural water resources, non-conventional resources, especially harvested rainwater and recycled wastewater, must be developed and utilized to their potential.

THANK YOU !

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Estimation of Domestic Water Demand

Manoj Kumar Tiwari

School of Water Resources

Indian Institute of Technology Kharagpur

Outline…

- Need of Water Demand Estimation
- Guidelines on Per Capita Water Demand
- Fluctuations in Water Demand
- Water Demand Estimation for Piped Water Supply System

Need for Estimating Water Demand

- Water services are usually established in advance for future.

- The kind of infrastructure and set-up needed *(pumping power, reservoir capacity, pipe sizes, treatment plant capacity etc.)* will depend on water demand to be fulfilled.

- **Under-estimation leads to inadequate design** whereas **over-estimation results in uneconomical and inefficient water systems.**

- **Therefore, it is important to estimate the water demand to the best accuracy possible for the life period of the water projects.**

Image Source:
https://wwtonline.co.uk/news/innovation-could-reduce-water-consumption-by-two-thirds-says-ofwat

Concept for Estimation of Domestic Water Demand

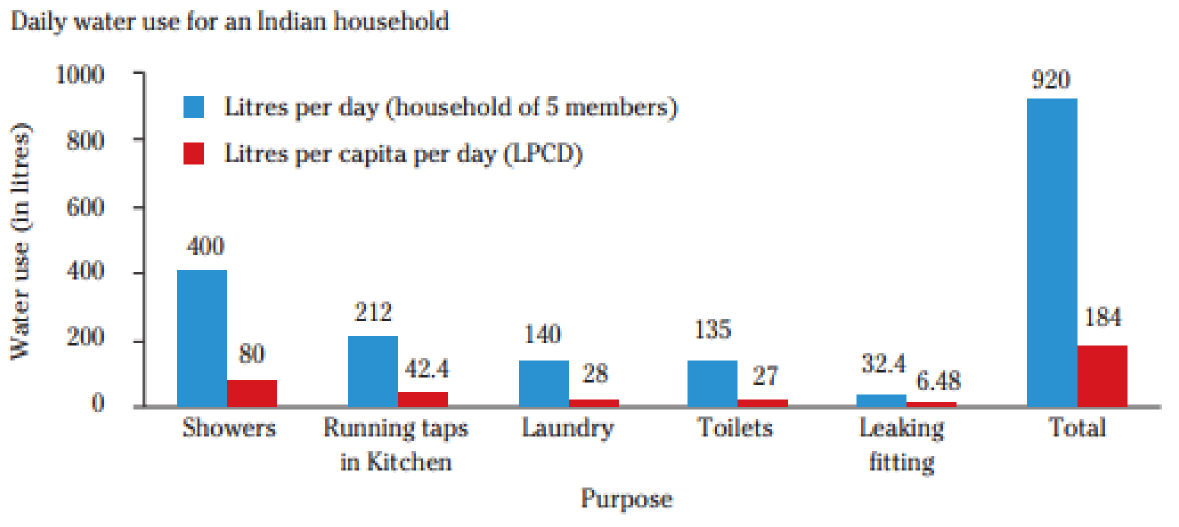
- **Quantity of water required for domestic activities depends on:**
  - Consumption rate (Per capita demand in litres/day/head).
  - Total population to be served (at the end of design period).
- **Quantity Required = Per capita demand x Total Population**
- **Additional demands such as Fire-fighting, Institutional and Industrial needs, losses etc.) is added.**
- **Water requirements are never constant, thus fluctuations and variations in water demand must be given due consideration.**

Per Capita Domestic Water Consumption

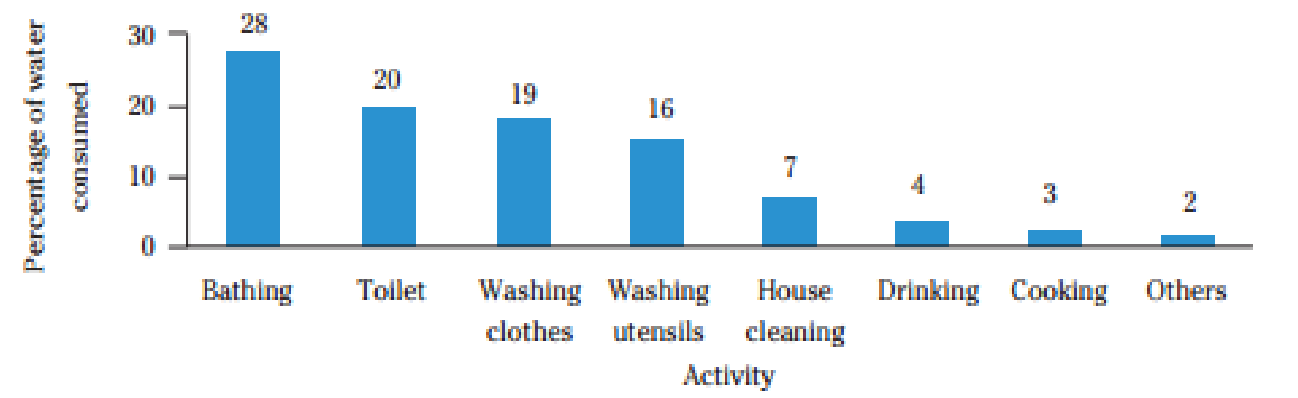
S. No.	Use/purpose	Quantity, L/c-d
1.	Drinking	05
2.	Cooking	05
3.	Bathing	55
4.	Laundry	20
5.	Utensils washing	10
6.	House washing	10
7.	Toilet washing, etc.,	30
	Total	135 L/c-d

Source: IS 1172–1983: Code of basic requirements for water supply, drainage and sanitation—Bureu of Indian standards

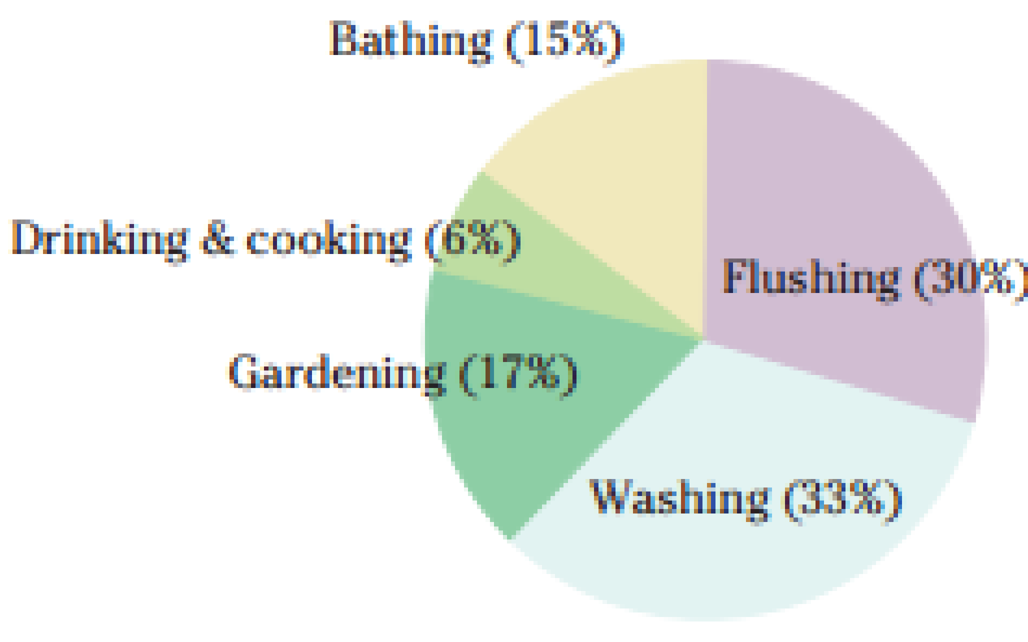
Per Capita Domestic Water Consumption: Variations



Source: Shah. S, Thakar. D, and Panda. S, 2009, Water Audit – Need of the Hour, Tata Consulting Engineering, Mumbai,



Source: Shaban. A, 2008, Water Poverty in Urban India: A Study of Major Cities, In: UGC-Summer Programme, June 30-July 19, 2008, Jamia Millia Islamia, New Delhi



Source: CPHEEO Manual on Water Supply and Treatment - 1999

Commercial and Institutional Water Demand

Sl. No.	Institutions	Liters per head per day
1.	Hospital (including laundry)	
.	(a) No. of beds exceeding 100	450 (per bed)
	(b) No. of beds not exceeding 100	340 (per bed)
2.	Hotels	180 (per bed)
3.	Hostels	135
4.	Nurses' homes and medical quarters	135
5.	Boarding schools / colleges	135
6.	Restaurants	70 (per seat)
7.	Air ports and sea ports	70
8.	Junction Stations and intermediate stations where mail or express stoppage (both railways and bus stations) is provided	70
9.	Terminal stations	45
10.	Intermediate stations (excluding mail and express stops	45 (could be reduced to 25 where bathing facilities are not provided)
11.	Day schools / colleges	45
12.	Offices	45
13.	Factories	45 (could reduced to 30 where no bathrooms are provided)
14.	Cinema, concert halls and theatre	15

Source: CPHEEO Manual on Water Supply and Treatment - 1999

Fire Fighting Water Demand

- The rate of fire demand is often treated as a function of population
- The per capita fire demand is very less, but the rate at which the water is required is very high.
- **As per the Indian Standard, IS: 9668-1990:**
  For towns/cities the water for fire fighting shall be provided at the scale of 1800 litres per minute for every 50 000 population or part there of for towns up to 3 lakhs population and an additional 1800 litres per minute for every 1 lakh population of more than 3 lakhs. A storage for 4 to 24 hours duration at this rate may be provided to meet the fire demand.
- **As per the CPHEEO Manual on Water Supply and Treatment:**
  It is usual to provide for fire fighting demand as a coincident draft on the distribution system along with the normal supply to the consumers as assumed. A provision in ***kiloliters per day based on the formula of 100√P where, P = population in thousands*** may be adopted for communities larger than 50,000.

Water Demand: Design Guidelines

- **As par IS 1171-1983, following range of demand is considered for domestics and non-domestic needs in India:**

1. For communities with populations up to 20,000 and without flushing system:
   a. Water supply through stand post: 40 lpcd (Min)
   b. Water supply through house service connection: 70 to 100 lpcd
2. For communities with population 20,000 to 100,00 together with full flushing system: 100 to 135 lpcd
3. For communities with population above 100,000 together with full flushing system: 150 to 200 lpcd

Water Demand: Other Suggested Standards

S. No	Agency	Physical Standard
1	Manual on water supply and Urban Deve lopment, Govt. of India, 1991	• Small cities: 70-100 lpcd" • Large cities: 150-200 lpcd • Public stand Posts (PSP): 40 lpcd
2	National Master Plan (NMP), India, International Water Supply and Sanitation Decade, 1981-90, MoUD, 1983	House connections: • 70-250 lpcd (average of 140 lpcd) • Public stand Posts: 25-70 lpcd (average 40 lpcd)
3	Basic Minimum Services Under Minimum Needs Programme, 9th Five Year Plan, Government of India, 1997-2002 (1999)	100 per cent coverage by safe drinking water in urban areas. • With Sewerage: 125 lpcd • Without Sewerage: 70 lpcd • With spot sources & public stand posts: 40 lpcd
4	Report on Norms and Space Standards for Planning Public Sector Project Towns, TCPO, Ministry of Works & Housing, Government of India, 1974	• 180 lpcd
5	Committee on Plan Projects for Industrial Townships (COPP), 1973	• 180-225 lpcd

Source: cseindia.org/userfiles/buildings.pdf

Water Demand: Other Suggested Standards

S. No	Agency	Physical Standard
6	Zakaria Committee (ZC on Augmentation of Financial Resources of Urban Local Bodies, 1963.	• Small: 45 lpcd • Medium: 67.5 - 112.5 lpcd • Large : 157.5-202.0 lpcd • Super metropolitan: 270 lpcd
7	Operations Research Group (ORG), Delivery and Financing of Urban Services, 1989	• Small: 80 lpcd • Medium: 80-150 lpcd • Large: 180 lpcd
8	National Institute of Urban Affairs (NIUA); Maintaining Gujarat Municipal Services - A Long Range Perspective, 1987	• Small: 95-125 lpcd • Medium: with Industrial base - 150 lpcd ▪ Problem areas: 90 lpcd; ▪ Average: 80-150 lpcd • Large: With Industrial base 170-210 lpcd ▪ Problem Areas: 120-125 lpcd ▪ Average: 115-210 lpcd
9.	World Health Organization (WHO), 2003	• no access (water available below 5 lpcd) • basic access (average approximately 20 lpcd) • inter-mediate access (average approximately 50 lpcd) • optimal access (average of 100-200 lpcd)

Source: cseindia.org/userfiles/buildings.pdf

Fluctuations in Domestic Water Demand

Average Daily Per Capita Demand = Quantity Required in a Year / (365 x Population)

If this average demand is supplied at all the times, it will not be sufficient to meet the fluctuations in the water demand, which could be due to:

- **Seasonal or Monthly Variation:** *Considers season specific high or low demand*
- **Daily Variation:** *Considers day-to-day variations in water demand*
- **Hourly Variation:** *Considers time dependent variations in water demand on a day. Also considers instantaneous variation in the demand.*

Fluctuations in Domestic Water Demand

Average Daily Per Capita Demand

= Quantity Required in 12 Months/ (365 x Population).

Maximum daily demand

=1.8 x average daily demand

Maximum hourly demand of maximum day i.e. Peak demand

= 1.5 x average hourly demand on a maximum day

= 1.5 x Maximum daily demand/24 = 1.5 x (1.8 x average daily demand)/24

= 2.7 x average daily demand/24 **= 2.7 x annual average hourly demand**

Note: Daily and Hourly peak factors may vary in different regions/conditions

Water Demand Estimation for Piped Water Supply System

- The service life of the system must be established before we estimate water demand. The future period, for which the provisions are made in the water supply scheme, is known as the design or service period.

- Design period is estimated based on, useful life of the components considering their obsolescence, wear and tear, expandability and development aspect of the city, available resources etc.

- The capacity of water supply schemes are based on the projected population of that particular area. As over the years the population of the area is ever changing, the system capacity should be computed by considering of the population at the end of the service period, or end of the first phase duration (before next phase extension is likely to be implemented).

- After collecting the present and past population record for the area (from census population records), the population at the end of design period can be predicted using various methods by considering the population growth pattern of the concerned area.

- The average demand is estimated by multiplying estimated population with per capita demand. Maximum demand may be computed by multiplying average demand with applicable peak factors.

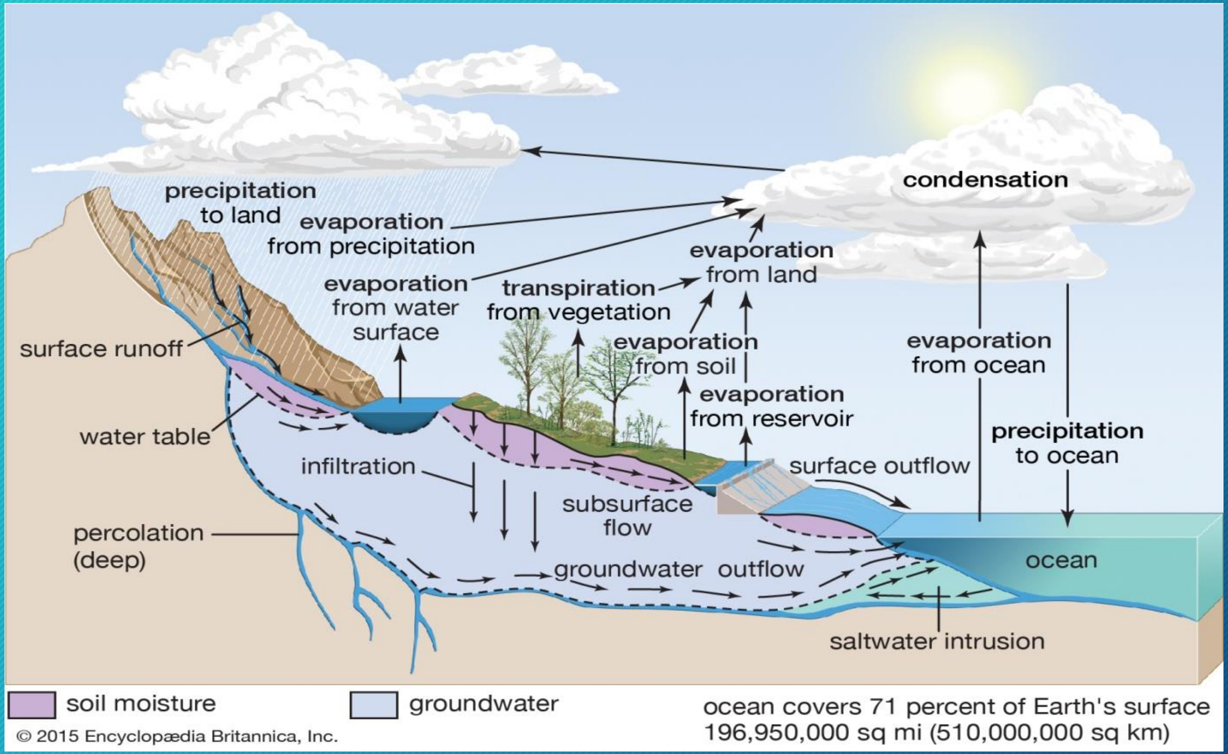
THANK YOU !

Water resource management

Estimation of water availability at village scale

Preparation of surface water and groundwater budget at the village level.

Estimation of the total water source available at the cluster level (small river, pool, puddle , canal, underground water source, etc.)



Water Consumption: Compute the total water demand of the area

<u>Domestic uses (drinking, washing kitchen gardening etc.)</u>

1. How much water consumed per capita for drinking , cooking?
2. How much water consumed in cleaning and washing house ?
3. How much water consumed in gardening ?
4. Number of hand pump and bore well/tube wells in village
   - There working hours and capacity
   - Depth of water level and boring.

Factors affecting per capita demand

- Size of the village: Per capita demand for big villages is generally large as compared to that for smaller towns as big villages have sewered houses.
- Presence of industries.
- Climatic conditions.
- Habits of people and their economic status.
- Quality of water: If water is aesthetically & medically safe, the consumption will increase as people will not resort to private wells, etc.

Factors affecting per capita demand

- Pressure in the distribution system.
- Efficiency of water works administration: Leaks in water mains and services; and unauthorized use of water can be kept to a minimum by surveys.
- Cost of water.
- Policy of metering and charging method: Water tax is charged in two different ways: on the basis of meter reading and on the basis of certain fixed monthly rate.

Water Consumption: Compute the total water demand of the area

Agricultural uses

- Collection of land use data.
- Computation of total agricultural area with different crops.
- Type of crops grown in village.
- Are farmers in the same area using different quantities for the same crop?

- How much water is consumed in farming ?
  - Is the crop currently grown is a traditional crop of the region and is suitable for the agro-climatic zone?
- Rate and frequency of irrigation ?
  - Are the crops currently grown appropriate according to the agro-climatic zone of the cluster?
- Assessment of the level of consciousness in the villagers regarding the proper use of the amount of water in irrigation

Water resources evaluation

- Survey of Nearest ponds river in the village
    - Type of water body, width and depth of river/ponds.

Other Consumptions and Data

- Consumption though animals (drinking, washing etc.)

- Industrial use of water, ex Textile Industry, Food Processing Industry, Chemical Industry, Cement Industry, Steel Industry, electricity industries, Meat processing etc.

- Evapo-transpiration of water through field apparatus

- Drainage system of village.

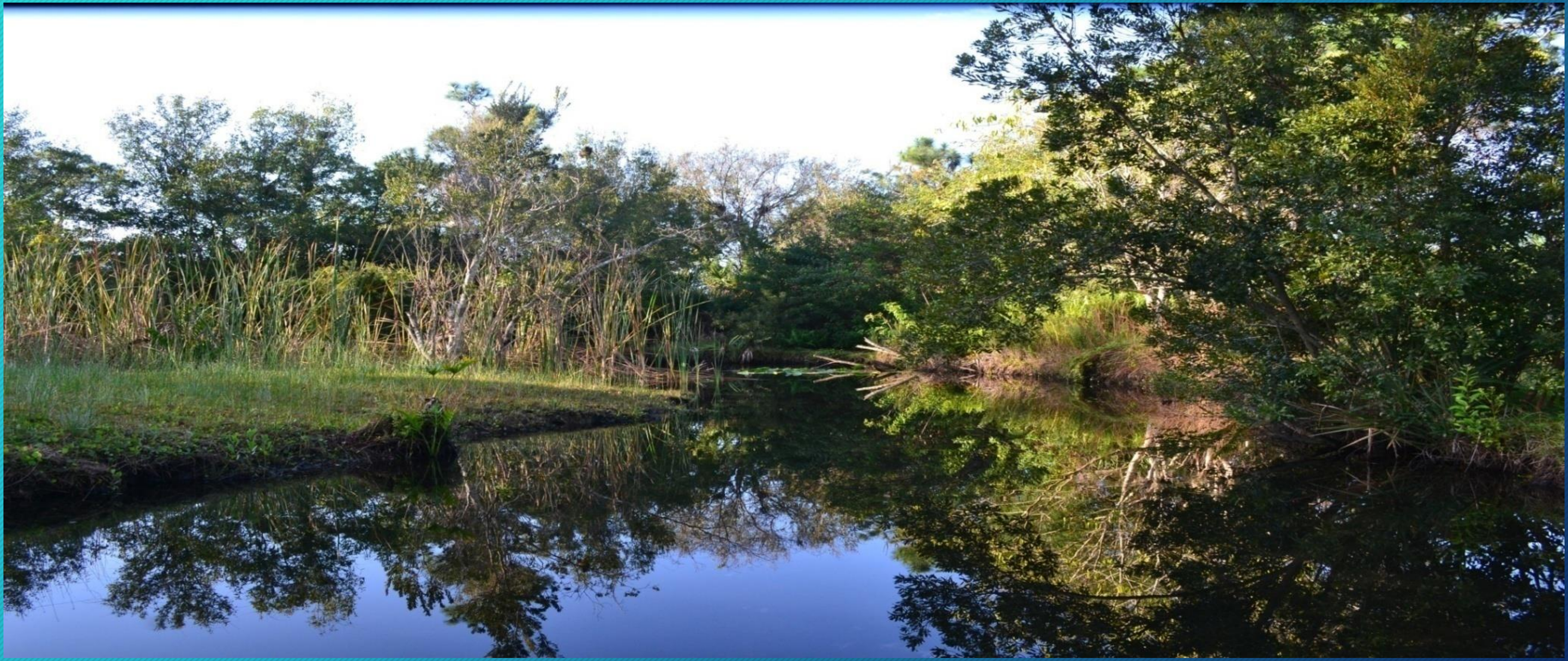
- Collect at least last two decades of data related to groundwater level.

- Collect the data of rainfall in the region in the last ten years.

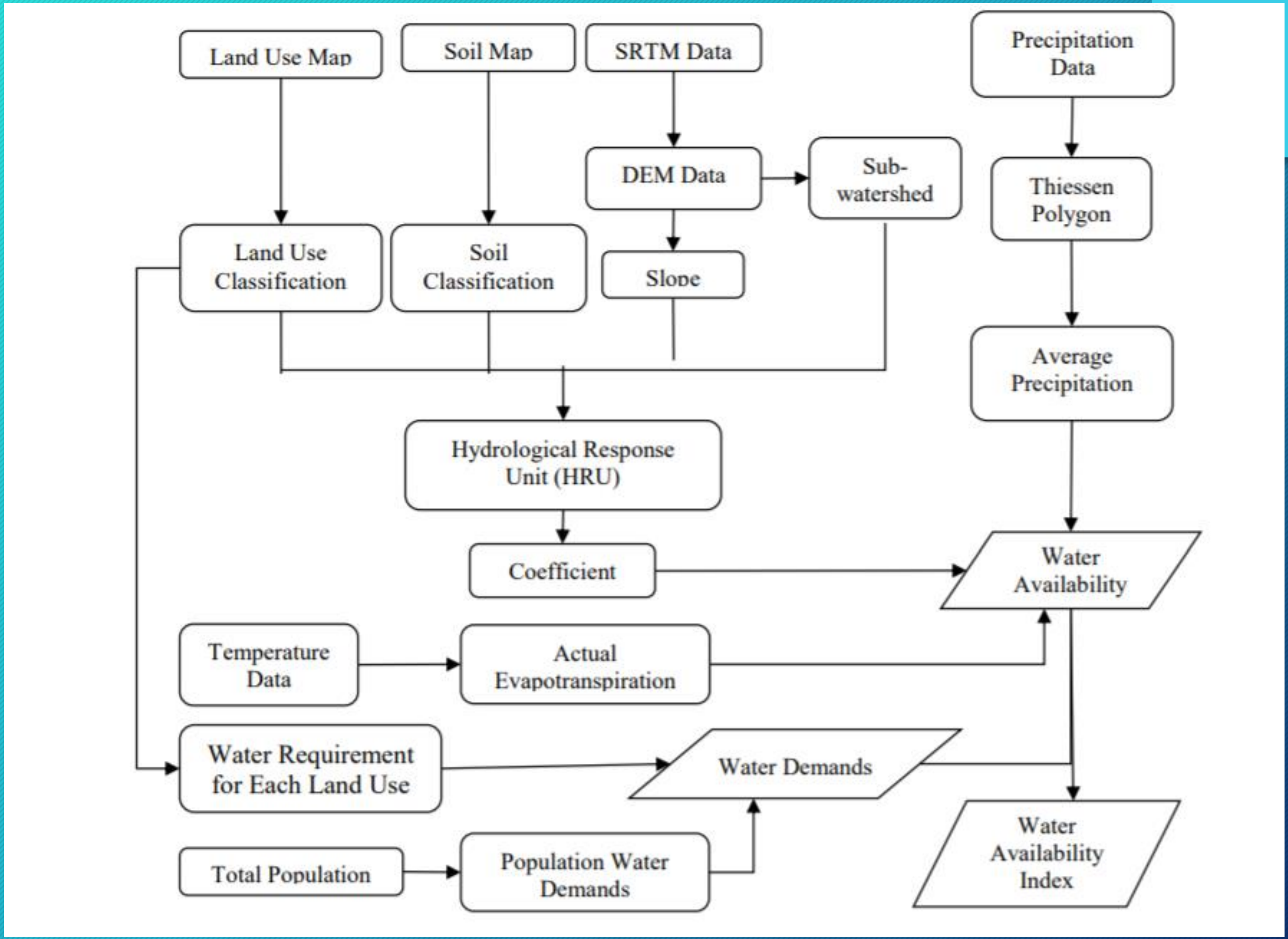
Data Preparation

•Mapping surface water sources in Packages based on the information received.

•Preparation of the map of the pond, and pond available in the village and all the information related to them such as size, quantity and quality of water, all the drains falling in it.



Factors & Workflow to calculate water availability based on GIS technology

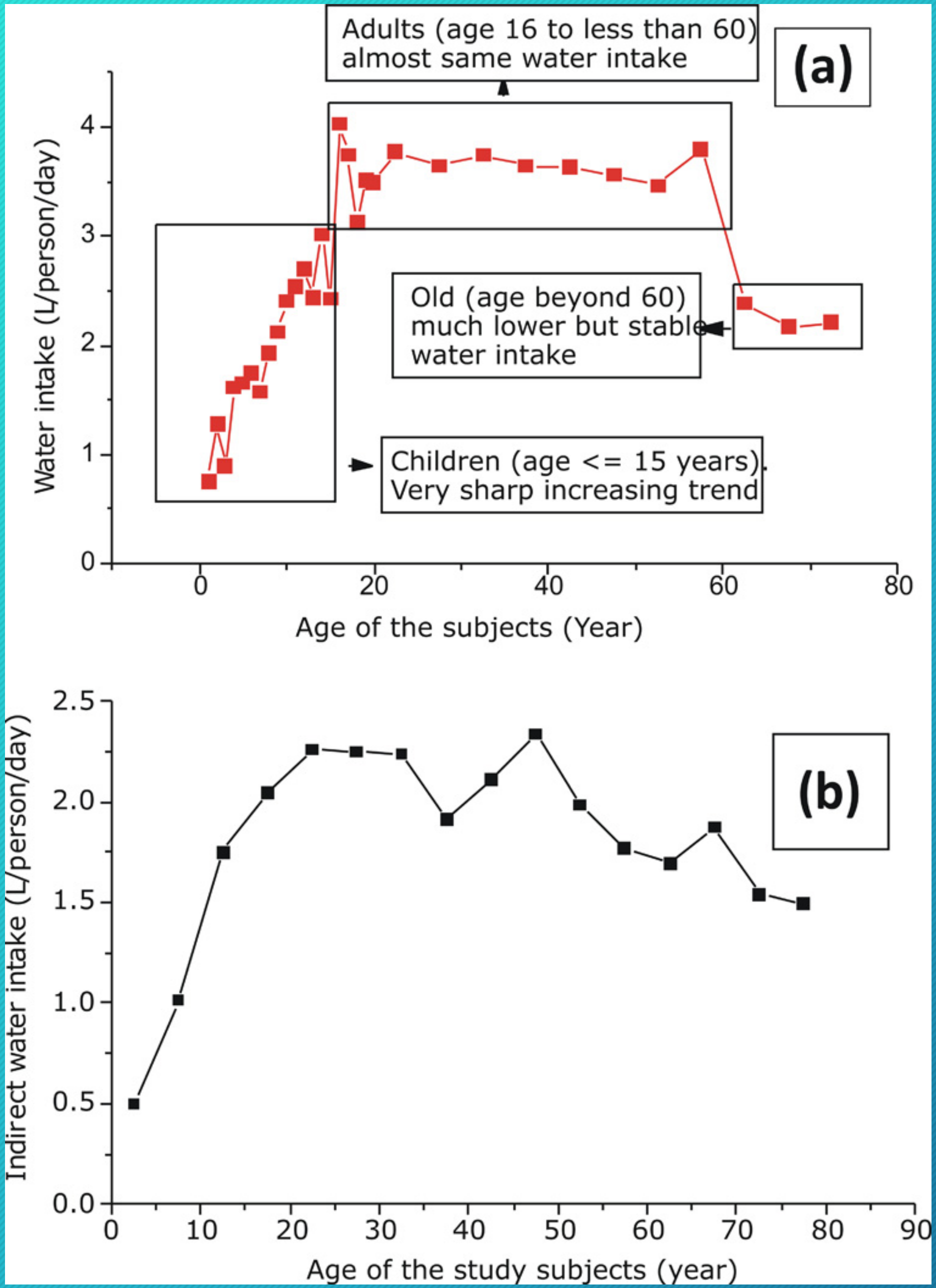


Fluctuations in Rate of Demand

Seasonal variation: The demand peaks during summer. Firebreak outs are generally more in summer, increasing demand. So, there is seasonal variation .

Daily variation depends on the activity. People draw out more water on Sundays and Festival days, thus increasing demand on these days.

Hourly variations are very important as they have a wide range. During active household working hours i.e. from 6 to 10 in the morning and 4 to 8 in the evening, the bulk of the daily requirement is taken.



Hossain MA, Rahman MM, Murrill M, et al. Water consumption patterns and factors contributing to water consumption in arsenic affected population of rural West Bengal, India. *Sci Total Environ*. 2013;463-464:1217-1224.

Water end-uses	Without conservation		With conservation		Water saving[a]
	lcd[a]	%	lcd	%	%
Bathing	61.90	53.77	43.48	54.62	18.08
Flushing WC	29.70	25.80	15.00	18.84	12.77
Brushing	8.39	7.29	6.00	7.54	
Drinking	1.63	1.42	1.63	2.05	
Cooking	4.71	4.09	4.72	5.92	
Clothes washing	6.87	5.97	6.87	8.63	
Other activities	1.92	1.67	1.92	2.41	
Total water use	115.12	100	79.61	100	30.85

[a]lcd, litres per capita per day.

[b]Calculated as percentage of the total water-use (savings for showerheads and WC retrofitting).


THANK YOU
Note : All the pictures are taken from the Google

उन्नत भारत अभियान
UNNAT BHARAT ABHIYAN

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

UBA Web-Seminar on Water Resources Management

May 14-15, 2020

Presentation on

Agriculture Water Demand Management

by

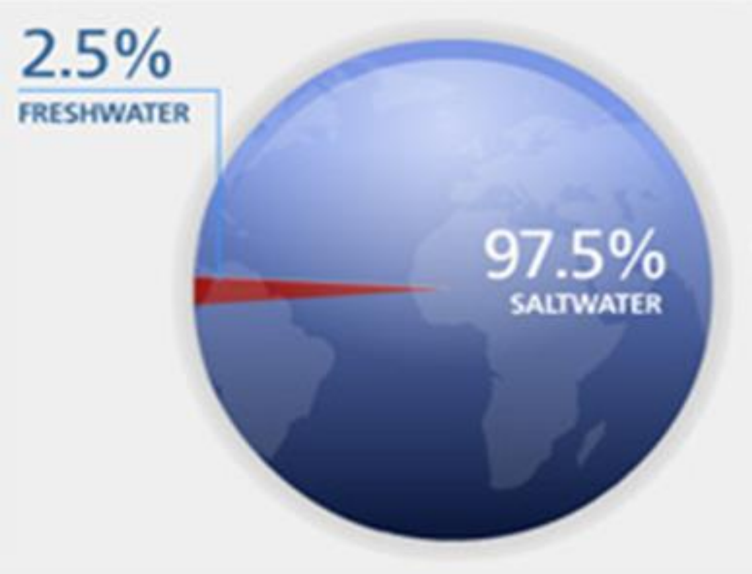
Dr. Ashish Pandey
Professor
Department of Water Resources Development and Management &
UBA Regional Coordinator

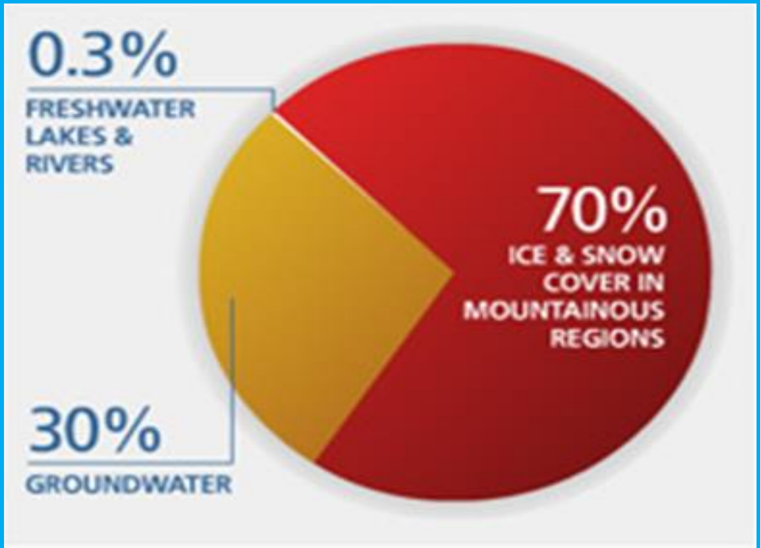
The **global** situation

Less than 3% of the world's water is fresh – the rest is seawater and undrinkable.

Of this 3% over 2.5% is frozen, locked up in Antarctica, the Arctic and glaciers, and not available to man.

- Thus humanity must rely on this 0.5% for all of man's and ecosystem's fresh water needs.





Annual Water Availability in India

Total precipitation	**4000 BCM**
Annual water availability **(after accounting for losses in the form evaporation etc.)**	**1869 BCM**
Utilizable water **(the available water cannot be fully utilized due to topographical and hydrological constraints and the need for allowing certain amount of water to flow in the river for maintaining the river regime.)**	**1123 BCM**
- **Surface water** - **Ground water**	**690 BCM** **433 BCM**

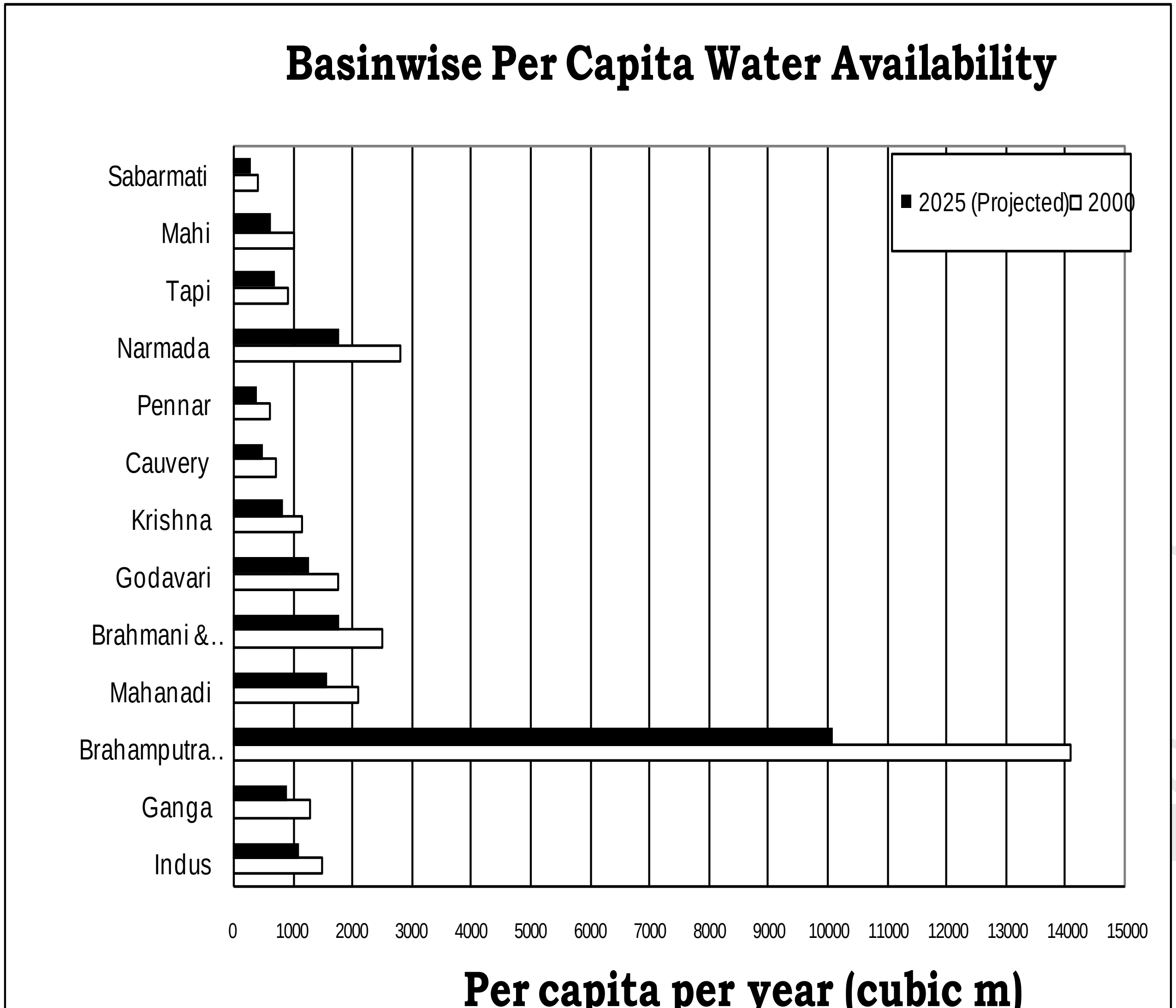
Per Capita Water Availability with Time

Year	Population (in millions)	Per Capita water availability (in cubic meter)
1951	361	5177
2001	1027	1820
2025 (projected)	1394	1341
2050 (projected)	1640	1140

India's Water Demands for Various Uses

Use	Year 2010		Year 2025		Year 2050	
	Water Demand (BCM)	% of total demand	Projected Demand (BCM)	% of total demand	Projected Demand (BCM)	% of total demand
Irrigation	557	78%	611	72%	807	69%
Domestic	43	6%	62	7%	111	9%
Industries	37	5%	67	8%	81	7%
Environment	5	1%	10	1%	20	2%
Others	68	10%	93	12%	161	13%
Total	710	100%	843	100%	1180	100%

Source: CWC/ NCIWRD



Per Capita Availability < 1700 Cubic Meter per year

- **Water Stressed**

Per Capita Availability < 1000 Cubic Meter per year

- **Water Scarce**

The Indian situation

- Groundwater [Depleted]
- Surface water [Polluted]
- Rainfall [Wasted]

- Population [→]
- Demand [→]
- Consumption [→]

↓

SCARCITY

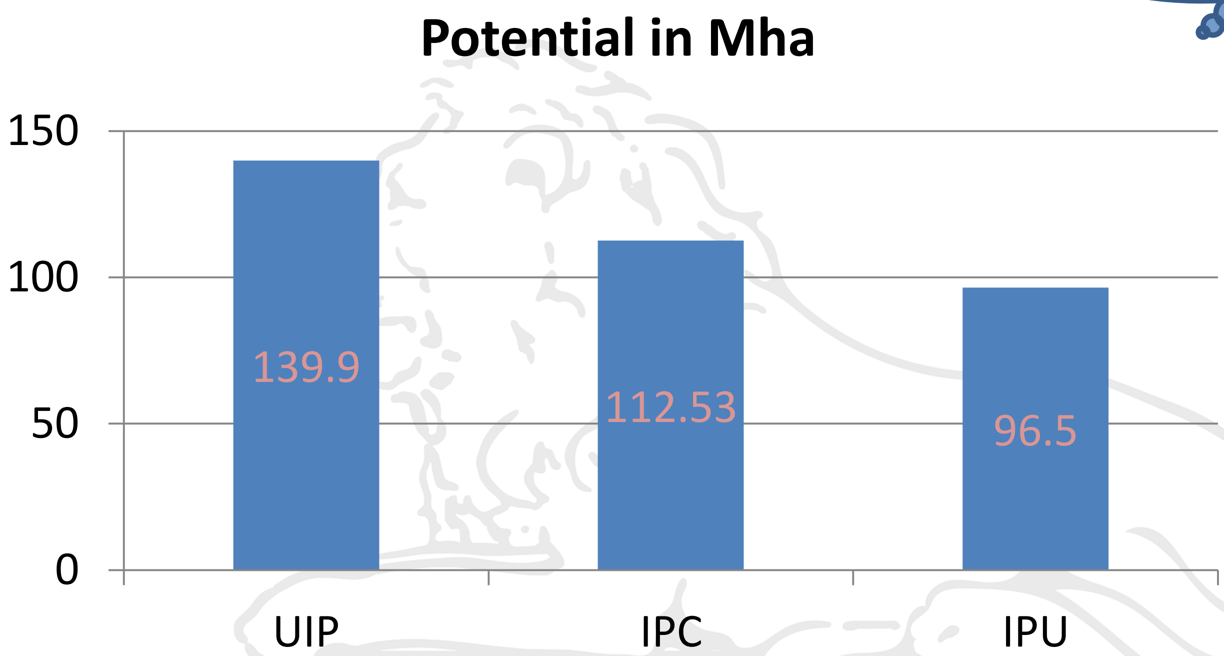
↑

- Industrial Growth [→]
- Economy-Industry [→]
- Water Business[→]

- Agriculture [←]
- Health & Environment[←]
- Future [?]

Irrigation potential development

Net Area under irrigation: 66.1 Mha



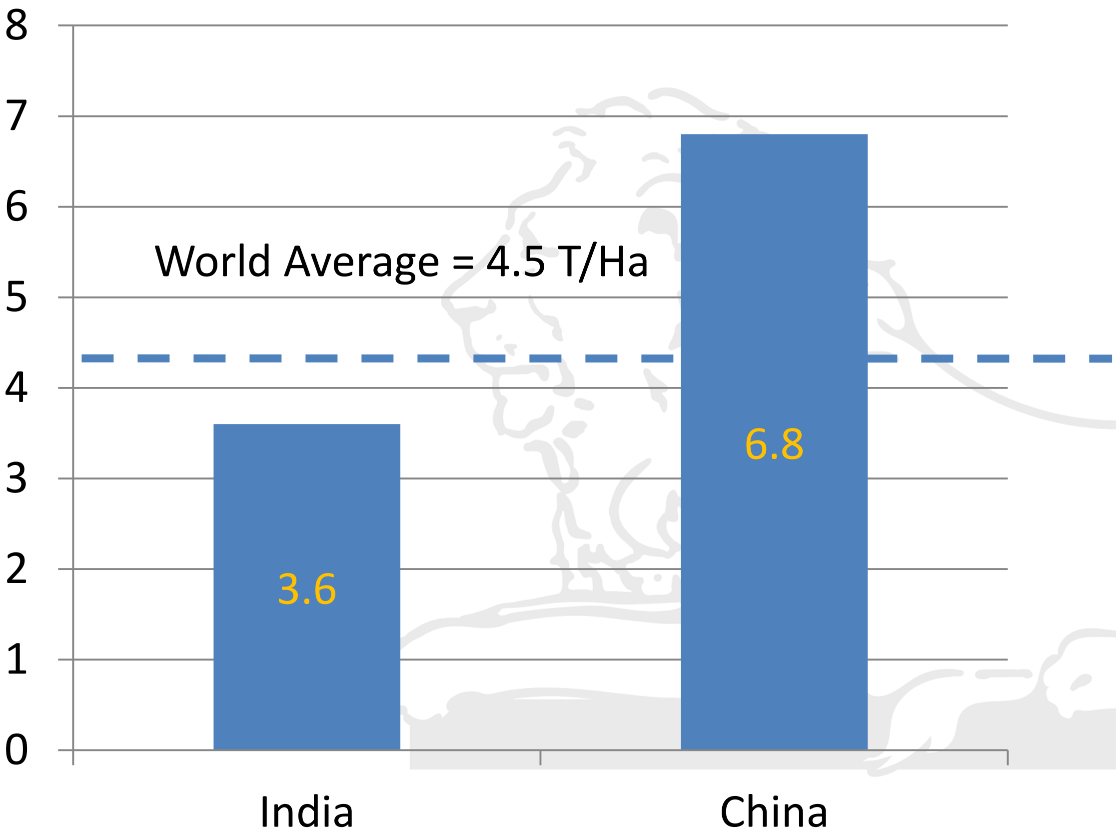
- Gap in IPC and IPU
- Low Water Use Efficiency

  Average water for paddy in India is 980 mm

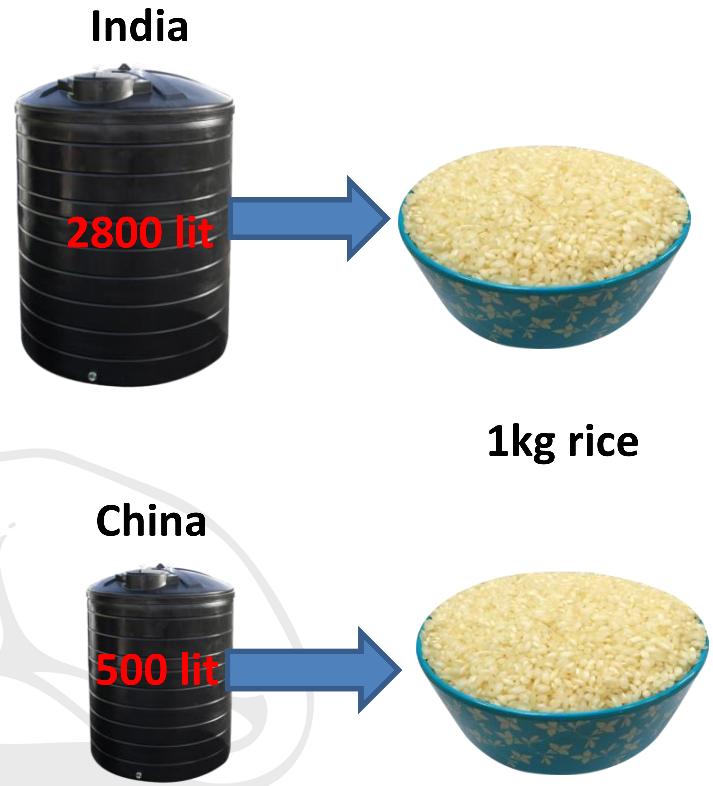
  FAO estimated crop water requirement is 400 – 700 mm

Paddy Productivity

Land productivity in Ton / Ha



Water Productivity

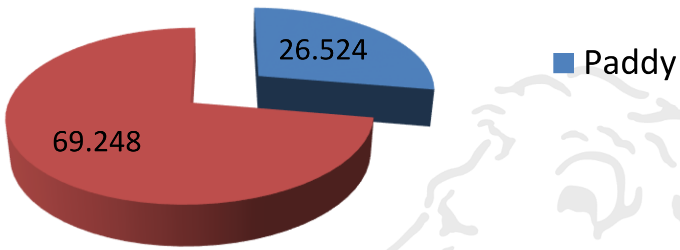


Source: Water Productivity Mapping of Major Indian Crops, 2018, NABARD and ICRIER

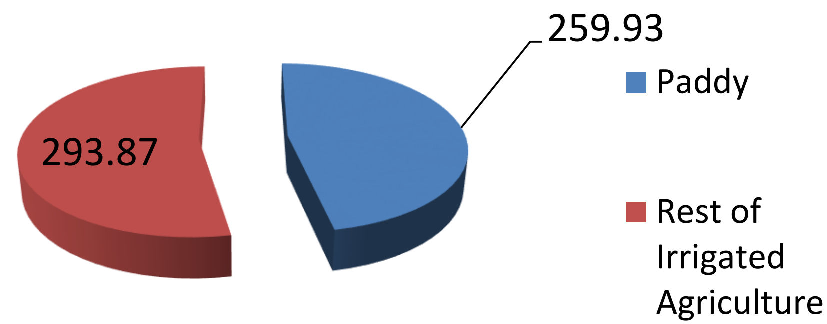
In India, about 60% of paddy cultivation is irrigated while in China, it is nearly 100%

Paddy: The Water Guzzler

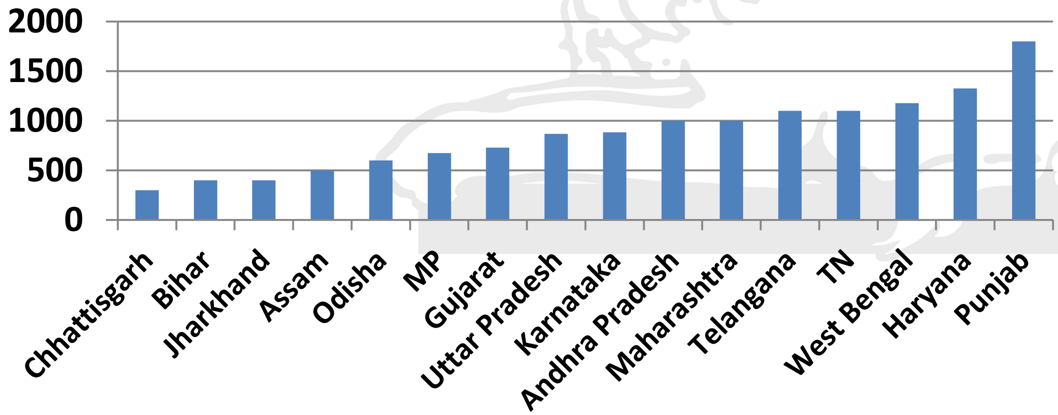
Gross Irrigated Area (Mha)



Water Consumption (BCM)



Water applied for paddy (mm)



- **Only 27.7% of Gross Irrigated Area but 47% of Water Consumption**
- **Average water use in paddy irrigation in India is 980mm. Punjab: 1800 mm**
- **FAO estimated water requirement for paddy: 400 – 700 mm (Avg 550 mm)**
- **Judicious use restricting to FAO estimate would save 109 BCM annually**
- **Prospect: Additional 19.8 MHa and additional 71.28 MT production**

Source: Water Productivity Mapping of Major Indian Crops, 2018, NABARD and ICRIER

Demand Side Management for Agricultural Water Management

- Shift from Water Resources Development to Water Resources Management
- Irrigation Scheduling
- Use of Agro Advisory Services
- Water Audit
- Micro Irrigation
- Participatory Irrigation Management

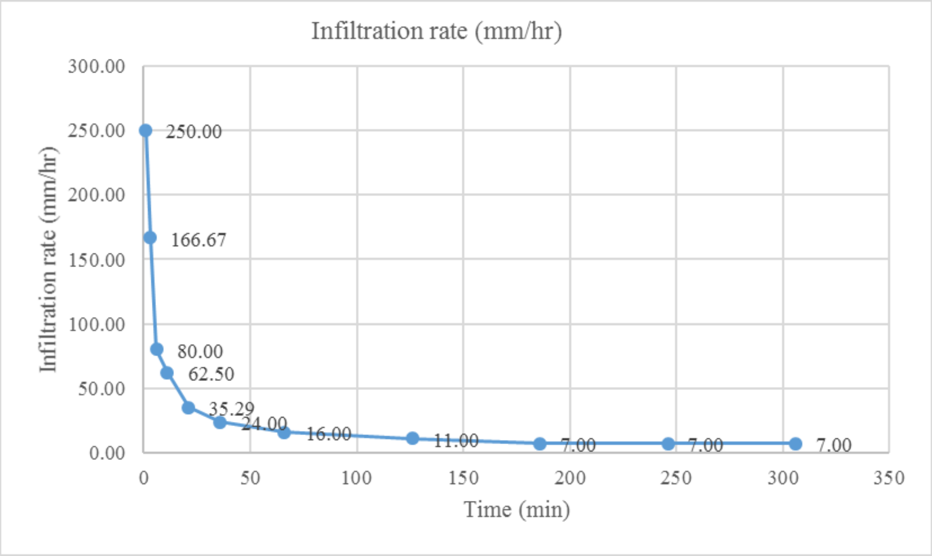
Irrigation Scheduling

- In irrigation sector, water demand is region specific depending upon the type of soil, cropping pattern/practices, climatic condition, type of infrastructure, conveyance system, water application technique etc.
- Among various methods available for working out irrigation water demand, Modified Penman Method is considered the most suitable and is recommended for assessing crop water demand.
- As a first step, crop evapo-transpiration (ET_{Crop}) is assessed. The crop water requirement can then be worked out, in consideration of percolation losses and other requirements like pre-sowing / land preparation, transplantation requirements etc., as applicable.
- The quantity of water actually used by the plants for their growth is termed as consumptive use. The Net Irrigation Requirement (NIR) is then worked out by deducting effective rainfall from the consumptive water use. The effective rainfall may meet only part of crop water demand. It may be insignificant in arid areas but may be a major portion in humid areas.

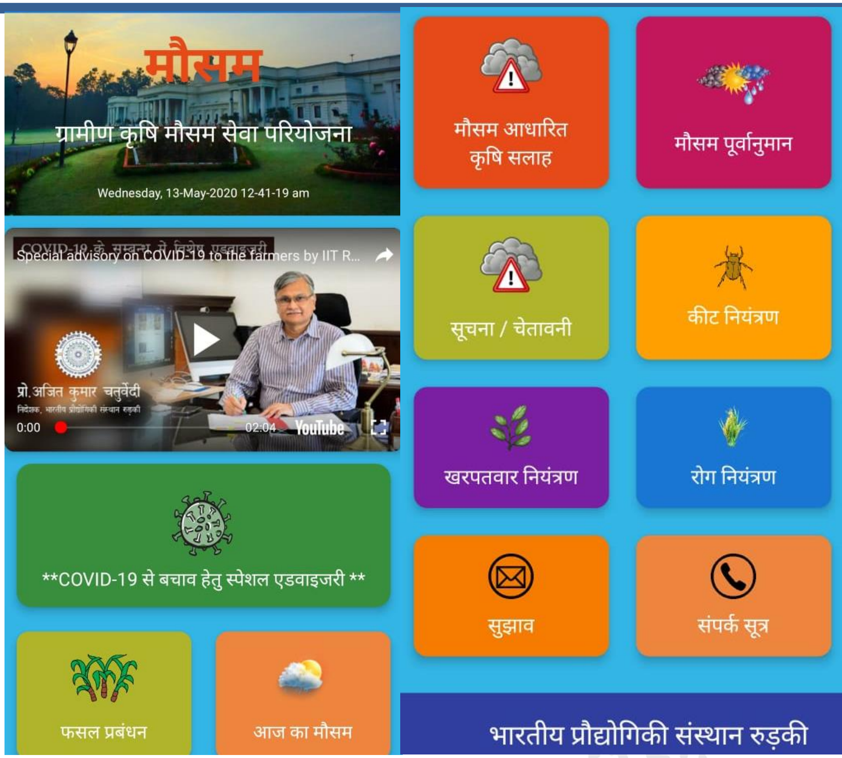
SOIL MOISTURE MEASUREMENT

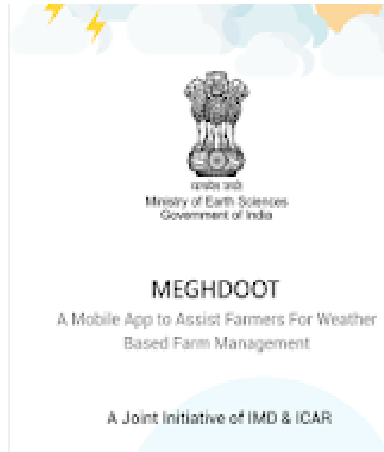
- Field tests were conducted to find the moisture holding capacity of soil in the command areas and average value of field capacity of soil measured just after the draining of gravity water is found to be 37.36 percentage by volume using TDR.
- Similarly, initial average soil moisture content is found to be 11.1 percentage by volume.



Use of Agro Advisory Services

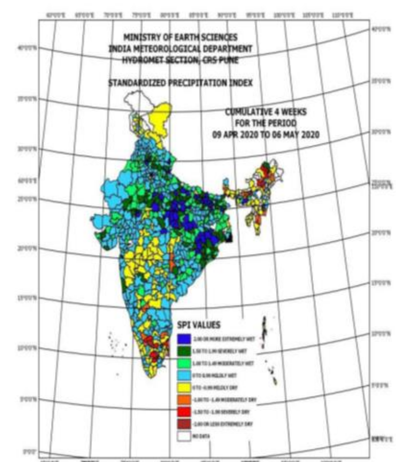




https://play.google.com/store/apps/details?id=com.aas.meghdoot&hl=en_IN

https://play.google.com/store/apps/details?id=com.gkms.mausam

Standardised Precipitation Index
Cumulative 4 weeks for the period 9th April to 6th May 2020



- Extremely/ Severely wet conditions exist in Upper Siang district of Arunachal Pradesh; Begusarai, Bhagalpur, East Champaran, Darbhanga, Gopalganj, Jamui, Khagaria, Kishanganj, Lakhisarai, Madhepura, Muzaffarpur, Patna, Purnea, Samastipur, Saran, Sitamarhi, Siwan, Vaishali districts of Bihar; Jamnagar, Gir Somnath district of Gujarat; Ambala, Kurukshetra, Kaithal districts of Haryana; Bhind, Datia, Gwalior, Morena, Neemuch, Sheopur, Shivpuri, Chhatarpur, Dindori, Katni, Narsinghpur, Panna, Rewa, Sagar, Satna, Shahdol, Umaria, Singrauli districts of West Madhya Pradesh; Ratnagiri, Osmanabad districts of Maharashtra; West Khasi Hills districts of Meghalaya; Angul, Bargarh, Bhadrak, Boudhgarh, Cuttack, Deogarh, Ganjam, Jagatsinghpur, Jajpur, Jharsuguda, Keonjhargarh, Mayurbhanj, Nayagarh, Sambalpur, Sonepur, Sundargarh districts of Orissa; Patiala district of Punjab; Pali, Chittorgarh, Sawai Madhopur, Tonk, Dholpur, Dausa districts of Rajasthan; Perambalur district of Tamilnadu; Dadara & Nagar Haveli districts of Union Territory; Allahabad, Ambedkar Nagar, Bahraich, Ballia, Banda, Barabanki, Basti, Deoria, Fatehpur, Gonda, Lucknow, Pratapgarh, Rae Bareilly, Sultanpur, Unnao, Varanasi, Sahuji Maharaj Nagar, Sant Ravidas Nagar, Amethi, Bareilly, Bijnor, Hamirpur, Muzaffarnagar, Saharanpur districts of Uttar Pradesh; Malda, East Midnapore, West Midnapore districts of West Bengal; Koderma, Sahibganj, East Singhbhum, West Singhbhum, Simdega, Seraikela-Khar, Khunti districts of Jharkhand; Nainital, Udham Singh Nagar, Bageshwar districts of Uttarakhand; Koriya, Surguja, Bijapur, Baloda Bazaar, Balrampur, Surajpur districts of Chhatisgarh.
- Extremely/Severely dry conditions exist in Papumpara, West Siang districts of Arunachal Pradesh; Darrang, Lakhimpur, Morigaon districts of Assam; Chamarajanagar district of Karnataka; Cuddalore, Dindigul, Erode, Madurai, Namakkal districts of Tamilnadu.
- Moderately wet to moderately dry conditions were experienced in remaining districts in the country.

किसानों को एडवाजरी जारी कर रहा आईआईटी

संवाद न्यूज एजेंसी

संस्थान निदेशक प्रो. चतुर्वेदी ने मोबाइल एप 'मौसम' और वेबसाइट से जुड़ने की अपील की

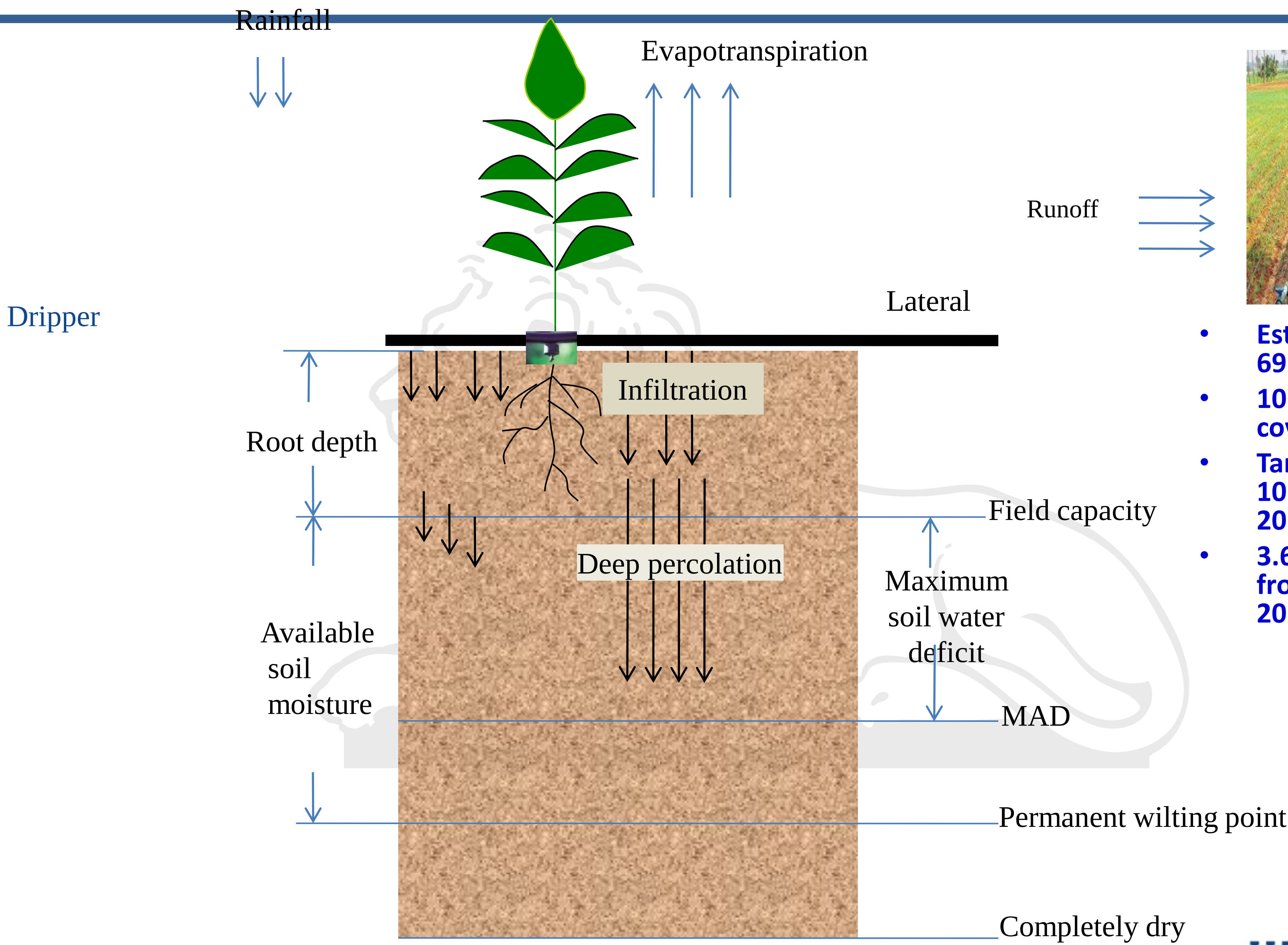
रुड़की। आईआईटी रुड़की के जल संसाधन विकास एवं प्रबंधन विभाग में

Water Audit in Irrigation Sector

A detailed profile of the distribution system & water users, thereby facilitating easier & effective management of the resources with improved reliability.

Proforma	Description
I	Water Demand
II	Water Indent
III	Daily Discharge Drawn by Various Sections
IV	Discharge Drawn at Various locations of canal
V	Water Used and Area Irrigated (Sub-division)
VI	Water Used and Area Irrigated (Section)
VII	Discharge letout through scouring sluices or escapes (Sub-division)
VIII	Discharge letout through scouring sluices or escapes (Section)
IX	Rainfall/Evaporation (Sub-division)
X	Rainfall/Evaporation (Section)
XI	Annual Water Account for Major and Medium Projects
XII	Annual Water Account for Minor Irrigation Projects
XIII	Water Auditing

MICRO IRRIGATION



- **Estimated potential - 69.5 MHa**
- **10 MHa (14%) covered so far.**
- **Target - additional 10 Mha (2015-16 to 2019-20)**
- **3.6 Mha covered from 2015-16 to 2018-19**

Participatory Irrigation Management
Ralegan Siddhi, Ahmednagar, Maharashtra

- Initiatives by Shri Baburao ‘Anna’ Hazare (in 1970s)
- Anna with 16 farmers dug 8 wells over 2 years to irrigate 700-800 acres
- Community was inspired to construct gully plugs, contour trenches and also afforestation
- Results:
  - Plentiful amounts of water
  - Farmers can grow crops year round.
  - Milk production increased four times.
  - Growth in economy

Every drop of water counts

Rain Water Harvesting and Water Conservation in Rural Areas

Sandeep Narulkar
Milind Dandekar
S.G.S.I.T.S., Indore

Rainwater

- The prime source of water
- Occurrence: Typically
- uncertain and variable
- Varies: spatially
- Varies: temporally
- Uncertain in quantity: Excess of it harms
- Dearth perturbs

Rainfall and Indian Context

- Indian rainfall scenario is well explained in above lines. It impacts the socio-economical as well as political scenario widely.
- The country's agricultural produce depends primarily on rainfall and a failed monsoon destroy the farming community and setback to the national economy.The principal cause of poverty and recurrent suicides of farmers in majority areas of the country is vagarious monsoon.
- During monsoon the rain water passes through drains and rivers like a super fast train keeping the landscape high and dry.
- Post monsoon situation: less surface water, dry rivers and dry wells. What has to be done?
- The solution is Rain Water Harvesting which was a tradition of Indian Civilization

Traditional Rainwater Harvesting in India

- Major part of India has been facing floods or droughts since historical times.
- The ancient civilizations and kingdoms simply vanished due to the vagaries of Monsoon and the communities had to shift from one place to other but there were live traditions to retain water and harvest it for future use.
- The wise kingdoms and native wisdom of the people in India have created a wonderful array of traditional water harvesting systems according to geographical and topographical conditions.

Present Scenario

- With the passage of time these traditions were forgotten either or were subjected to modern systems of water management.
- However, in recent times lots of people in different areas are reviving the traditions and bringing it back to the practice. The government is also supporting such revivals.
- A few examples of traditional water harvesting system are presented

Step Wells

Jhalaras are rectangular-shaped step wells that have steps on three sides. These step wells collect the seepage of an upstream lake. The city of Jodhpur has eight jhalaras, the oldest being the Mahamandir Jhalara that dates back to 1660 AD.

Bawaris are step wells that were common in hard rock areas and arid areas. In Rajasthan it is a part of the network of water storage created through the run-off from canals built on the hilly outskirts of cities.

Step Wells

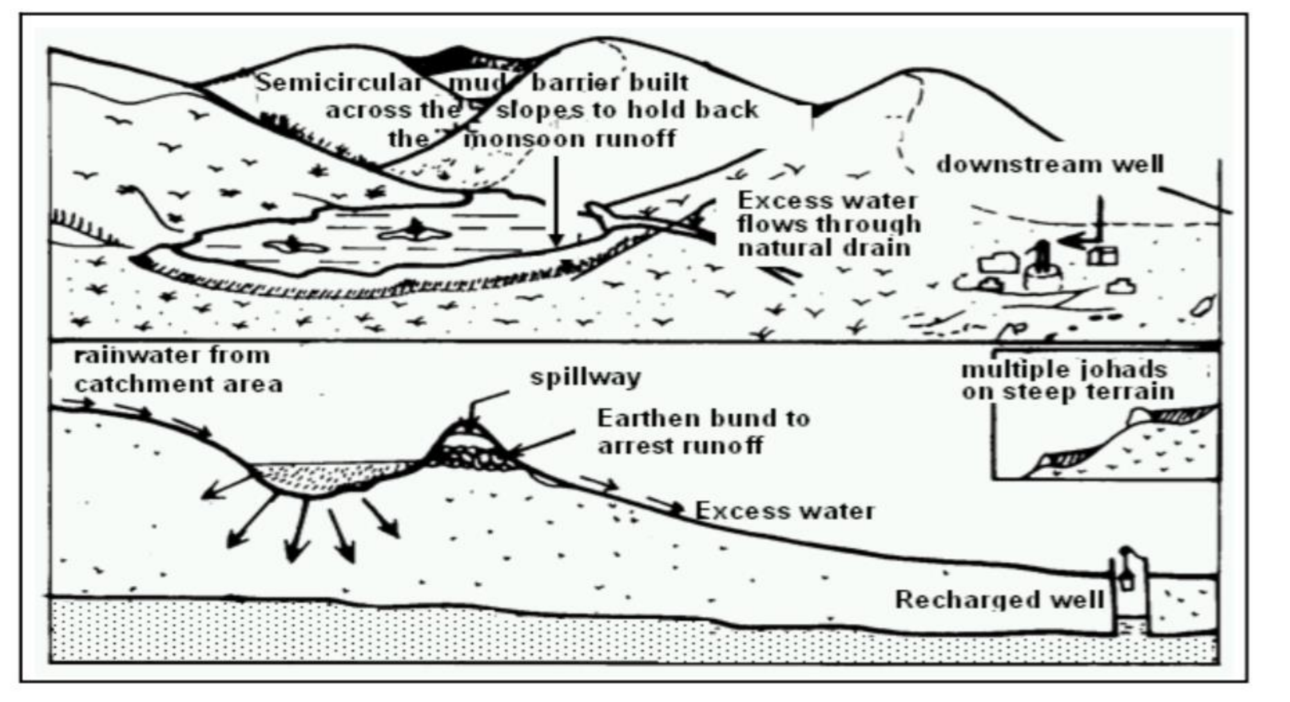
Baolis are palatial decorative step wells with amenities like secret rooms, bathrooms, and assembly spaces. It was created for water harvesting. The beautiful step wells have beautiful arches, carved motifs. Its Gujarat version is called as waw.

A kund is a shallow step well having central deep well or an artesian spring. Its main purpose is to harvest rainwater for drinking. Most of the big temples are having kunds for water supply besides them.

Talab/ Bandhi/ Nadis/ Pokhar/ pukoor/ Sagar/ Samad/ Kere/ Eri/ Jheel/ Taal/ Talaiyya/ Tale/

Talabs are the most common surface water reservoirs all over the country from north to south and east to west. The construction is done for many purposes and many ways are in practice since ancient times. They may be natural or man made. The richness or generosity of the kings used to be decided with the number of Talabs he built in his life. They were built to harness surface water as well as recharge ground water, were feeding the rivers.

Area Specific Water Harvesting Structures



Taanka is a significant structure indigenous to the Thar Desert of Rajasthan. A Taanka is a cylindrical paved underground pit into which rainwater from rooftops, courtyards or artificially prepared catchments flows. Once completely filled, the water stored in a taanka can last throughout the dry season and is sufficient for a family of 5-6 members.

Johads are small downhill Talabs that capture and store rainwater and recharge ground water. Several johads are interconnected through deep channels, with a single outlet opening into a river or stream nearby. This prevents structural damage to the water pits. These are also called madakas in Karnataka and pemghara in Odisha.

Area Specific Water Harvesting Structures

Traditional water harvesting system — an ideal setting of the khadin system

Khadin system (or dhora) to harvest surface run-off water is also typical to Rajasthan is a long earthen/rock embankment built to intercept slopes. Once the water percolates in wells the saturated soil is used for crop production. First designed by the Paliwal Brahmins of Jaisalmer in the 15th century.

The Zabo or Ruza ('impounding run-off') system of Nagaland combines water conservation with forestry, agriculture and animal hubandary. The water on forested hill slopes is channelized in pond-like structures created on the terraced hillsides. The water is crystallized in to small ponds created in the paddy fields for irrigation these fields are then used to rear fish and foster the growth of medicinal plants.

Area Specific Water Harvesting Structures

The Kumar tribe (of Wayanad) uses a special well called panam keni. Wooden cylinders are made by specially treated toddy palm barks. These cylinders, four feet in diameter as well as depth, are then immersed in groundwater springs located in fields and forests. This is the secret behind how these wells have abundant water even in the hottest summer months.

Zings, found in Ladakh, are small tanks that collect melting glacier water. A network of guiding channels brings water from the glacier to the tank. The water is used in the fields on the following day. A water official called a *Chirpun* is responsible for the equitable distribution of water in this dry region that relies on melting glacial water to meet its farming needs.

Area Specific Water Harvesting Structures

Phad is an old community-managed irrigation system. The system is formed of a *bhandhara* (check dam) across a river, *kalvas* (canals) carry water into the fields in the phad (agricultural block). The Phad system is operated on three rivers in the Tapi basin – Panjhra, Mosam and Aram – in the Dhule and Nasik districts of Maharashtra.

The Pat system of Bhitada village in Jhabua district of Madhya Pradesh diverts water from hill streams into irrigation channels through a system of diversion bunds across a stream piling up stones and then lining them with teak leaves and mud to make them leak-proof. The Pat channel passes through deep ditches and stone aqueducts that are skilfully cut info stone cliffs to create an irrigation system that the villagers use in turn.

Area Specific Water Harvesting Structures

Kuhls an important cultural tradition are surface water channels in Kangda Valley of Himachal Pradesh that carry glacial waters from rivers and streams into the fields. The system has an estimated 715 major kuhls and 2,500 minor kuhls that irrigate more than 30,000 hectares in the valley. These were built either through public donations or by royal rulers and managed by a kohli.

Ahar Pynes are traditional flood water harvesting systems indigenous to South Bihar and Jharkhand. Ahars are reservoirs with embankments on three sides that are built at the end of diversion channels like pynes. Pynes are artificial rivulets led off from rivers to collect water in the ahars for irrigation in the dry months. Paddy cultivation in this relatively low rainfall area depends mostly on ahar pynes.

Area Specific Water Harvesting Structures

Bamboo Drip irrigation System is an efficient water management in north-east India. The tribal farmers of the region have developed a system for irrigation in which water from perennial springs is diverted to the terrace fields using varying sizes and shapes of bamboo pipes. This ancient system is used by the farmers of Khasi and Jaintia hills to drip-irrigate their black pepper cultivation.

The Shompen tribe of the Great Nicobar Islands lives in a region of rugged topography. They construct a series of pits encircled by bunds made from logs of hard wood named as jackwells connected through half cut bamboos. Often, these split bamboos are placed under trees to collect the throughfall.

Summary of the Traditional Water Harvesting Methods

We have seen many examples of traditional water harvesting systems across India. The list is yet not complete and requires visiting lots of areas and villages therein to understand the importance of these systems. From the foregoing discussion it is quite clear that India has a extremely rich culture of water harvesting and revival of the systems is required.

However, due to modern learning and understanding we have forgotten the treasure. It is requested to all the participants to accept the fact that each of the villages has a history of water harvesting in itself. Let us first find the best harvesting practices in each village and then proceed for training the people for creating a water harvesting system.

Rainwater Harvesting

- Rain water harvesting is the collective term for a wide variety of interventions to use rainfall through collection and storage, either in soil or in man-made dams, tanks or containers bridging dry spells and droughts. The effect is increased retention of water in the landscape, enabling management and use of water for multiple purposes. (UNEP, 2009)
- The basic aim of the rain water harvesting is to reduce the speed of flowing water (run-off) and storing more water in the landscape (watershed) to enhance the soil water and ground water storage for use in the dry

Rainwater Harvesting

- By retaining landscape water flow, increased rainfall infiltration increase growth of vegetation, and decrease soil erosion, surface run-off and incidence flooding. (UNEP, 2009)

- Rainwater Harvesting is done either naturally or artificially.

Benefits of Rain Water Harvesting

The major benefits of rain water harvesting are as follows:
1) Increased Water Availability for multiple uses
2) Reduction in floods
3) Reduction in Soil Erosion
4) Increased Ground Water Storage
5) Better water security throughout the year
6) Drought Proofing
7) Increase green cover thus better climate change resilience
7) More employment opportunities
And Many More

Natural Rainwater Harvesting

- Natural rainwater harvesting is accomplished mostly by the vegetation cover but the mass deforestation and denudation of slopes has hampered this process in many of the otherwise fertile and
- Managing water resources in the landscape is thus management the permanent vegetation cover to enhance biomass production for fibers and energy, to harvest non-timber forest products and to enrich landscape biodiversity. Although forest and trees ‘consumes’ rainfall, they also safe-guard and generate many ecosystem services for livelihoods and economic good. (UNEP, 2009)

Vegetated Hill Slopes and Water Availability

Denudated Hill Slopes

What Can be Done?

- The slide with the denuded hill is indicative of heavy deforestation and extraction of mineral resource. The soil depth appears to be so less that rejuvenation of the forest on this land will not be an easy task. For that we have to apply certain simple engineering measures along with plantation of the vegetation from tiny grass to bigger trees to hold the soil followed by water also.
- The structures suitable in various slope ranges to protect the erodible soil and to enhance the soil cover have to be chosen according to the topography, geology and antecedent geomorphic situation at the site.

Artificial Rainwater Harvesting

- Artificial Rainwater Harvesting is done either through agronomical measures adopted or engineering structures along the water path in the watershed area to retain water as well as the soil.
- In soil and water conservation, the agronomical measure is a more economical, long lasting and effective technique.
- Engineering measures too are very important since they alter the topography and geomorphology for collecting more water.
- In a watershed both the resumes are to be blended to get maximum advantage

Agronomical Measures of Rain Water Harvesting

- In soil and water conservation, the agronomical measure is a more economical, long lasting and effective technique.
- The Agronomical Measures are

1. Contour Cropping
2. Strip cropping
3. Broad Bed and Furrow System
4. Mulching
5. Pasture cropping, Grass land farming and Wood lands

Contour Cropping

Contour Cropping is a farming method that is used on slopes and the crops are planted on a contour. This reduces the run-off speed as well as protects soil erosion inducing more infiltration. Contour cropping is most effective on slopes between 2 and 10 percent.

Figure Source: www.studyblue.com

Strip Cropping

- In this agronomical measure crops are sown in the form of narrow strips across the land slope. The strips can be of one or multiple crops. The crops chosen may be close growing and erosion controlling crops. Strip Cropping may be Contour, field and buffer types
- Figure Source:

BROAD BEDS AND FURROWS

- The Broad Beds and Furrows system has an advantage of reducing water logging in the field since the furrows act as drains. If the strips are grown in furrow and broad bed system there is an added advantage in checking the speed surface run-off thus increasing infiltration opportunity.
- Figure Source: Sadhna Organic Natural

Mulching

- Mulching is a process of covering the bare soil between the crop strips by dried biomass like grass and other vegetation, These days artificial mulching is also provided. This helps in reducing the impact of rain drop and soil is protected from erosion. The water conservation and less evaporation from the bare soils are other advantages

- Figure Source: www.fao.org

Pasture cropping, Grass land farming and Wood lands

- The topography with smaller hillocks and rock outcrops are required to be covered with vegetation.
- The peaks as well as steeper slopes are required to be covered with wood lands. The milder slopes are required to be covered either through Pasture Cropping or grass land farming. This protects the soil erosion as well as the run-off speed
- Figure Source: https://www.ppwcma.vic.gov.au

Engineering Measures of Rainwater Harvesting

- The intervention in the flowing water to reduce the speed of flow and increasing infiltration opportunity is the main aim.
- The engineering or mechanical intervention requires creation of pits, trenches, ditches, embankments of various sizes and with different materials, check dams, ponds etc.. mostly from locally available materials.
- These structures also require basic knowledge about the topography, soil, geology and geomorphology of the area to understand the process of run-off, infiltration and percolation to the ground water.
- The other aspects to be known are hydro-meteorology of the area and the traditional techniques of water harvesting prevailing in the area

Engineering Structures / Interventions

The Engineering Structures for water harvesting are listed as follows

1. Trenches and bunds
2. Bench Terracing
3. Gully Plugs
4. Check dams/ Stop Dams/ Bandharas/ Nalla Bunds
5. Cheaper Options

(i) Gunny Bag Dams

(ii) Gabion Dams

(iii) Earthen / Rock filled Embankments

6. Talaabs with Earthen Dams
7. Farm Ponds

Engineering Structures / Interventions

- Slope Side Foothill Dug Ponds
- Subsurface Dykes or Underground Dams
- Artificial Pot Holes (Dohs) in Nallahs and Rivers
- Stone Barriers and Earthen Barriers
- Artificial Recharge of Ground Water
- (i) Open Well Recharging System
- (ii) Tube Well/ Bore Well Recharging
- (iii) Recharge Shaft
- Ferro cement Tanks

Trenches and Bunds

To retard the velocity of the overland flow and to reduce the soil erosion n the sloping land surfaces trenches and bunds are constructed. These are simple for construction and require quite general knowledge. The trenches are constructed in different geometrical configurations namely contour trenching, continuous trenching, staggered trenching and in line trenching. The selection of trenches depends on the site characteristics and rainfall intensity. The schematic diagram of different types of trenches are shown in adjoining Figure.

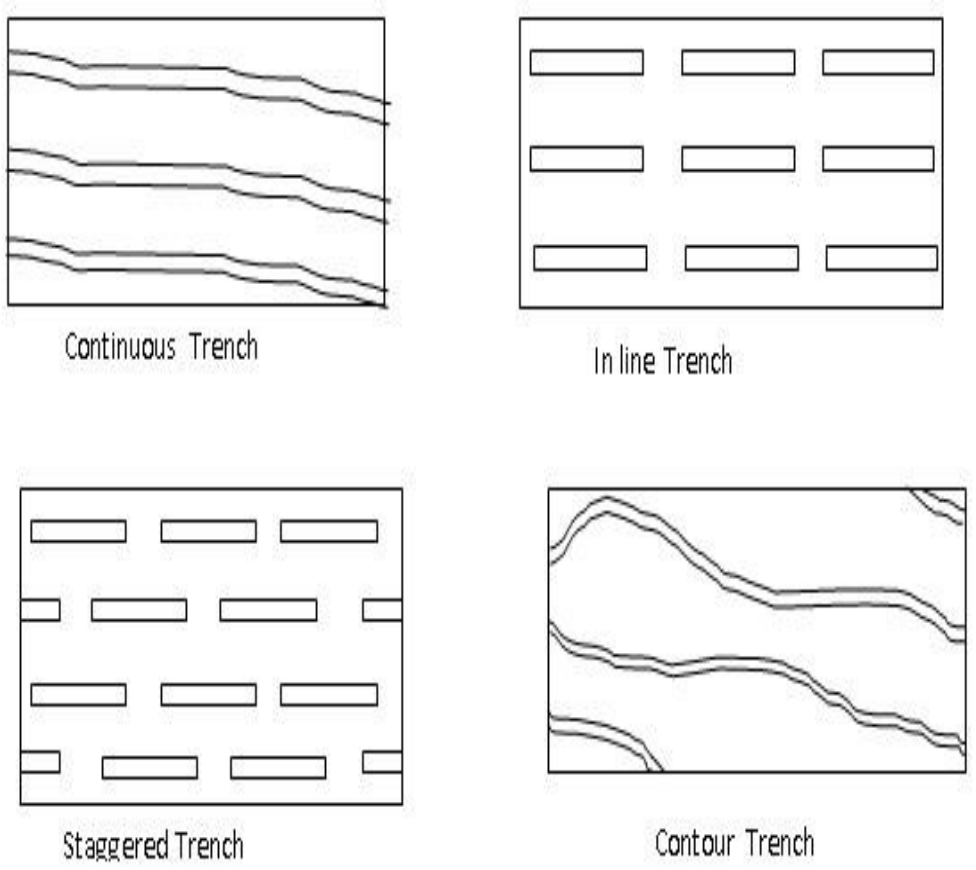


Fig. 29.1. Types of trenches. (Source: Murthy and Jha, 2009)

Trenches and Bunds

continuous trenching

in line trenching

staggered trenching

contour trenching

Continuous and Contour Trenches with Bunds

The trenches at suitable spacing are dug continuously along a contour on moderate to gentle hill slopes. The bunds are created by stacking the excavated material on its side. These type of trenches are long trenches (as long as 50 m) and have fixed interval (15 -30 meter). The cross-sectional area of the trench is usually kept as 0.25 m2 and depth should not be higher than 0.5 m. The cross section of trenches are kept as square. The life of trench is

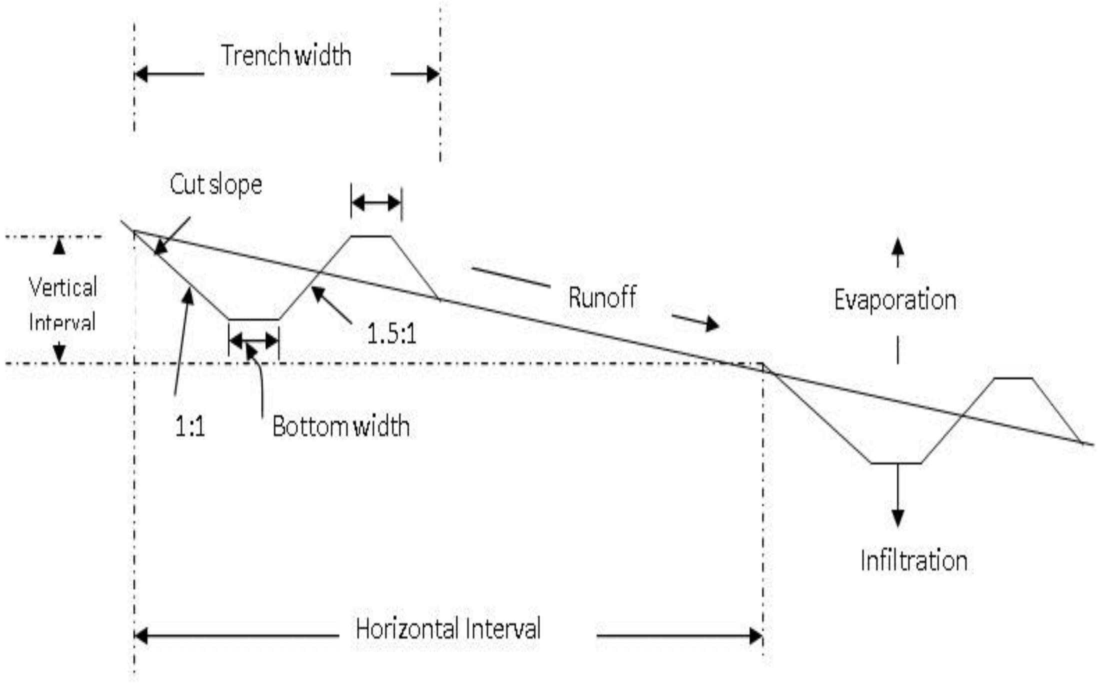


Fig. 29.4. Definition sketch of contour trenches.

(Source: Training manual on Soil Conservation and Watershed management (Vol II), CSWCRTI, Dehradun)

Staggered Trenches

The staggered trenching involves the excavation of trenches of shorter length in a row along the contour with inter space between them. These trenches are arranged in straight line (staggered form). Suitable vertical intervals between the rows are restricted to impound the run-off without overflow. In the alternate row, the trenches are located directly below one another. The trenches in successive rows are thus staggered, with the trenches in the upper row and the inter space in the lower row being directly below each other. The length of the trench and the inter space between the trenches in the same row should be suitably designed such that no long unprotected or uninterrupted slope to cause unexpected run-off or erosion. As the trenches are not continuous, no vertical disposal drain is excavated. The cross sectional area of these trenches should be designed to collect the run-off expected from intense storms at recurrence intervals of 5-10 years.

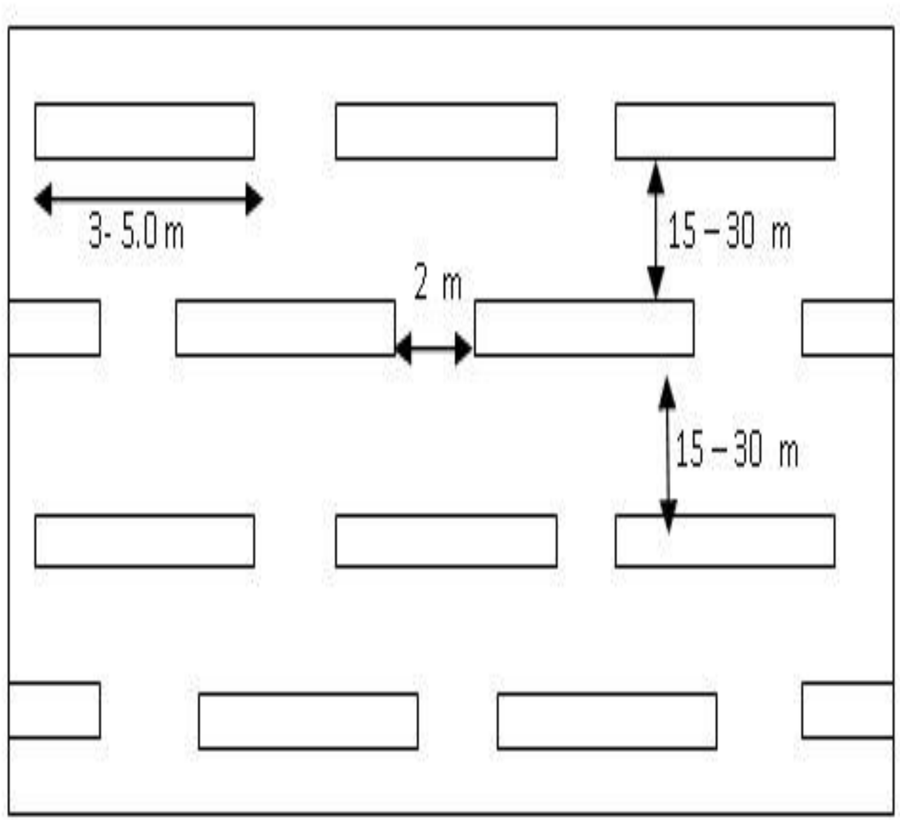
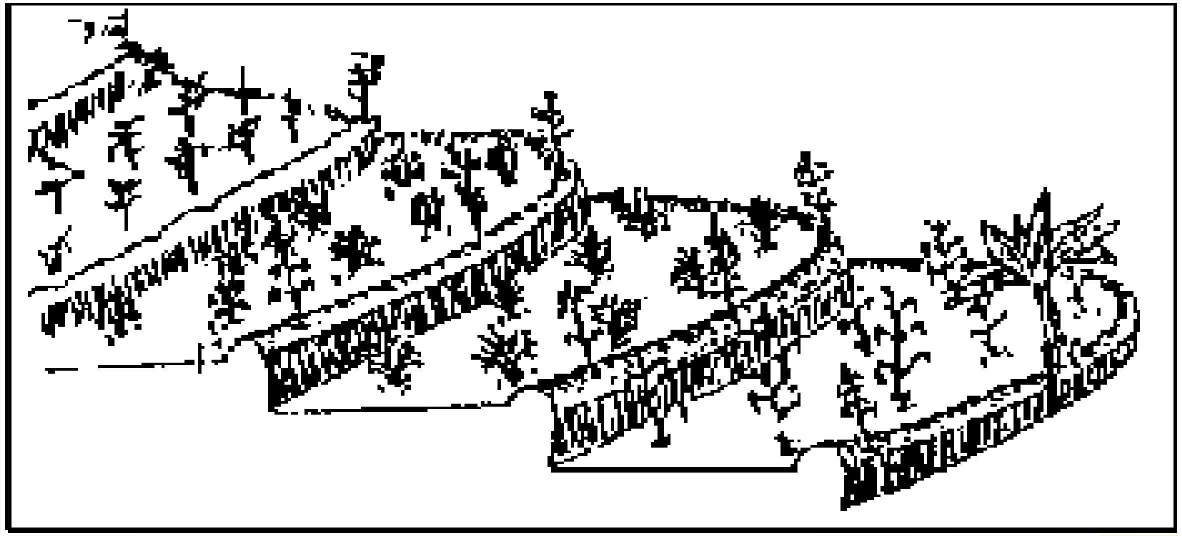


Fig. 29.3. Schematic diagram of staggered trenches.

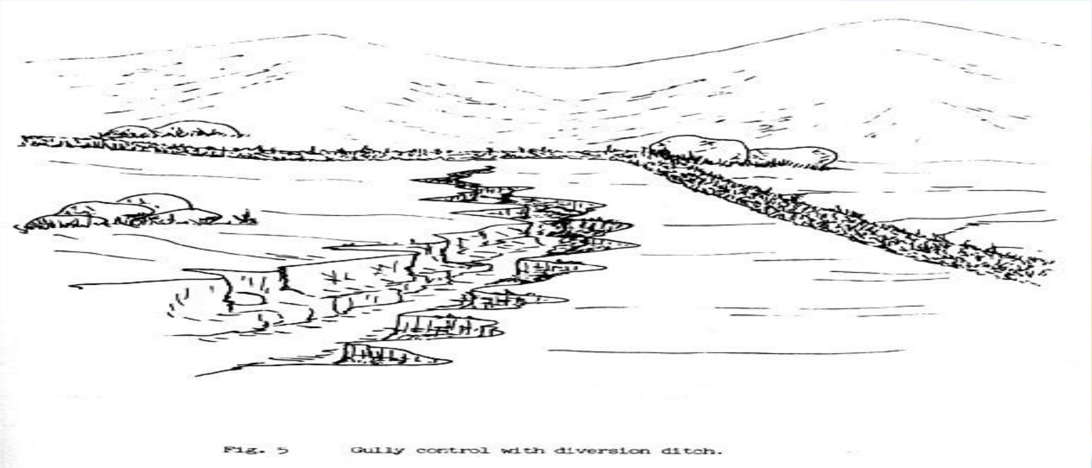
Bench Terracing

- Bench terraces are soil and water conservation measures used on sloping land with relatively deep soils to retain water and control erosion. They are normally constructed by cutting and filling to produce a series of level steps or benches. This allows water to infiltrate slowly into the soil. Bench terraces are reinforced by retaining banks of soil or stone on the forward edges. This is almost similar to contour farming. Effectively controls soil and water run-off and erosion. Trapping of sediments, reduction in slope length, reduction in the velocity and soil erosion and improvement in soil fertility over the long run are the best advantages.



Gully Formation and its Impact

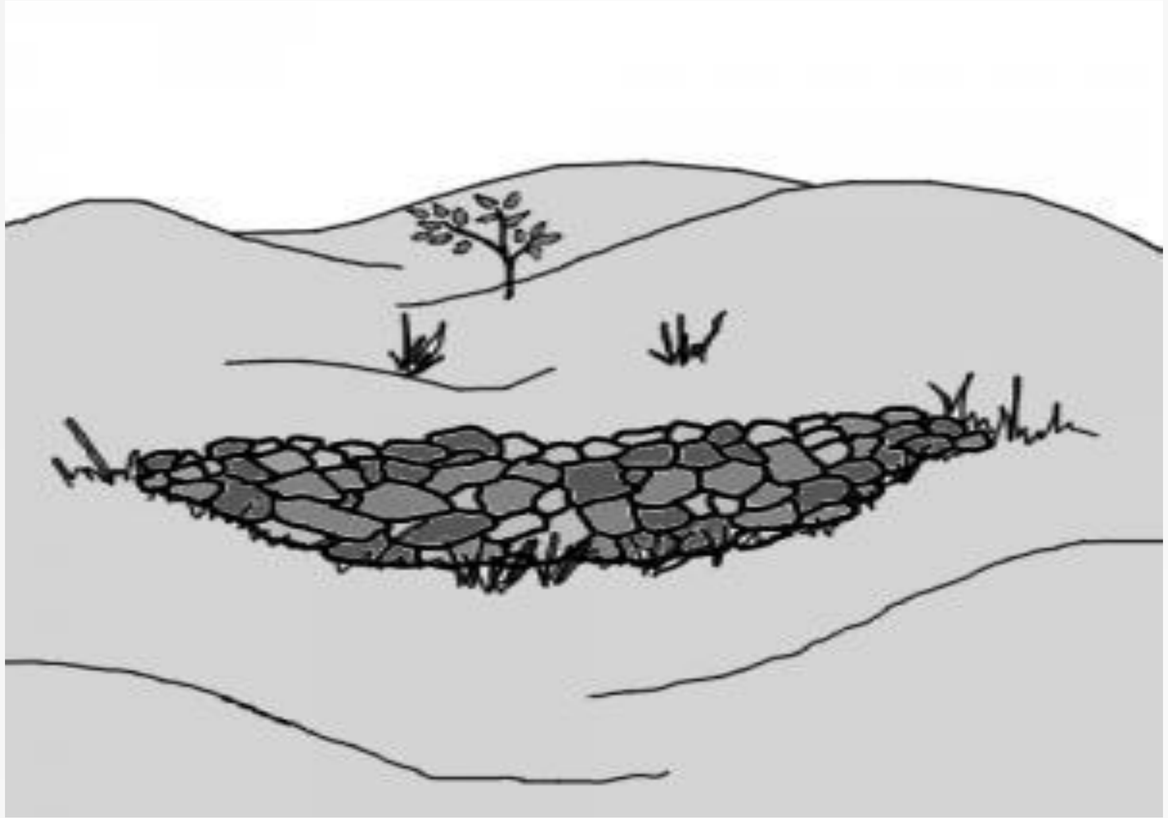
Gullies are channels formed due to erosion of top soil due to flow of rain water on unprotected slopes. Once initiated the gullies will continue to widen and deepen by progressive erosion or by slumping of the side walls unless steps are taken to stabilise. This creates an ugly land surface and leaves the land in ravines. These gullies need care and attention. Repair work done in the early stages of newly formed gullies is easier and more economical than letting the problem go unchecked for too long. Large gullies are difficult and costly to repair. The Plugging begins with the use of boulder dams. These boulder dams of dry stone masonry are created across the gully by stalking boulders to check soil and reduce the water speed.



Gully Formation

Extremely Gullied Land

Gully Plugging



Lose Boulder Gully Plug

Gabion Gully Plug

Check Dams/ Stop Dams/ Bandharas/ Nallah Bund

The check dams are small dams that are created across small drains in plain regions to store water. These dams may be ungated or gated as per the hydraulic or hydrologic requirements. The dams are created by stone masonry or concrete. These are constructed in many styles and shapes as per the local technical knowledge. These dams store the run-off and recharge

Ungated Check Dam

Gated Check Dam

Arch Type Check Dams

Cheaper Option: Gunny Bag Check Dam/ Nallah Bund

The rural water harvesting needs to be more local and indigenous. The villagers use fertilizers and other chemicals for agriculture and feed for cattle raring almost everything is packed in bags. If the bags are filled with local soil/sand and used as basic masonry unit for creation of gunny bag dam. These dams are created by just laying the bags one over the other in an interlocked fashion and is usually created immediately after the monsoon so that the possibility of washing off is reduced.

Cheaper Option: Gabion Check Dam/ / Nallah Bund

Gabion is an Italian word meaning big cage. A cage of soft interlocking mesh of hexagonal form is filled by boulders and pebbles and boxes are formed. The dam structure created using these boxes is called as Gabion Dam. These dams are also created on small streams and are quite useful in checking silt or conservation of water. The dams do not require much foundation treatment.

Cheaper Option: Earth and Rock Check Dam/ Nala Bund

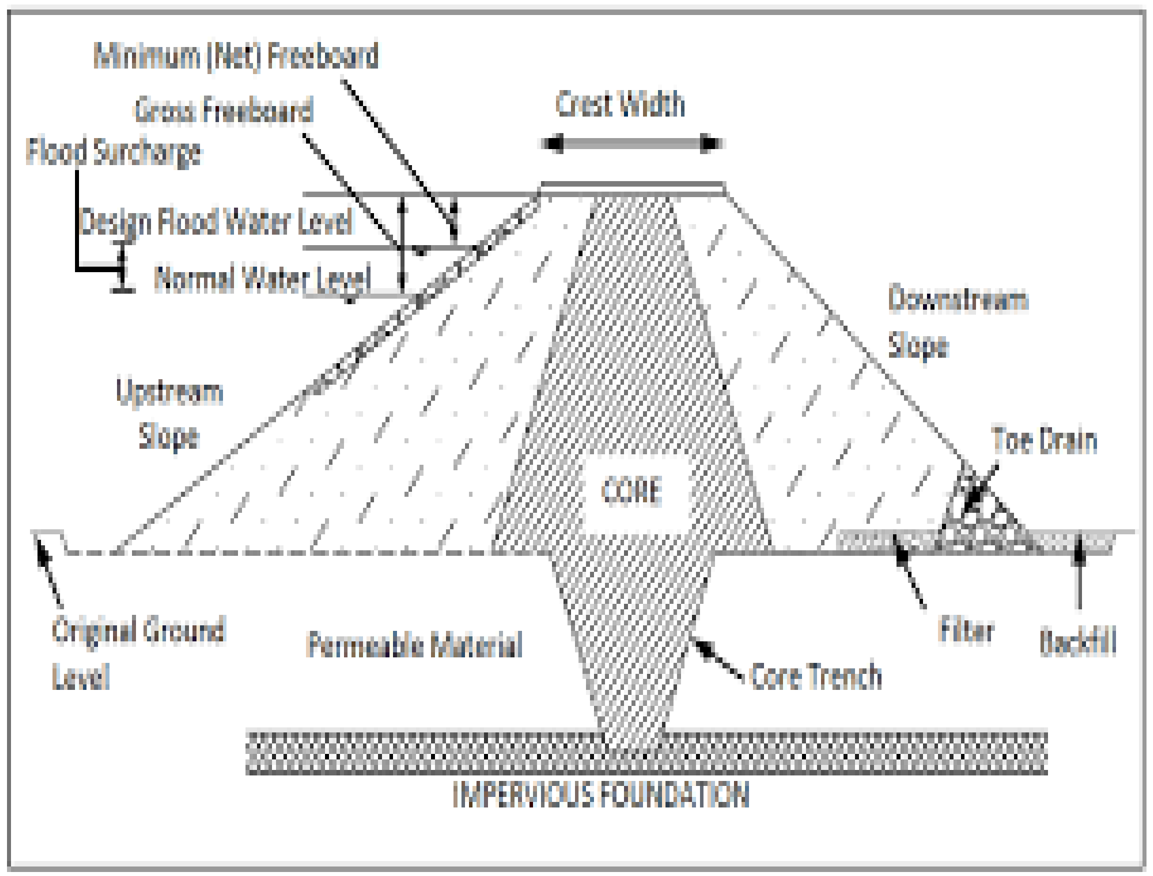
Earthen and Rock filled dams are one of the primitive structures naturally came to human minds. Checking water flows by creating earth filled or rock filled embankments is very common phenomenon. This can be created with locally available materials. The earthen structures are requiring proper compaction for water tightness and strength. The core of the dam has to be of impermeable

Talab or Pond with Earthen Embankment Dam

Earth embankments have been used since the earliest times to impound and divert water. They are simple compacted structures that rely on their mass to resist sliding and overturning and are the most common type of dam found worldwide. Modern haulage methods and developments in soil mechanics since the end of the nineteenth century have greatly increased the safety and life of

As discussed earlier that the Talabs are key water storage structures of the rural areas with flatter topography. In old times the kings, local jamindars, malgujars used to get it constructed to store water for various purposes and recharge. Many of these ponds or tanks have their area of spread on permeable land making these tanks as percolation tanks adding

Talab or Pond with Earthen Embankment Dam



Farm Side Pond

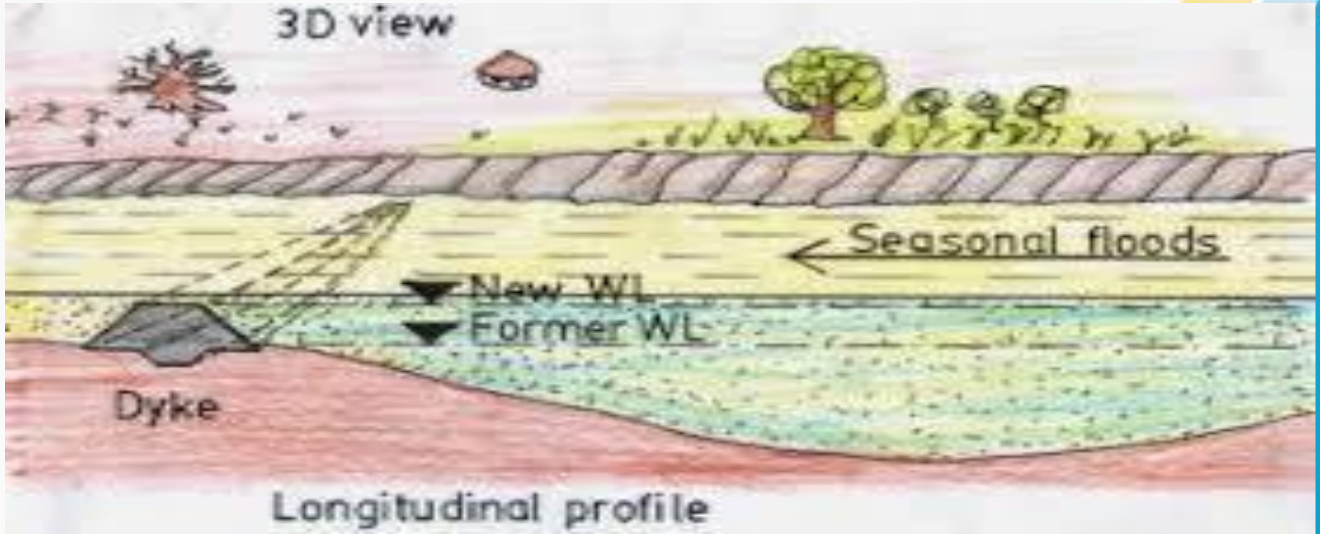
As a result of excessive ground water exploitation in hard rock areas the open wells and the tube wells are parched and the water level has gone to exceptional depths. As an alternative water source near the surface Farm Pond is a better alternative. They are dug close to individual fields. The rain water and regenerated water from irrigation are collected in this pond. The the power consumption in pumping is reduced. If the soil is impermeable lining is not required but in many cases PVC of HDPE Lining is required to be provided.

Slope Side Foothill Dug Ponds

These kind of ponds can be dug at foothill portions to harness surface as well as subsurface run-off on hill slopes. These pond will function just like farm ponds and will be useful in supplying water at the surface.

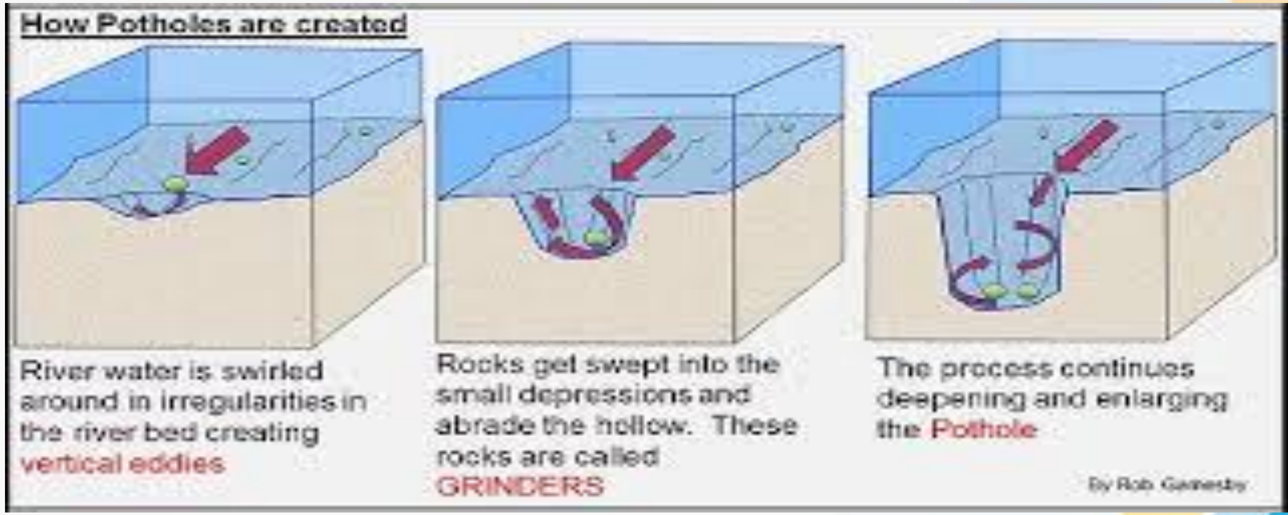
Subsurface Dykes or Underground Dams

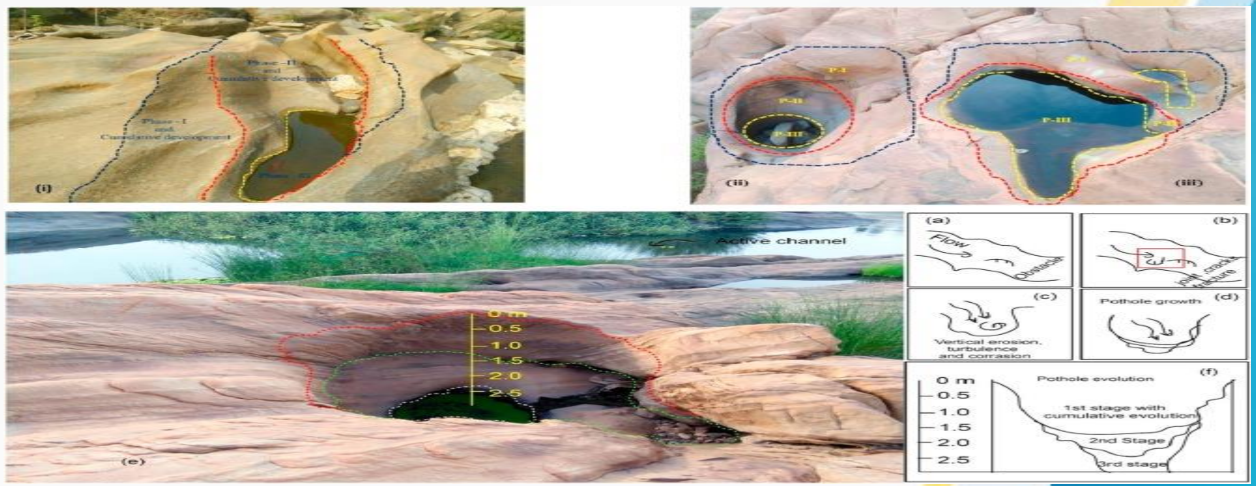
The Dyke is a geological feature across the stratified rocks that is created due to intrusion of quartz like minerals making it to act as an impermeable partition within the rock mass. This stops the ground water flow. But this kind of feature can be used by creating an artificial dam like structure in the river bed or a stratified rock region digging it up to a certain depth and constructing a clay or cement barrier.



Artificial Pot Holes (Doha) in Allah and Rivers

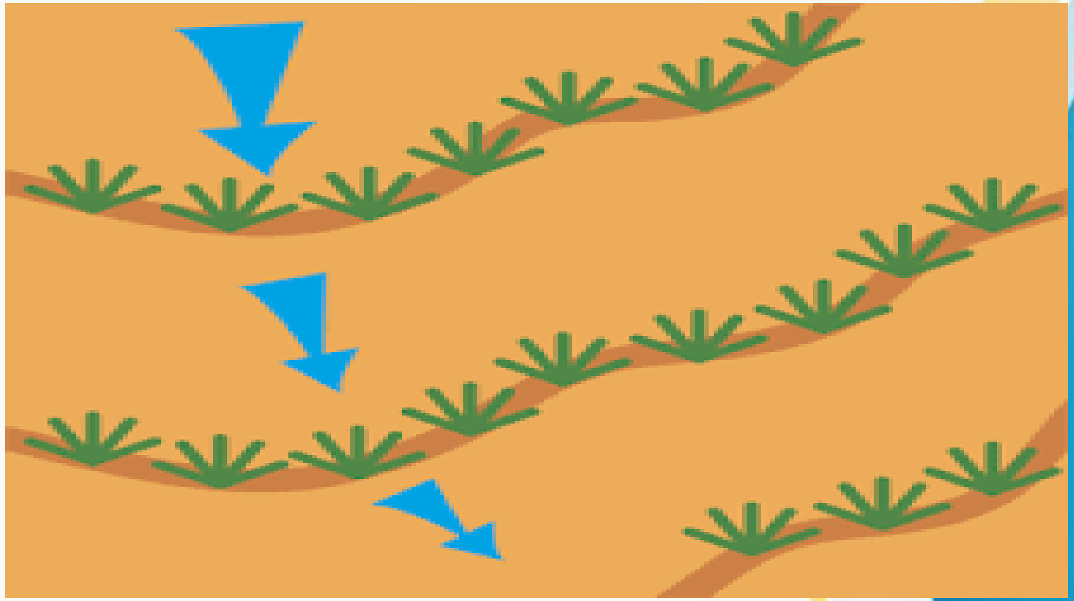
- Pot holes are created in rivers and rivulets as a natural mechanical process due to fluvial erosion. The famous story of Kaliamardan by Krishna in a 'Doh' in River Yamuna is well known. The check dams and other kinds of bunds have common problems of foundation, scour and side cutting. If deep pot holes are created within the rivers and





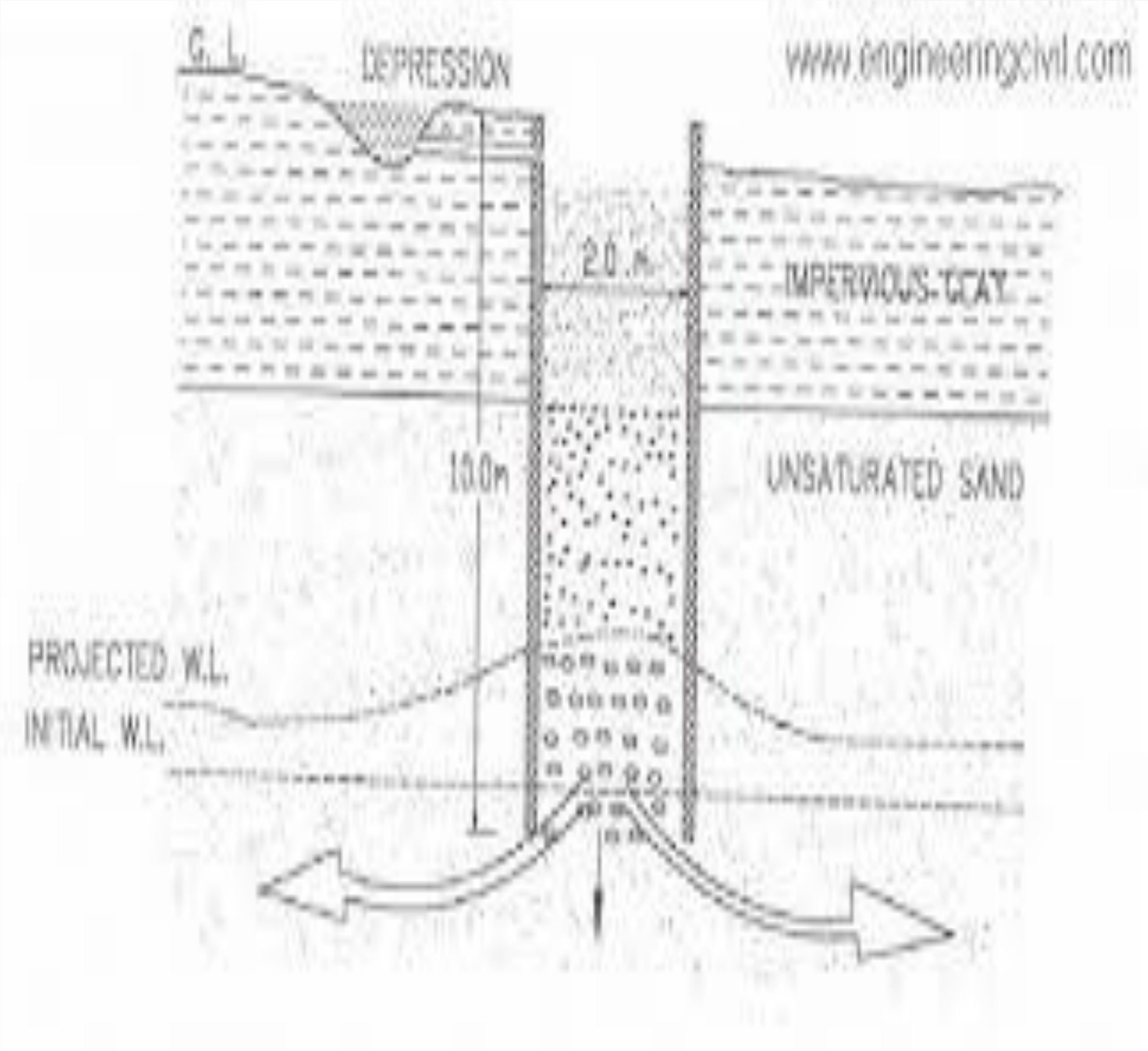
Stone Barriers and Earthen Barriers

- The soils of tilled fields get easily eroded hence to protect these the fields in old days used to have raised borders all around (popularly known as Medh). These borders have got vanished due to mechanization of farming practices. If these borders are revived this will protect soils as well as harvest water. These kinds of barriers can also be constructed across the slopes of grasslands, small forests etc.. to reduce the soil erosion as well as water harvesting. The earthen barriers can be stabilized by planting small and medium plants like vettiver grass and other type of local species



Artificial Recharge of Ground Water

Artificial Recharge of Ground Water is a hot topic on the agenda of NGO's and Government Agencies. To tackle the problems of declining ground water table, artificial ground water recharge is one of the effective measures. The Central Ground Water Authority with State Government is implementing many schemes all around the country to demonstrate the recharge practices. These practices require proper study of the geology and topography of the local area. A caution however is that the recharge should not be done with polluted water otherwise it will ruin the ground water storage



Open Well Recharging System

Open well recharging system consist of primary, secondary and main filtration unit. Run-off water from the cultivated area/ catchment area is diverted towards well recharge unit through field trenches. It allows to enter in primary filter unit wherein the major sediments will be arrested and water flows to the secondary filter unit. In secondary unit , the velocity of water will be reduced and heavy silt will be deposited at the bottom. This unit is also called as energy dissipation unit. The muddy water containing suspended and dissolved silt will passed to main filtration unit through a notch. The filtered water will pass to open well through connected PVC pipe.

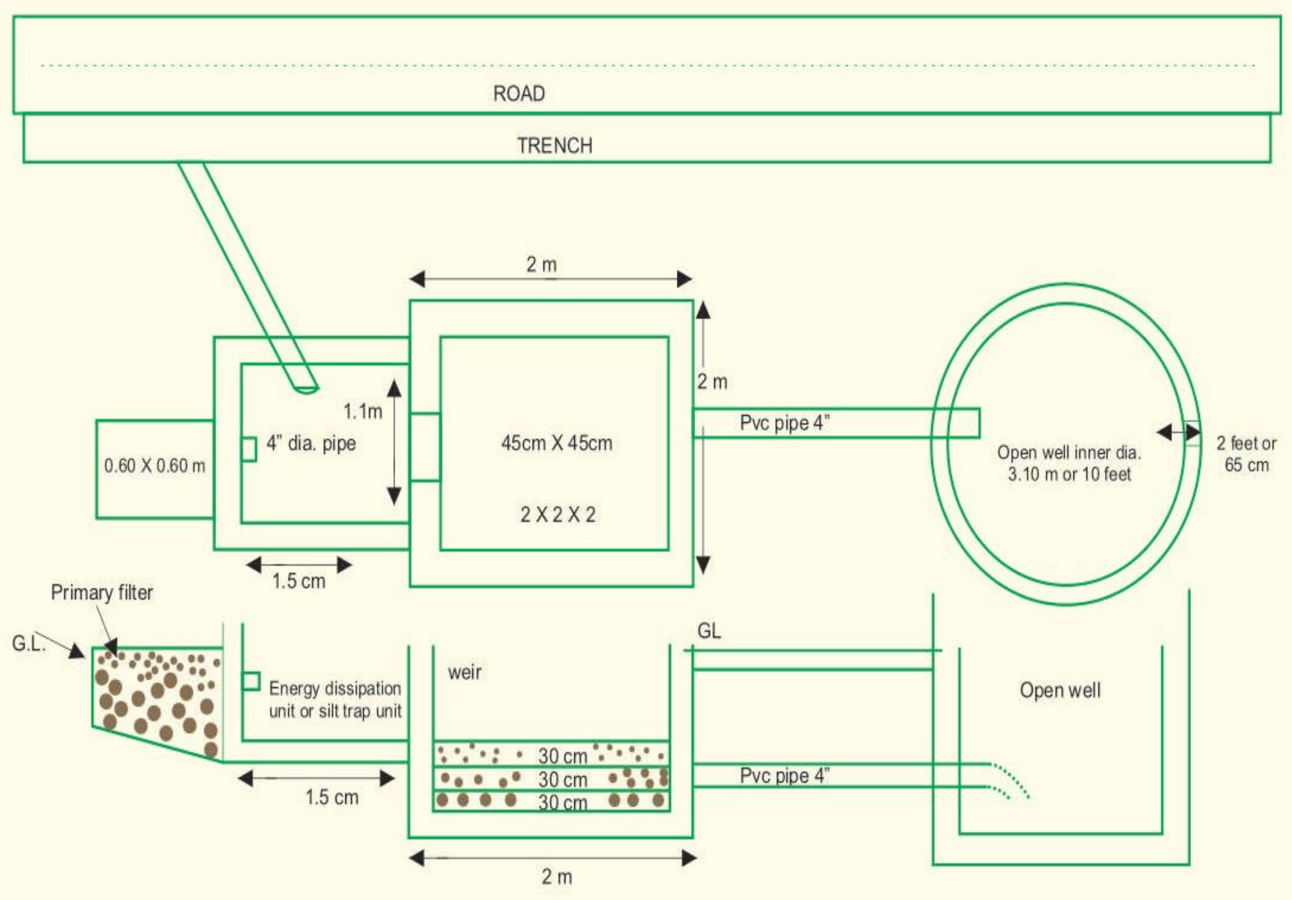


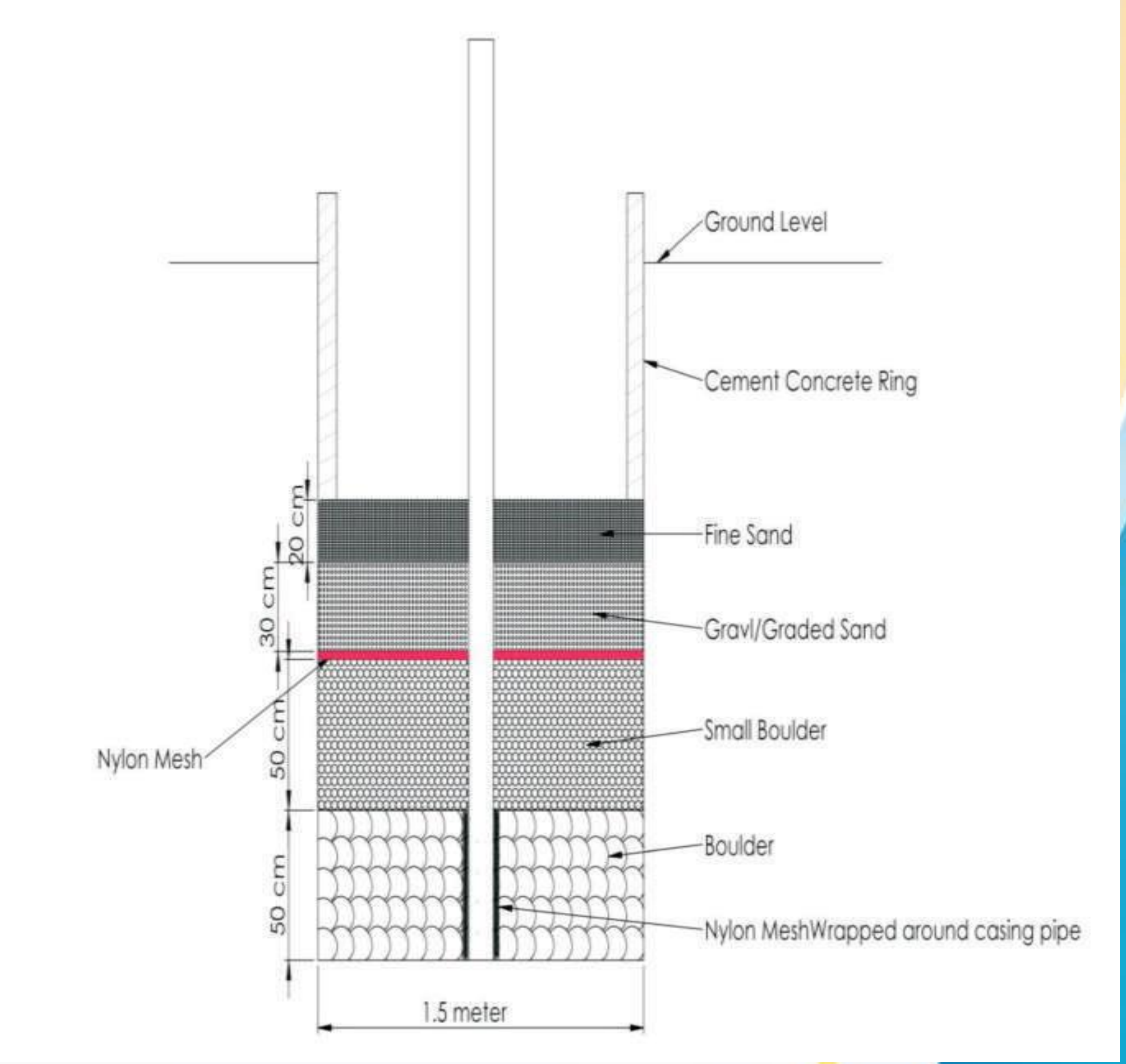
Fig.1 : Artificial Well Recharging System

Open Well Recharging System



Tube Well/ Bore Well Recharging

Bore well recharging system consist of primary and secondary filter. The primary filter consist of excavation of pit of 1 x 0.60 x 0.60 m dimensions filled with stones, gravel and sand. This unit filters the run-off water receiving through field trenches a. This filter unit is connected by 3” aid PVC pipe to main filtration unit Secondary filter unit consist of excavation of soil around the bore well casing pipe with dimensions as 2.5 m depth and 1.5 aid. From the bottom, up to 50 cm height, small wholes should be made with pointer at a spacing of 5 cm and this casing pipe is wrapped with nylon mesh in double layer. Then the pit is filled with 3 layers of big stone (50 cm), metals(50cm), Gravel (30 cm) and fine sand(20 cm) one above each. After second layer of mete, horizontal covering of nylon mesh should be provided and than gravel and sand layers should be placed. The top of the unit is covered with cement ring for not allowing the sediment from the flowing water.

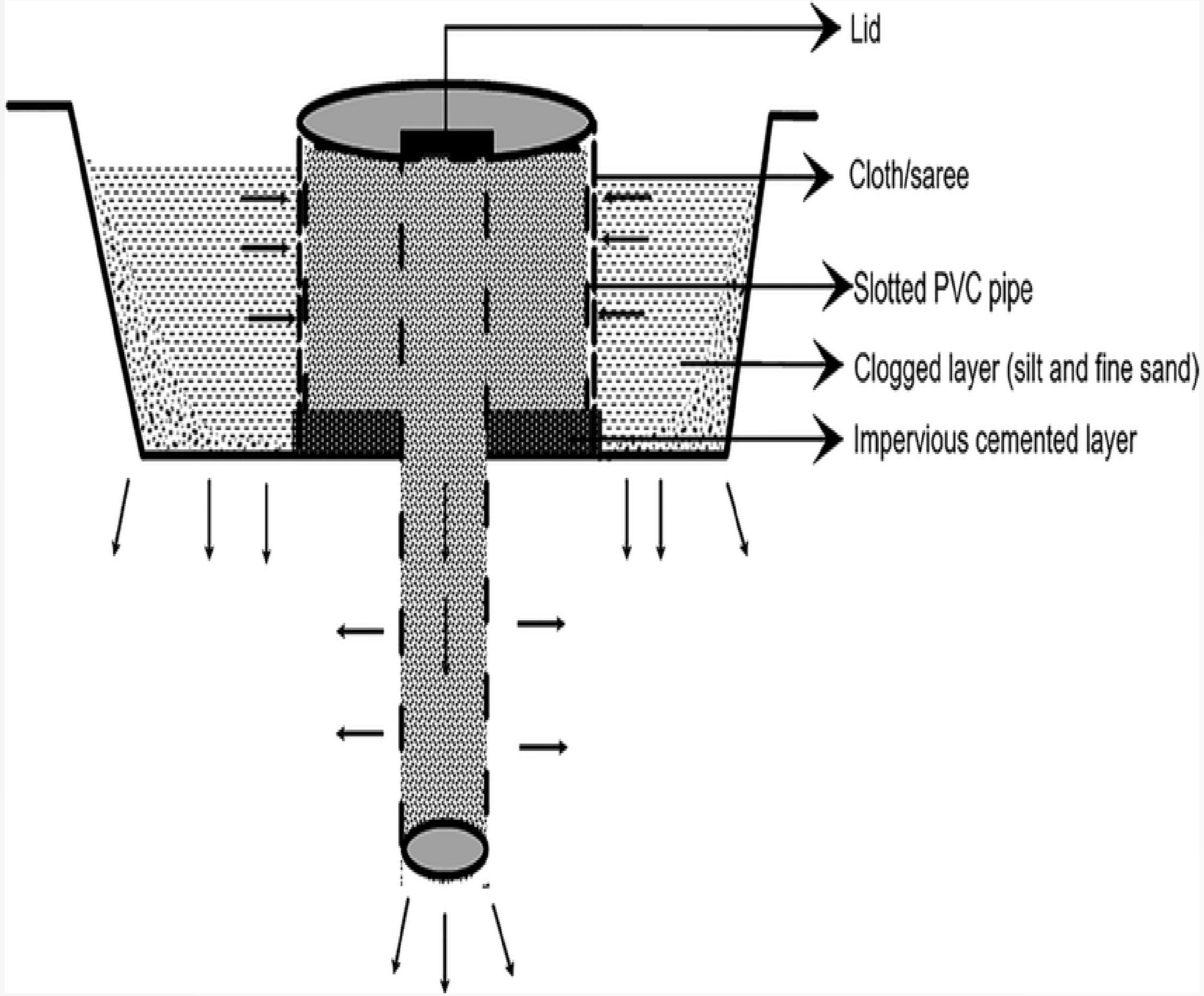


Tube Well/ Bore Well Recharging





Recharge Shafts



Ferro Cement Tanks

Ferro Cement Tanks

Watershed Management

- FAO defines a watershed as the geographical area drained by a watercourse, and watershed management as any human action aimed at ensuring the sustainable use of watershed resources. Unlike sectoral development approaches, watershed management involves examining the interactions among various natural processes and land uses and managing land, water and the wider ecosystem of the watershed in an integrated way.
- It combines measures that improve or conserve the ecosystem services and functions in the watershed (mainly those related to water); increase land productivity and resource efficiency; and improve or diversify people's livelihoods and income.

Watershed Management

- By integrating these measures in a well-defined geographic space and time sequence, the approach is expected to deliver multiple benefits, both on and off site and in the short and longer term.
- Watershed management is predominantly relevant for upland areas, where smallholder agriculture, forestry and animal husbandry are the prevailing land-use systems and where human action has an impact, positive or negative, on downstream areas. Mountain watersheds provide a wide range of ecosystem services and goods such as freshwater supply, high biodiversity, timber, food, fibre and medicinal plants; yet the inhabitants of these areas are disproportionately poor and vulnerable to climate change and natural hazards.

Examples of Ideal Villages with Participatory System of Watershed Management

Raleghan Siddhi is in a drought-prone and rain-shadowed village receiving 450-650mm of rains with temperatures reaching 44°C in summer. The village was a place of poverty and hopelessness. The natural resources were abused resulting into uncultivable lands, heavily degraded barren hillocks, deeper and meagre ground water leading to massive unemployment leading to secondary issues like high indebtedness, liquor addiction and quarrels heading to massive migration. But a single person Shri Baburao Hazare, or 'Anna' changed the socio-economic scenario of a drought stricken hell to a heavenly village through water harvesting and watershed management.

Examples of Ideal Villages with Participatory System of Watershed Management

- Hiware Bazar is another village telling the story of transformation through the watershed management and rain water harvesting under the leadership of Mr. Popatrao Pawar.
- Such examples are spread india wide and we all must learn from these examples

Concluding Remarks

In the time of COVID-19 we are experiencing chaos of rural migrant labours that have started walking towards their places.

Why this Situation?

Increase in population and pressure on small parcels of land has made people to migrate to big cities. The lock down and other consequences have a very bad impact in the economy and the migrant labours have no option. Our villages are not able to support the total population.

Solution?

The water is a major issue in many of the areas in central, north western and western part of India. Unnatural Ararat Abeyant should Focus on water harvesting and watershed management to attain better water availability followed by better livelihood opportunities

References and Acknowledgements

The presentation on traditional water harvesting is greatly benefited by following books and websites. Many of the photographs and texts have been taken from these websites and literature:

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Thank You

Role of Community in RURAL AREA WATER SUPPLY : UBA Partnering with NJJM

Prof Vivek Kumar
IIT Delhi

BACKGROUND

- 14th Finance Commission (2015-2020) recognized health, education, drinking water and sanitation as public services of national importance
- Defined the sustainable drinking water supply systems operated under a formal management model, 100% household metering, net revenues (water tariffs and subsidies) sufficient to cover at least the O&M costs.
- In this backdrop, Jal Jeevan Mission (JJM) aims at **providing Functional Household Tap Connection (FHTC) to every rural household by 2024.**
- The programme focuses on empowerment of Gram Panchayat/ local community, service delivery, partner with other stakeholders, convergence with other programmes, methodical monitoring of the programme and to capture service delivery data automatically for ensuring the quality of services.

STRUCTURE OF JJM

Fig 1: Structure of JJM

Role of GPs in Water supply infrastructure development

Planning and mobilization phase; implementation phase; post-implementation phase.

Activities	Agency responsible
Testing for yield and quality	PHED/ RWS Department
Development/ augment of source	GP & PHED/ RWS Department
Creation of infrastructure for water supply till FHTC including source sustainability	GP & PHED/ RWS Department
Entry into MB and preparation of running bills	PHED/ RWS Department
Greywater management works (to be executed in parallel with above)	DWSM & GP
Enabling payment post third party inspection	DWSM & GP
Geo-tagging of assets	PHED/ RWS Department
Create and maintain register for accounts	GP & PHED/ RWS Department
Trial runs	GP & PHED/ RWS Department
Installing water measurement devices, i.e. meter or sensor and integrating the same in IMIS	DWSM, PHED/ RWS Department, GP
Fixing & collection of O&M costs/ water tariff	GP
Scheme commissioning	GP & PHED/ RWS Department

UBA Connect with Component of JJM

- Development of in-village piped water supply infrastructure to provide tap water connection to every rural household;
- **Development of reliable drinking water sources and/ or augmentation of existing sources to provide long-term sustainability of water supply system;**
- Bulk water transfer, treatment plants and distribution network to cater to every rural household if necessary;
- **Technological interventions for removal of contaminants**
- Retrofitting of completed and ongoing schemes to provide FHTCs at minimum service level of 55 lpcd;
- **Greywater management;**
- **Support activities, i.e. IEC, HRD, training, development of utilities, water quality laboratories, water quality testing & surveillance, R&D, knowledge centre, capacity building of communities, etc.;**
- Unforeseen challenges/ issues emerging due to natural disasters/ calamities.

STRATEGIC POINTS OF JJM RELEVANT FOR UBA

- Community led partnership with States/ UTs strategy for achieving the objectives of JJM. Government to play a role of facilitator- long term sustainability in the sector.
- Role of Gram Panchayat and/ or its sub-committee/ local community critical in planning, implementation, management, operation and maintenance of water supply within the villages.(Panchayats have a constitutional mandate to manage drinking water).
- Local community/ Gram Panchayat and/ or its sub-committee, i.e. VWSC/ Paani Samiti/ User Group, etc. to play the key role for O&M, cost recovery, and good governance.
- Community participation, ownership and contribution in all decisions pertaining to water supply systems.

VAP -UBA

- Water quality management, catchment protection, recycling of used water and grey water management etc through Village action plan (VAP) by Gram panchayat or sub- committee, i.e. VWSC/Paani Samiti/User Group, etc. with support of ISA, PHED/ RWS.
  - History of water supply/ availability in the village; emergency arrangements like water supply through tankers, trains, etc.; part works related to water supply, source strengthening, general trend of water availability, major water-borne diseases;
  - Existing status of village water supply including source, water quality issues, if any, and O&M arrangement;
  - Current availability of water in water source and its long-term sustainability;
  - Need assessment and the available resources.
  - People's contribution towards partial capital cost in cash/ kind and/ or labor and towards O&M;

VAP…..

- Capacity building of members of Gram Panchayat and/ or its sub-committee, barefoot technicians, awareness generation among community on judicious use of water and change in living standards; persons to conduct water quality tests through Field Test
- location of proposed water source, washing/ places, cattle trough, finalization of technology option, implementation schedule, long-term O&M plan, etc.;
- Plan for providing water to public institutions,
- Schedule ad planning for sanitary inspection;
- Water safety and security plan.

JJM INSTITUTIONAL MECHANISM AT GROUND

- District water and sanitation mission (DWSM) and Village Water Sanitation Committee (VWSC- to implement the water supply schemes at ground level
- NGOs/ VOs/ women SHGs/ CBOs/ Trusts/ Foundations as partners in mobilizing and engaging the communities to plan, design, implement, manage, operate & maintain in-village water supply infrastructure.

JJM TECHNOLOGICAL INTERVENTIONS AND UBA

- Reject Management in case of Water Treatment Plant
- JJM guidelines promotes Innovation and R&D- for improving water efficiency, water quality monitoring, and sanitation and grey water management.
- Mechanism for water audit to reduce losses, promote conservation and to improve the water use efficiency in Village Action Plan.

SUPPORT ACTIVITIES AND UBA

- Information, Education and Communication (IEC),
- Human Resource Development (HRD) & training,
- Leadership development and change management,
- Skill Development & Entrepreneurship,
- Mobilization of local communities,
- Third party inspection,
- Key Resource Centers,
- Knowledge Centre and Documentation.
- Awareness on judicious use of water, community contribution and ownership, build capacities of GP and/ or its sub-committee

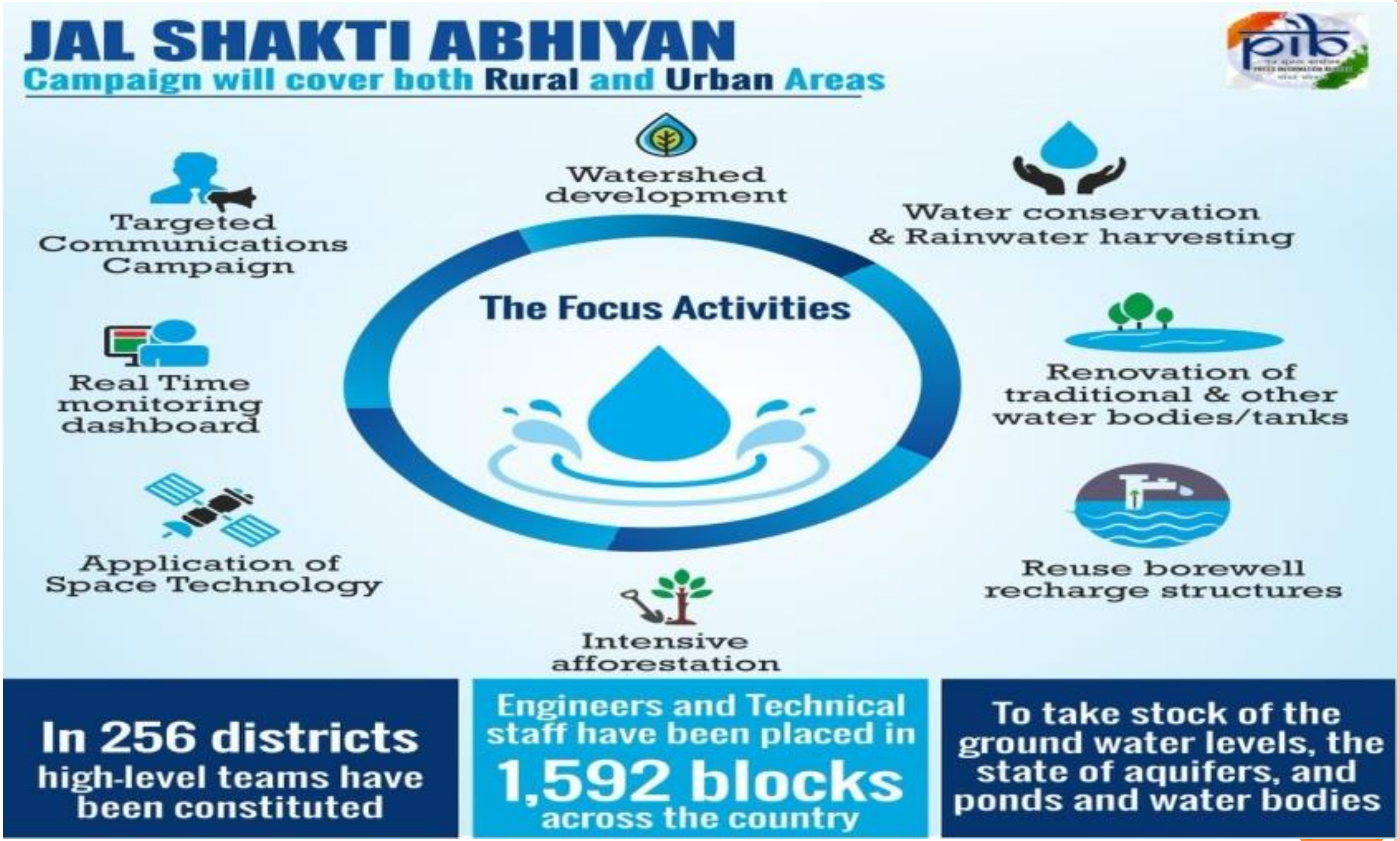
WATER QUALITY MONITORING AND SURVEILLANCE

- Sub-divisional/ block lab to test 100% water sources under its jurisdiction;
- Once for chemical parameters and twice for bacteriological parameters in a year, covering all sources of a block at least for 13 basic water quality parameters.
- The positively tested samples be referred to the district laboratory.
- Water quality surveillance using filed test Kits (FTKs) and sanitary inspection through community-Gram Panchayat and/ or its sub-committee, i.e. VWSC/ Paani Samiti/ User Group, etc.

MONITORING AND EVALUATION

- Centralized and continuous monitoring in real-time proposed using IoT, GIS, etc.
- Use of data analytics to enable analyzing data collected from rural areas to be used for various purposes by the utilities for smart management and better services.
- Strategy for the use of technologies for planning and monitoring like HGM maps, digital contour maps, digital inventory using GIS, use of sensors etc.
- State of art technologies like SCADA in treatment facility, software for project management.

Components of Jal Shakti Abhiyan



Any Queries Pls…..

उन्नत भारत अभियान
UNNAT BHARAT ABHIYAN

UBA Web-Seminar on Water Resources Management

May 14-15, 2020

Water Quality Monitoring and Treatment

Manoj Kumar Tiwari

School of Water Resources

Indian Institute of Technology Kharagpur

Outline…

- Water Pollution and common water contaminants
- Water quality monitoring
- Drinking water quality standards
- Common contaminants in surface water and groundwater
- Water treatment units for removal of common water pollutants

Is Water Quality a Concern ?

- ***Supply of water in sufficient quantity in itself is a major challenge***
- ***In the past, water quality have been considered as secondary issue.***

Approximately 3.5 million deaths related to inadequate water supply, sanitation and hygiene occur each year, predominantly in developing countries.

World Water Development Report 2012

Poor water quality incurs many economic costs:

Degradation of ecosystem services; Health-related costs;
Increased water treatment costs; Reduced property values
Impacts on economic activities such as agriculture, commerce and tourism etc.

Sufficient water supply of ***appropriate quality*** is a key ingredient in the health and well-being of humans and ecosystems, and for social and economic development.

Water quality is just as important as water quantity for satisfying basic human and environmental needs. Moreover, the two are inextricably linked.

Major Types of Water Pollution

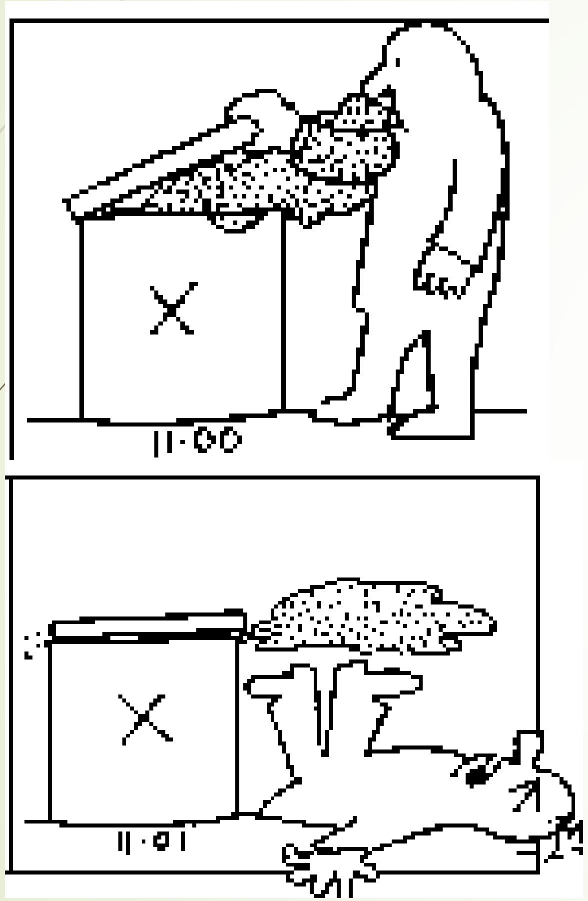
Type of Water Pollution	Cause of Pollution	Symptoms of Pollution	Effect of Pollution	Source of Pollution
Biodegradable waste	Humans and animals	Decreasing numbers of fish and other aquatic life, increasing number of bacteria	Increased number of bacteria, decreased oxygen levels, death of aquatic life	Run-off, improperly treated effluent,
Nutrients	Nitrates and phosphates	Green, cloudy, slimy, stinky water	Algae blooms, eutrophication of water source	Over use of fertilizers, run-off from fields, improper disposal of containers, wastewater treatment
Heat	Increased water temperature	Warmer water, less oxygen, fewer aquatic organisms	Decrease in oxygen levels, death of fish and plants	Industrial run-off, wastewater treatment
Sedimentation	Suspended particles settling out of water	Cloudy water, increased amount of bottom	Warms up water, decreases depth of water source, deposits toxins	Construction sites, farming and livestock operations, logging, flooding, city run-off, dams
Chemicals	Toxic and hazardous chemicals	Water colour changes, develops an odour, aquatic life die out	Kills aquatic life, can enter human food chain, leads to birth defects, infertility, cancer and other diseases in humans and animals	Human-made, improper disposal, run-off, dams, landfill leachate, industrial discharge, acid rain
Radioactive pollutants	Radioactive isotopes	Increased rates of birth defects and cancer in human and animal populations.	Kills aquatic species and leads to cancer and death in humans and other animals	Waste water discharges from factories, hospitals and uranium mines
Medical	Medicines, antibiotics	Infertility in aquatic organisms, and other unknown symptoms	Unknown	Humans dumping medicines into water systems, wastewater treatment
Microbiological	Bacteria, viruses, protozoa	People and animals become ill with gastrointestinal disorders	Undrinkable water	Improper treatment of water/effluent, can occur naturally

Source: https://www.safewater.org/operation-water-pollution-1/2017/1/30/lesson-2-types-of-water-pollution

Image Source: Jayaswal K., Sahu V., Gurjar B.R. (2018) Water Pollution, Human Health and Remediation. In: Bhattacharya S., Gupta A., Gupta A., Pandey A. (eds) Water Remediation. Energy, Environment, and Sustainability. Springer, Singapore

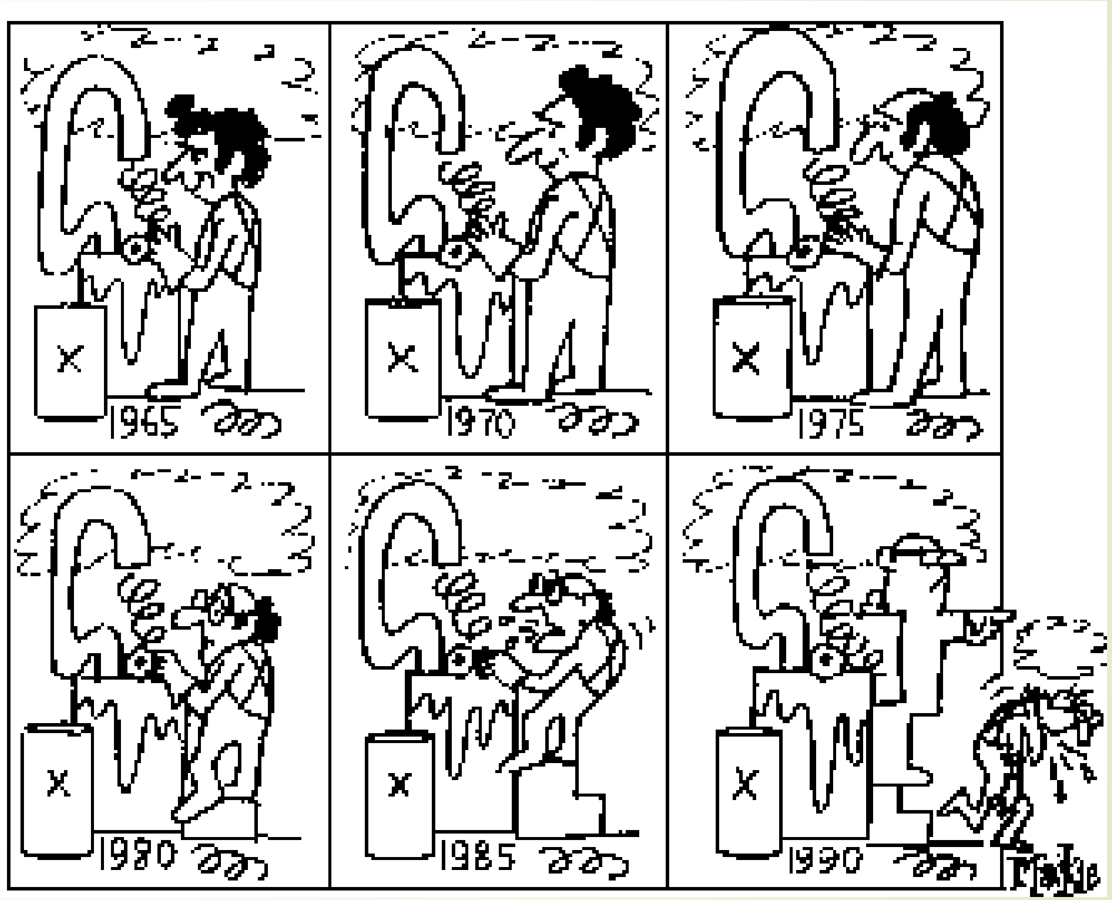
Acute vs Chronic Water Pollution

Acute



Short-term exposure to pollutant concentrations sufficient to result in acute effects.
e.g. exposure to pathogens

Chronic



Long-term exposure to relatively low level of pollutant concentrations leading to chronic effects.
e.g. exposure to arsenic, fluoride etc.

How to Monitor Quality of Water ?

Only physical appearance is often not enough to distinguish the quality of water.

Image Source:
https://www.hindustantimes.com/india-news/dump-waste-into-ganga-in-varanasi-and-pay-rs-50-000-fine/story-MrkA3gPseJO2HdL0jFc9ZL.html
https://www.westernvawater.org/drinking-water/water-sources-and-treatment/reservoir-levels

Water Quality Assessment

- The assessment of water quality is done through monitoring / analysing *Water Quality Parameters*, which show it's physical, chemical and biological properties.

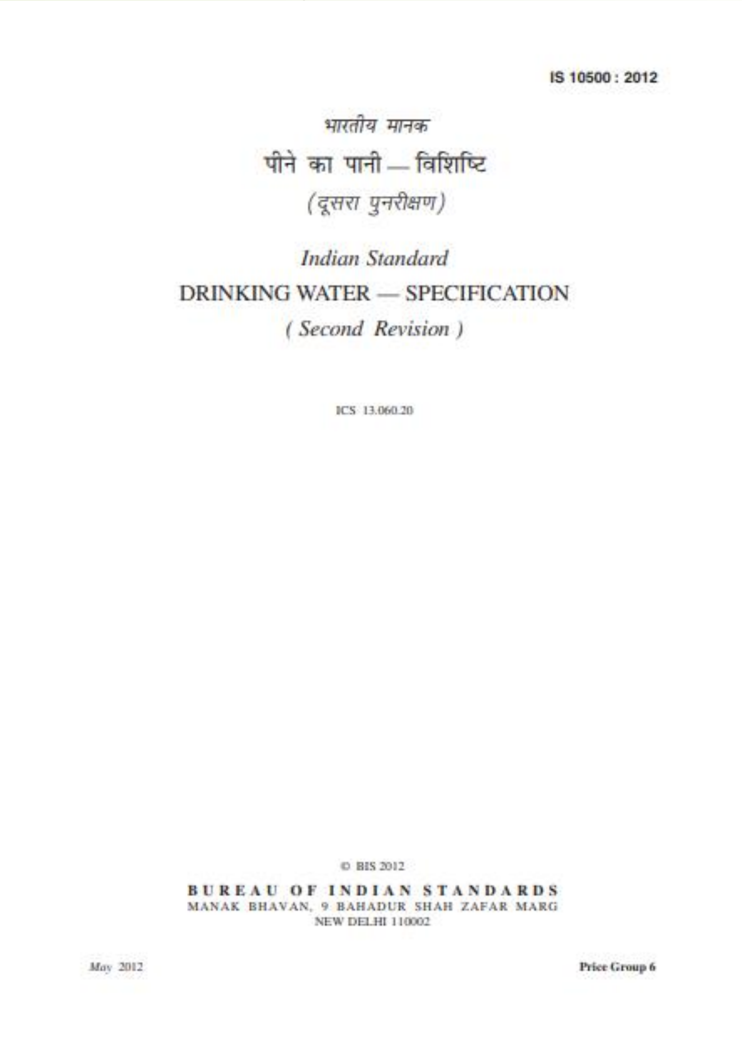
- Some of the common water quality parameters include:

  - Temperature, Colour, Odour, Turbidity, Conductivity, Solids (total, suspended, dissolved, fixed, volatile)

  - pH, Acidity, Alkalinity, Hardness, Nutrients (nitrogen, phosphorous), Metals (Fe, Al, As, Cr, Zn, Ni, Co etc.), Ions (chloride, carbonate, nitrate, sulphate etc.), Pesticides, Radioactive Emission, Dissolved Oxygen (DO), Chemical Oxygen Demand (COD), Biochemical Oxygen Demand (BOD), and other trace elements etc.

  - Most Probable Number (MPN), Total and Fecal Coliform

Drinking Water Quality Standards



IS 10500 : 2012

भारतीय मानक
पीने का पानी — विशिष्टि
(दूसरा पुनरीक्षण)

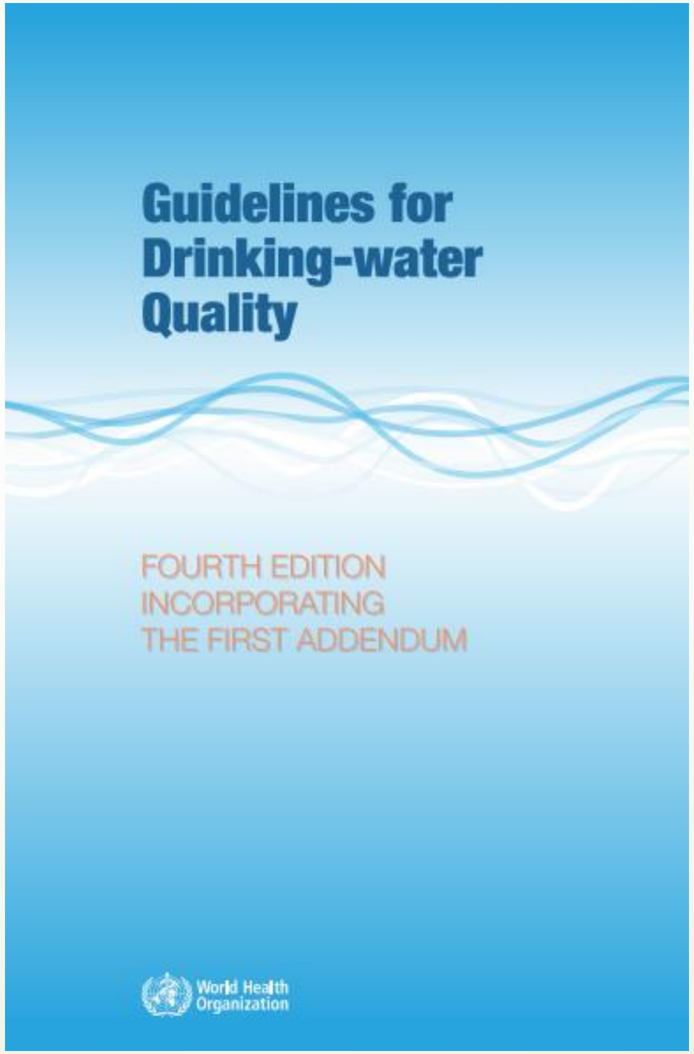
Indian Standard
DRINKING WATER — SPECIFICATION
(Second Revision)

ICS 13.060.20

© BIS 2012

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

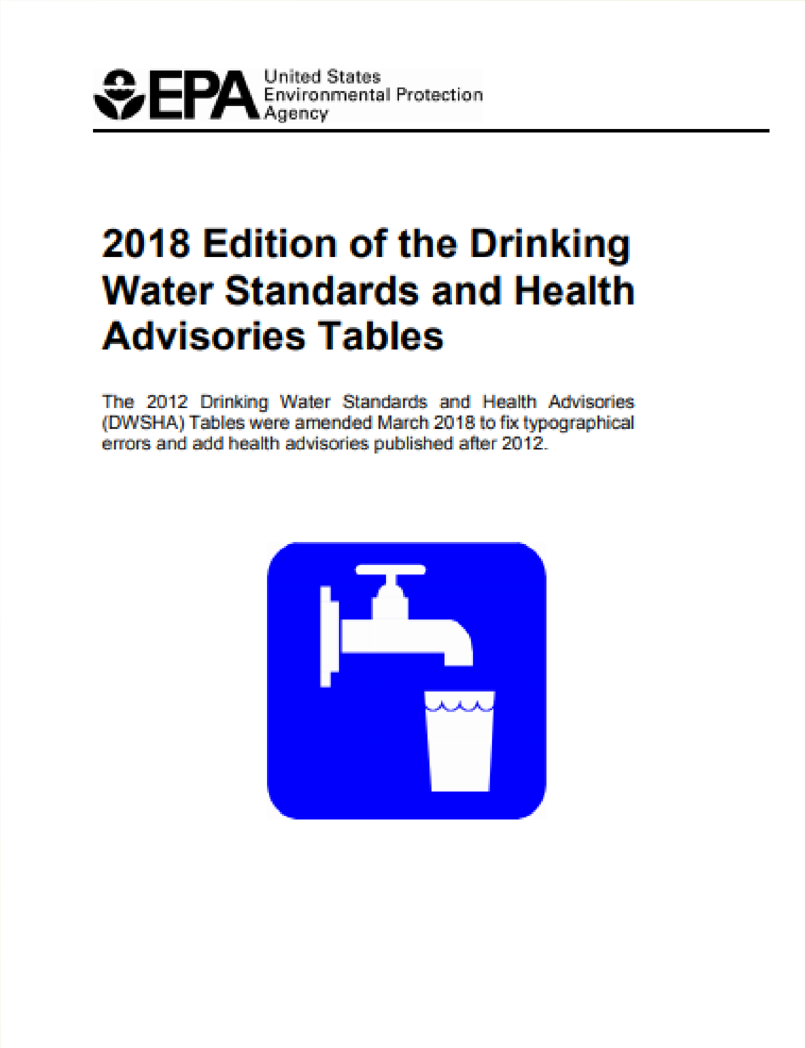
May 2012 Price Group 6



Guidelines for Drinking-water Quality

FOURTH EDITION
INCORPORATING
THE FIRST ADDENDUM

World Health Organization



EPA United States Environmental Protection Agency

2018 Edition of the Drinking Water Standards and Health Advisories Tables

The 2012 Drinking Water Standards and Health Advisories (DWSHA) Tables were amended March 2018 to fix typographical errors and add health advisories published after 2012.

BIS Drinking Water Quality Standards (IS 10500 : 2012)

Table 1 Organoleptic and Physical Parameters
(*Foreword* and *Clause* 4)

Sl No.	Characteristic	Requirement (Acceptable Limit)	Permissible Limit in the Absence of Alternate Source	Method of Test, Ref to Part of IS 3025	Remarks
(1)	(2)	(3)	(4)	(5)	(6)
i)	Colour, Hazen units, *Max*	5	15	Part 4	Extended to 15 only, if toxic substances are not suspected in absence of alternate sources
ii)	Odour	Agreeable	Agreeable	Part 5	a) Test cold and when heated b) Test at several dilutions
iii)	*p*H value	6.5-8.5	No relaxation	Part 11	—
iv)	Taste	Agreeable	Agreeable	Parts 7 and 8	Test to be conducted only after safety has been established
v)	Turbidity, NTU, *Max*	1	5	Part 10	—
vi)	Total dissolved solids, mg/l, *Max*	500	2 000	Part 16	—

NOTE — It is recommended that the acceptable limit is to be implemented. Values in excess of those mentioned under 'acceptable' render the water not suitable, but still may be tolerated in the absence of an alternative source but up to the limits indicated under 'permissible limit in the absence of alternate source' in col 4, above which the sources will have to be rejected.

BIS Drinking Water Quality Standards (IS 10500 : 2012)

Table 2 General Parameters Concerning Substances Undesirable in Excessive Amounts
(*Foreword* and *Clause* 4)

Sl No.	Characteristic	Requirement (Acceptable Limit)	Permissible Limit in the Absence of Alternate Source	Method of Test, Ref to	Remarks
(1)	(2)	(3)	(4)	(5)	(6)
i)	Aluminium (as Al), mg/l, *Max*	0.03	0.2	IS 3025 (Part 55)	—
ii)	Ammonia (as total ammonia-N), mg/l, *Max*	0.5	No relaxation	IS 3025 (Part 34)	—
iii)	Anionic detergents (as MBAS) mg/l, *Max*	0.2	1.0	Annex K of IS 13428	—
iv)	Barium (as Ba), mg/l, *Max*	0.7	No relaxation	Annex F of IS 13428* or IS 15302	—
v)	Boron (as B), mg/l, *Max*	0.5	1.0	IS 3025 (Part 57)	—
vi)	Calcium (as Ca), mg/l, *Max*	75	200	IS 3025 (Part 40)	—
vii)	Chloramines (as Cl_2), mg/l, *Max*	4.0	No relaxation	IS 3025 (Part 26)* or APHA 4500-Cl G	—
viii)	Chloride (as Cl), mg/l, *Max*	250	1 000	IS 3025 (Part 32)	—
ix)	Copper (as Cu), mg/l, *Max*	0.05	1.5	IS 3025 (Part 42)	—
x)	Fluoride (as F) mg/l, *Max*	1.0	1.5	IS 3025 (Part 60)	—
xi)	Free residual chlorine, mg/l, *Min*	0.2	1	IS 3025 (Part 26)	To be applicable only when water is chlorinated. Tested at consumer end. When protection against viral infection is required, it should be minimum 0.5 mg/l
xii)	Iron (as Fe), mg/l, *Max*	0.3	No relaxation	IS 3025 (Part 53)	Total concentration of manganese (as Mn) and iron (as Fe) shall not exceed 0.3 mg/l
xiii)	Magnesium (as Mg), mg/l, *Max*	30	100	IS 3025 (Part 46)	—
xiv)	Manganese (as Mn), mg/l, *Max*	0.1	0.3	IS 3025 (Part 59)	Total concentration of manganese (as Mn) and iron (as Fe) shall not exceed 0.3 mg/l
xv)	Mineral oil, mg/l, *Max*	0.5	No relaxation	Clause **6** of IS 3025 (Part 39) Infrared partition method	—
xvi)	Nitrate (as NO_3), mg/l, *Max*	45	No relaxation	IS 3025 (Part 34)	—
xvii)	Phenolic compounds (as C_6H_5OH), mg/l, *Max*	0.001	0.002	IS 3025 (Part 43)	—
xviii)	Selenium (as Se), mg/l, *Max*	0.01	No relaxation	IS 3025 (Part 56) or IS 15303*	—
xix)	Silver (as Ag), mg/l, *Max*	0.1	No relaxation	Annex J of IS 13428	—
xx)	Sulphate (as SO_4) mg/l, *Max*	200	400	IS 3025 (Part 24)	May be extended to 400 provided that Magnesium does not exceed 30
xxi)	Sulphide (as H_2S), mg/l, *Max*	0.05	No relaxation	IS 3025 (Part 29)	—
xxii)	Total alkalinity as calcium carbonate, mg/l, *Max*	200	600	IS 3025 (Part 23)	—
xxiii)	Total hardness (as $CaCO_3$), mg/l, *Max*	200	600	IS 3025 (Part 21)	—
xxiv)	Zinc (as Zn), mg/l, *Max*	5	15	IS 3025 (Part 49)	—

NOTES

1 In case of dispute, the method indicated by '*' shall be the referee method.

2 It is recommended that the acceptable limit is to be implemented. Values in excess of those mentioned under 'acceptable' render the water not suitable, but still may be tolerated in the absence of an alternative source but up to the limits indicated under 'permissible limit in the absence of alternate source' in col 4, above which the sources will have to be rejected.

BIS Drinking Water Quality Standards (IS 10500 : 2012)

Table 3 Parameters Concerning Toxic Substances
(*Foreword* and *Clause* 4)

Sl No. (1)	Characteristic (2)	Requirement (Acceptable Limit) (3)	Permissible Limit in the Absence of Alternate Source (4)	Method of Test, Ref to (5)	Remarks (6)
i)	Cadmium (as Cd), mg/l, *Max*	0.003	No relaxation	IS 3025 (Part 41)	—
ii)	Cyanide (as CN), mg/l, *Max*	0.05	No relaxation	IS 3025 (Part 27)	—
iii)	Lead (as Pb), mg/l, *Max*	0.01	No relaxation	IS 3025 (Part 47)	—
iv)	Mercury (as Hg), mg/l, *Max*	0.001	No relaxation	IS 3025 (Part 48)/ Mercury analyser	—
v)	Molybdenum (as Mo), mg/l, *Max*	0.07	No relaxation	IS 3025 (Part 2)	—
vi)	Nickel (as Ni), mg/l, *Max*	0.02	No relaxation	IS 3025 (Part 54)	—
vii)	Pesticides, µg/l, *Max*	See Table 5	No relaxation	See Table 5	—
viii)	Polychlorinated biphenyls, mg/l, *Max*	0.000 5	No relaxation	ASTM 5175*	— or APHA 6630
ix)	Polynuclear aromatic hydro-carbons (as PAH), mg/l, *Max*	0.000 1	No relaxation	APHA 6440	—
x)	Total arsenic (as As), mg/l, *Max*	0.01	0.05	IS 3025 (Part 37)	—
xi)	Total chromium (as Cr), mg/l, *Max*	0.05	No relaxation	IS 3025 (Part 52)	—
xii)	Trihalomethanes:				
	a) Bromoform, mg/l, *Max*	0.1	No relaxation	ASTM D 3973-85* or APHA 6232	—
	b) Dibromochloromethane, mg/l, *Max*	0.1	No relaxation	ASTM D 3973-85* or APHA 6232	—
	c) Bromodichloromethane, mg/l, *Max*	0.06	No relaxation	ASTM D 3973-85* or APHA 6232	—
	d) Chloroform, mg/l, *Max*	0.2	No relaxation	ASTM D 3973-85* or APHA 6232	—

NOTES

1 In case of dispute, the method indicated by '*' shall be the referee method.

2 It is recommended that the acceptable limit is to be implemented. Values in excess of those mentioned under 'acceptable' render the water not suitable, but still may be tolerated in the absence of an alternative source but up to the limits indicated under 'permissible limit in the absence of alternate source' in col 4, above which the sources will have to be rejected.

Table 4 Parameters Concerning Radioactive Substances
(*Foreword* and *Clause* 4)

Sl No. (1)	Characteristic (2)	Requirement (Acceptable Limit) (3)	Permissible Limit in the Absence of Alternate Source (4)	Method of Test, Ref to Part of IS 14194 (5)	Remarks (6)
i)	Radioactive materials:				
	a) Alpha emitters Bq/l, *Max*	0.1	No relaxation	Part 2	—
	b) Beta emitters Bq/l, *Max*	1.0	No relaxation	Part 1	—

NOTE — It is recommended that the acceptable limit is to be implemented. Values in excess of those mentioned under 'acceptable' render the water not suitable, but still may be tolerated in the absence of an alternative source but up to the limits indicated under 'permissible limit in the absence of alternate source' in col 4, above which the sources will have to be rejected.

Table 5 Pesticide Residues Limits and Test Method
(*Foreword* and *Table* 3)

Sl No. (1)	Pesticide (2)	Limit µg/l (3)	Method of Test, Ref to: USEPA (4)	Method of Test, Ref to: AOAC/ ISO (5)
i)	Alachlor	20	525.2, 507	—
ii)	Atrazine	2	525.2, 8141 A	—
iii)	Aldrin/ Dieldrin	0.03	508	—
iv)	Alpha HCH	0.01	508	—
v)	Beta HCH	0.04	508	—
vi)	Butachlor	125	525.2, 8141 A	—
vii)	Chlorpyriphos	30	525.2, 8141 A	—
viii)	Delta HCH	0.04	508	—
ix)	2,4- Dichlorophenoxyacetic acid	30	515.1	—
x)	DDT (*o, p* and *p, p* – Isomers of DDT, DDE and DDD)	1	508	AOAC 990.06
xi)	Endosulfan (alpha, beta, and sulphate)	0.4	508	AOAC 990.06
xii)	Ethion	3	1657 A	—
xiii)	Gamma — HCH (Lindane)	2	508	AOAC 990.06
xiv)	Isoproturon	9	532	—
xv)	Malathion	190	8141 A	—
xvi)	Methyl parathion	0.3	8141 A	ISO 10695
xvii)	Monocrotophos	1	8141 A	—
xviii)	Phorate	2	8141 A	—

NOTE — Test methods are for guidance and reference for testing laboratory. In case of two methods, USEPA method shall be the reference method.

Table 6 Bacteriological Quality of Drinking Water[1)]
(*Clause* 4.1.1)

Sl No. (1)	Organisms (2)	Requirements (3)
i)	*All water intended for drinking:*	
	a) *E. coli* or thermotolerant coliform bacteria[2), 3)]	Shall not be detectable in any 100 ml sample
ii)	*Treated water entering the distribution system:*	
	a) *E. coli* or thermotolerant coliform bacteria[2)]	Shall not be detectable in any 100 ml sample
	b) Total coliform bacteria	Shall not be detectable in any 100 ml sample
iii)	*Treated water in the distribution system:*	
	a) *E. coli* or thermotolerant coliform bacteria	Shall not be detectable in any 100 ml sample
	b) Total coliform bacteria	Shall not be detectable in any 100 ml sample

[1)] Immediate investigative action shall be taken if either *E.coli* or total coliform bacteria are detected. The minimum action in the case of total coliform bacteria is repeat sampling; if these bacteria are detected in the repeat sample, the cause shall be determined by immediate further investigation.

[2)] Although, *E. coli* is the more precise indicator of faecal pollution, the count of thermotolerant coliform bacteria is an acceptable alternative. If necessary, proper confirmatory tests shall be carried out. Total coliform bacteria are not acceptable indicators of the sanitary quality of rural water supplies, particularly in tropical areas where many bacteria of no sanitary significance occur in almost all untreated supplies.

[3)] It is recognized that, in the great majority of rural water supplies in developing countries, faecal contamination is widespread. Under these conditions, the national surveillance agency should set medium-term targets for progressive improvement of water supplies.

Common Contaminants in Surface Water

- Pathogens / Microbial contaminants
- Sediments
- Heavy metals
- Organic compounds
- Emerging contaminants
  - Pesticides
  - Pharmaceuticals and personal care products
  - Endocrine disrupting compounds (EDCs)

Major Contaminants in Groundwater

<u>*Source:*</u> *Central Ground Water Board, Ministry of Jal Shakti, Govt. of India*

Nature of quality problem	Number of affected habitations	Approximate population at risk (million)	Affected regions
Excess Arsenic (0.05-3.2 mg/L)	5,029	25	79 blocks of 8 districts (Bardhaman, Hoogli, Howrah, Malda, Murshidabad, Nadia, North and South 24 Parganas) of West Bengal, parts of Bhojpur and Patna districts of Bihar and Ballia district of Uttar Pradesh, parts of Rajnandgaon district of Chhattisgarh and parts of Assam
Excess Fluoride (1.5-48 mg/L)	36,988	71	(a) Kerala, Jammu & Kashmir, West Bengal, Orissa, Assam, Bihar and Delhi with less than 30 per cent of the districts affected. (b) Punjab, Haryana, Madhya Pradesh, Karnataka, Uttar Pradesh, Tamil Nadu, Chattisgarh and Maharashtra with 30-70 per cent of the districts affected. (c) Rajasthan, Gujarat and Andhra Pradesh with 70-100 per cent of the districts affected.
Excess Iron (1-20mg/L)	1,38,670	-	Prevalent mostly in hilly regions, parts of Assam, Agartala, Bihar, Orissa, Rajasthan, Tripura, West Bengal, Uttar Pradesh, Punjab, Maharashtra, Madhya Pradesh, Chhattisgarh, Jharkhand, Tamilnadu and Kerala.
Excess Nitrate (50-1000 mg/L)	13,958	842.54	Parts of Uttar Pradesh, West Bengal, Rajasthan, Madhya Pradesh, Chandigarh, Punjab, Haryana, Delhi, Bihar, Maharashtra, Karnataka, Kerala, Orissa, Jammu & Kashmir, Himachal Pradesh, Gujarat, Tamil Nadu and Andhra Pradesh
Excess Salinity (Inland and coastal) (2000-27000 mg/L)	32,597	-	Inland salinity: Inland salinity in ground water is caused due to geogenic sources. The problem of inland salinity has been observed in arid and semi arid regions of Rajasthan, Haryana, Punjab, and Gujarat with limited extent in the states of Uttar Pradesh, Delhi, Karnataka, Maharashtra, Madhya Pradesh and Tamilnadu. Electrical conductivity in these areas exceeds 4000 micro Siemens/ cm. Coastal salinity: Problem of coastal salinity in ground water that is caused due to excessive exploitation of ground water has been observed in Mangrol - Chorwad areas and Coastal Saurashtra of Gujarat, Minjur area in Tamilnadu, Pondicherry coast, parts of Orissa, Andhra Pradesh and Kerala coast.
Other reasons (Heavy metals, Pesticides, Fertilizers, etc.)	25,092	-	Parts of Andhra Pradesh, Assam, Bihar, Goa, Gujarat, Haryana, Himachal Pradesh, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Meghalaya, Orissa, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh, West Bengal and NCT of Delhi

Concept of Water Treatment

Process of removal of pollutants from water to produce safe water for specific uses.

Image Source: https://genesiswatertech.com/blog-post/drinking-water-treatment-necessary/

In centralized water supply systems, the water treatment should be provided before sending water to consumers. Positively, the post treatment safety should also be ensured, eliminating chances of contamination in distribution systems. Also, the treated waters should not be stored for long in storage or overhead reservoirs to reduce the chances of contamination due to long storage.

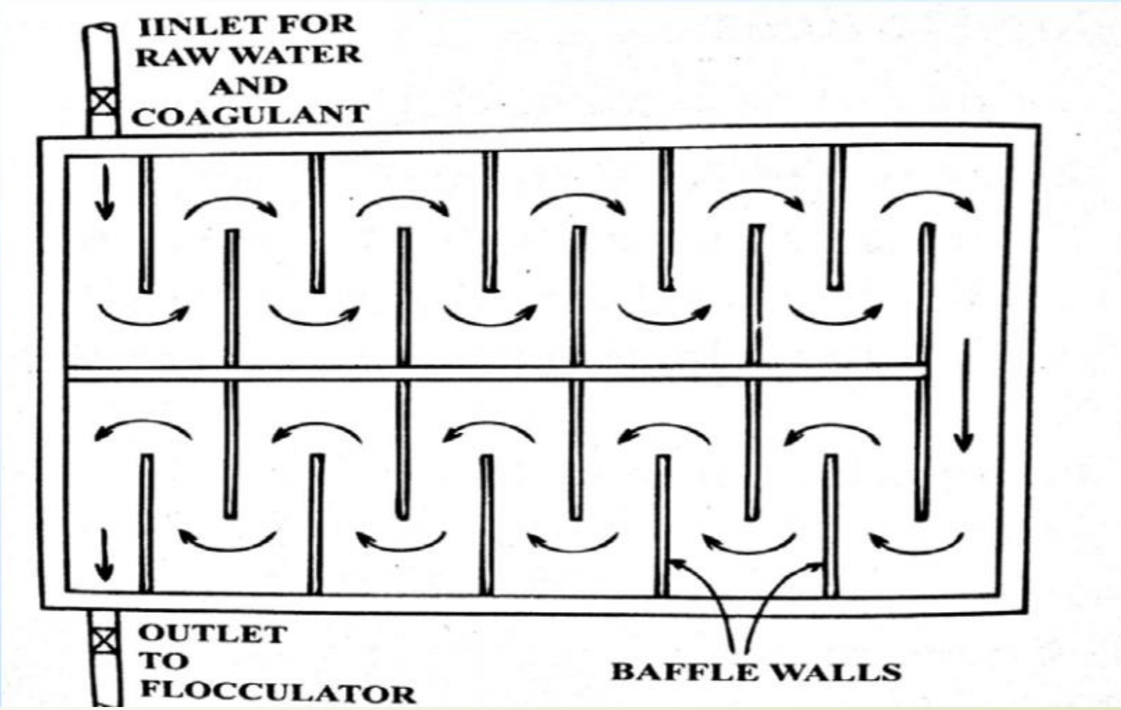
Treatment: Removal of Sediments

Settling / Sedimentation Tank

Treatment: Removal of Collides

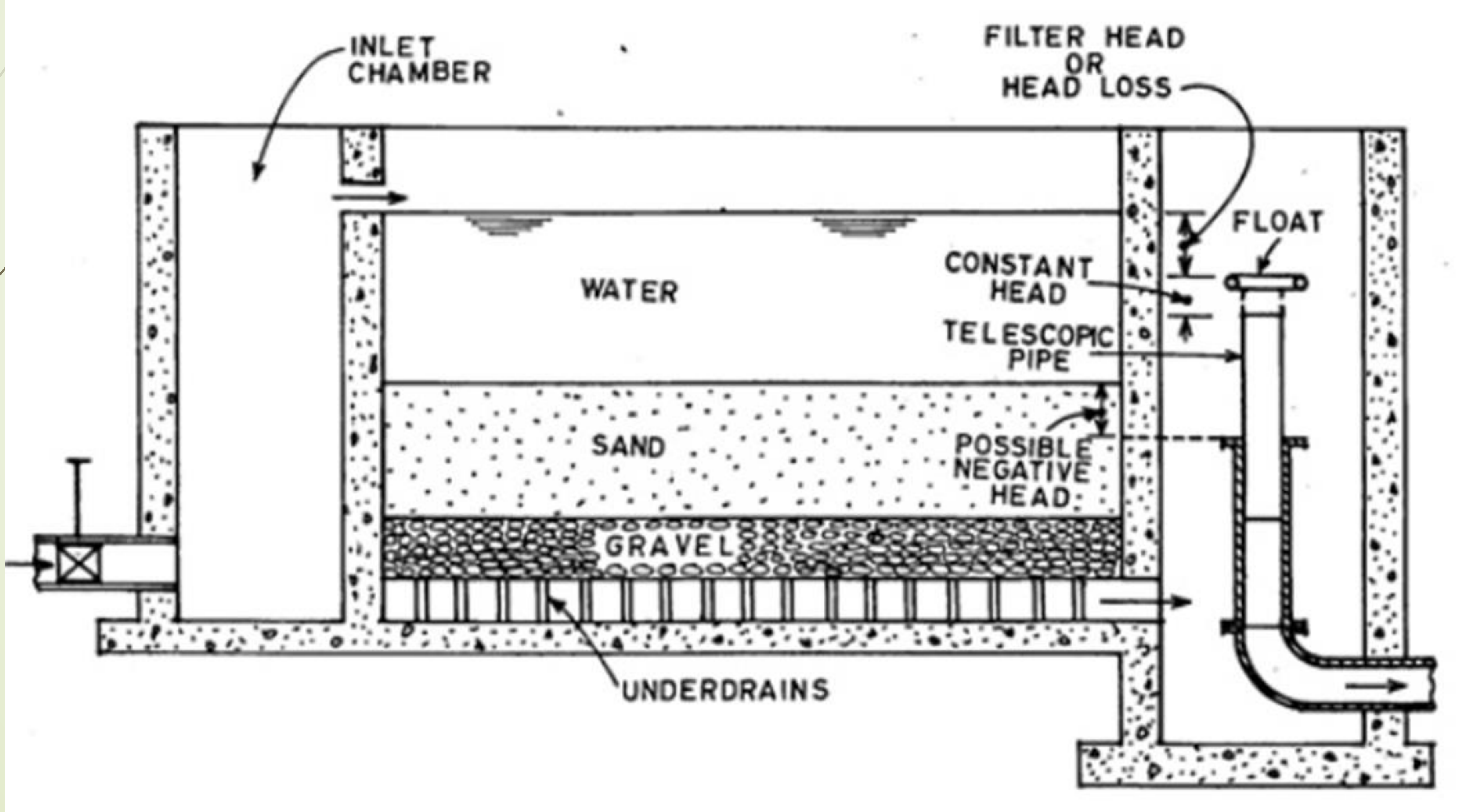
Flocculation Basin / Baffled channels

(prior addition of alum/iron salts as coagulant is needed; post settling is also needed)



Treatment: Removal of Micro-flocs and Fine Sediments

Slow Sand Filters (Rapid sand for larger systems)



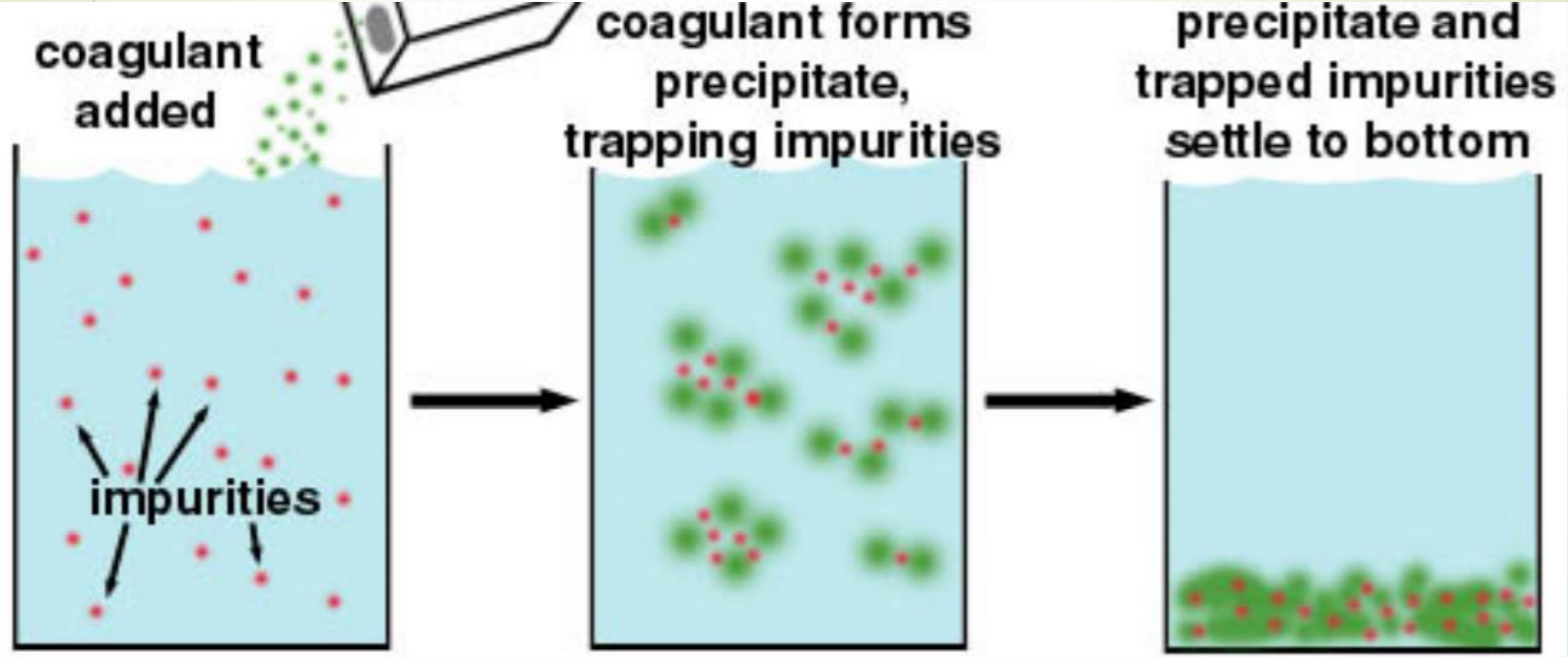
Treatment: Removal of Pathogens

Disinfection - Chlorination/UV Exposure/Ozonation; Ceramic Filters

Treatment: Removal of Dissolved Metals

Chemical Precipitation of Co-precipitation

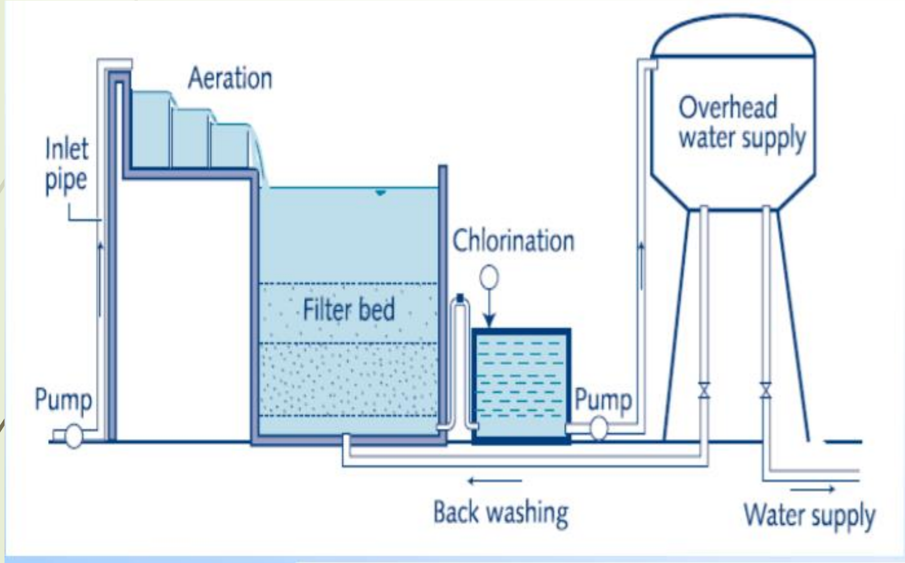
(prior addition of coagulant is needed and the process is followed by settling/filtration)

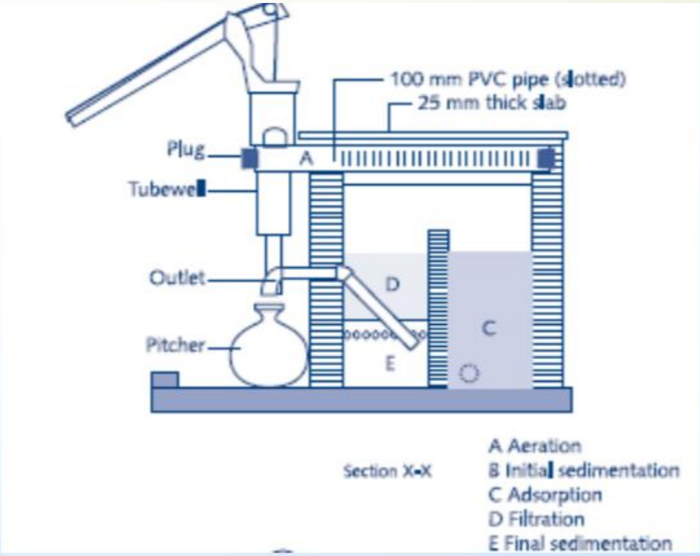


Treatment: Removal of Iron and Arsenic

Oxidation and Precipitation / Co-precipitation

(the process is followed by settling/filtration)



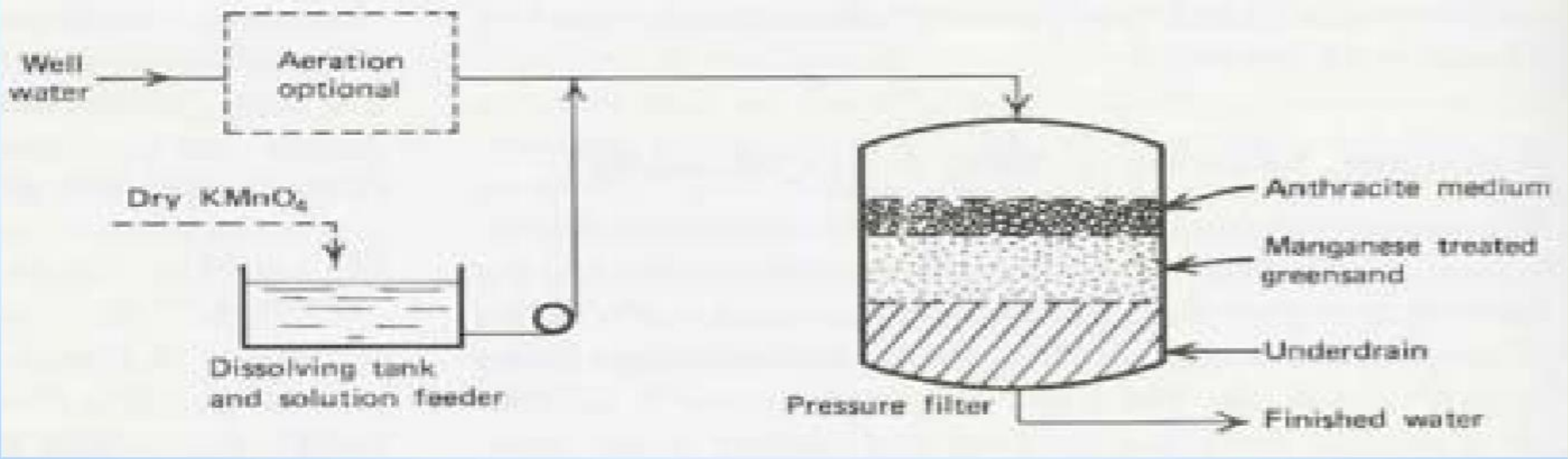


SORAS (Solar Oxidation and Removal of Arsenic)

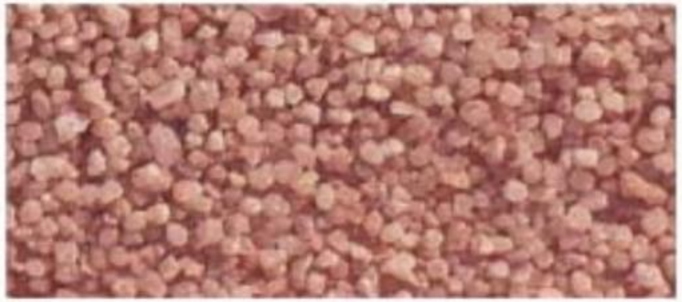
SONO Filter

Treatment: Removal of Iron and Manganese

Oxidation and Filtration



Effective Filtration Media

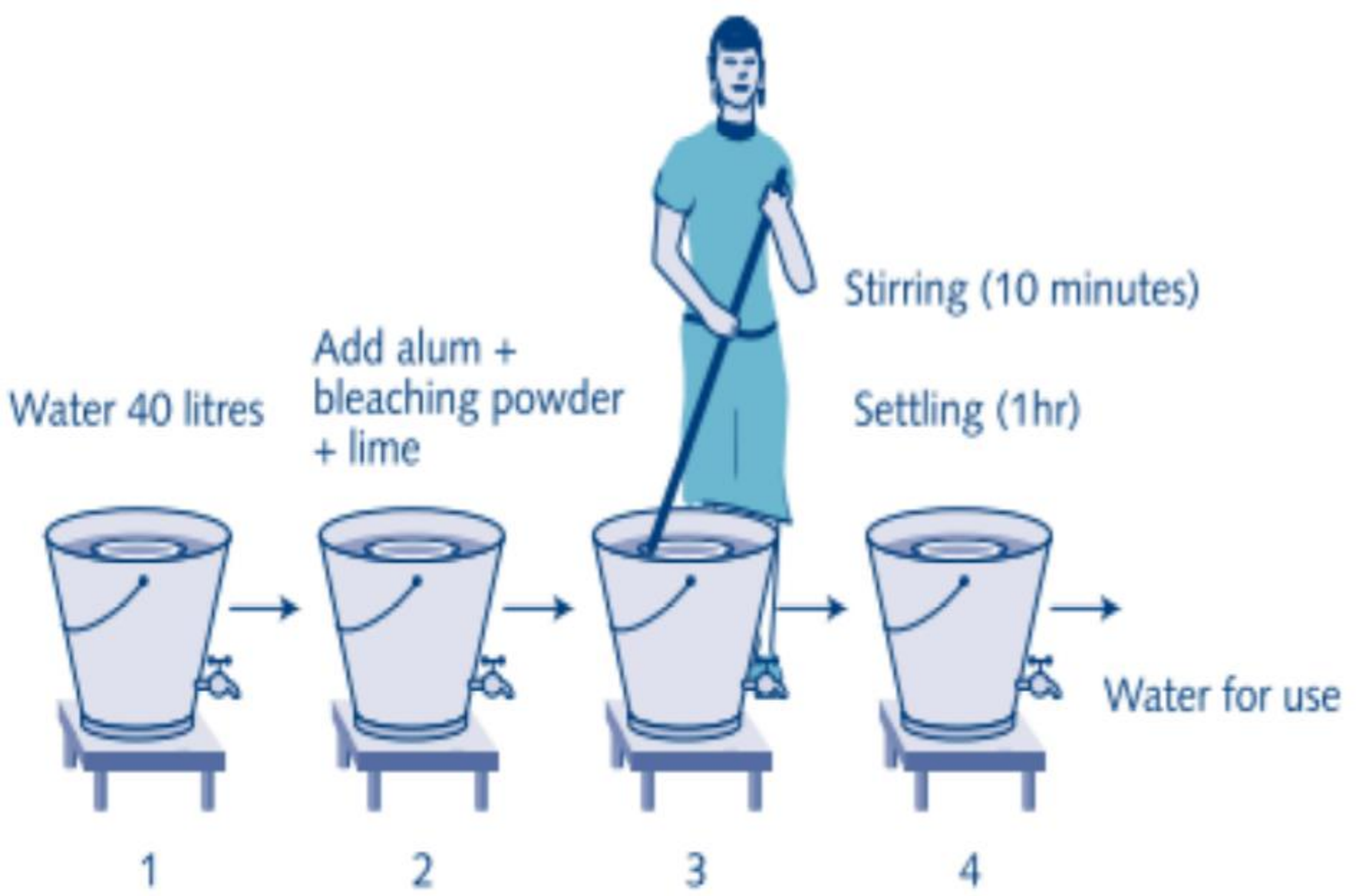

Manganese greensand

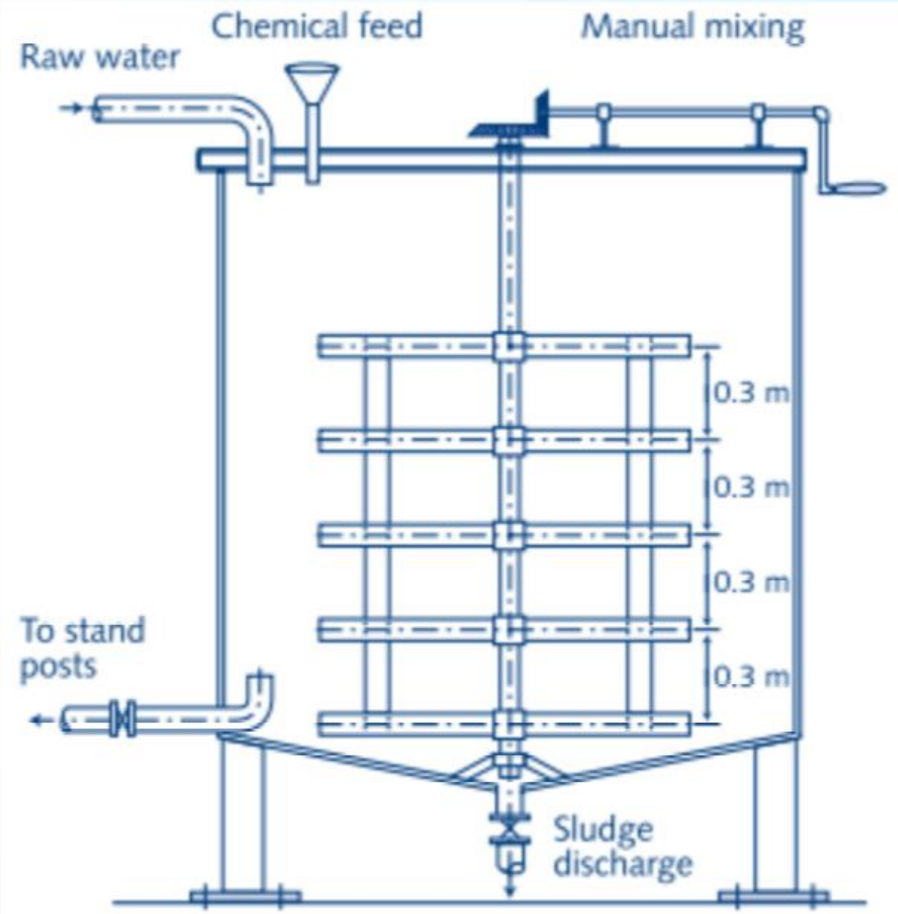

anthracite

Treatment: Removal of Fluoride

Nalgonda Technique: Alum-lime treatment

(Poly Aluminium Chloride (PAC) or Poly Aluminium Hydroxy Sulphate(PAHS) gives better removal at lesser dose than Alum)





Adsorption, Ion-exchange or membrane processes may be used for better efficiency

Advanced Treatment

Processes for water softening, heavy metals removal, nutrients removal, emerging contaminants removal, advanced microbiol control etc.

Non-Membrane Systems

- Lime Soda Softening or Precipitation
- Alum or Iron compound co-precipitation
- Dissolved Air Flotation
- Ion Exchange
- Granular Activated Carbon
- Advanced oxidation processes
- UV / Ozone disinfection

Membrane Processes

- Microfiltration
- Ultrafiltration
- Nanofiltration
- Reverse Osmosis
- Electrodialysis

Key Remarks

- Water quality monitoring is essential but costly affair. Therefore, one must carefully identify all important parameters to monitor.

- Two of the most common and important parameters for drinking water are pathogens count (MPN/CFU) and TDS. Overall toxicity must also be monitored, at-least, occasionally.

- Treatment technologies are available for removal/treatment of any short of pollutant present in water.

- Various treatment alternatives are available for removal of similar kind of contaminants. The selection of treatment units must be based on raw water characteristics, desired removal efficiencies, and cost budget, and feasibility of managing operation and maintenance of the alternate treatment systems.

THANK YOU !

INDIGENOUS AND TRADITIONAL TECHNOLOGIES OF RAINWATER HARVESTING

Dr. P.K. Singh
Professor
Department of Soil & Water Engineering
College of Technology & Engineering,
MPUAT, Udaipur

SALIENT FACTS

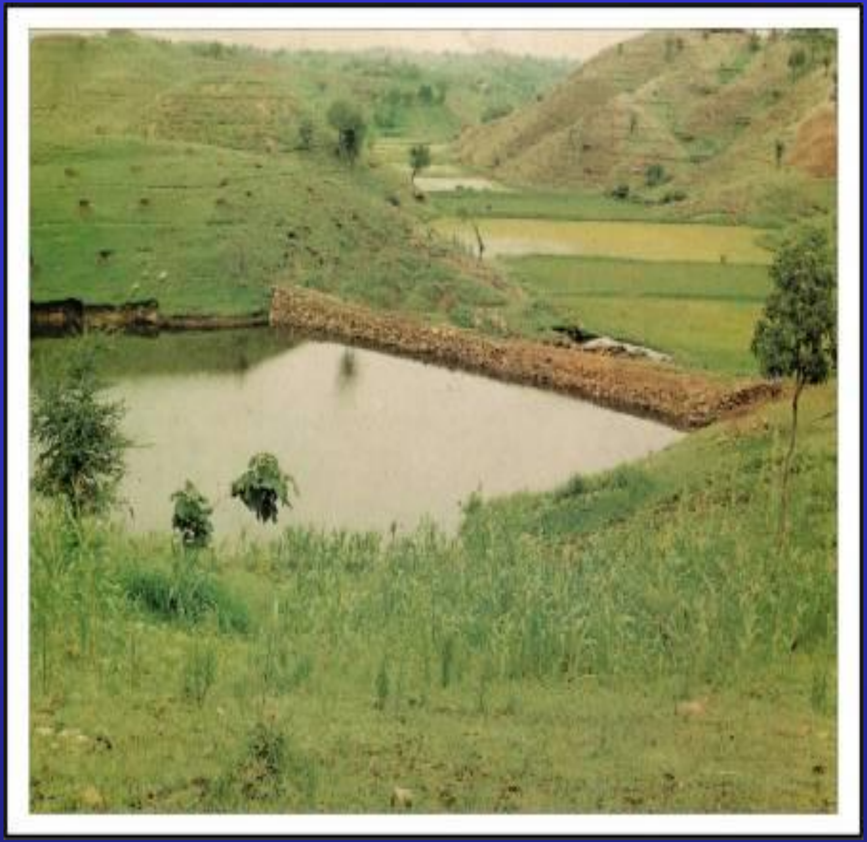
- India is having 2.4% of World Total Area
- 16% of World Population
- 18% of World Livestock
- 4% of total available fresh water
- 90% drinking water supply in rural area depends on groundwater.
- Rainfall- four months only in monsoon season (June to Sept.)

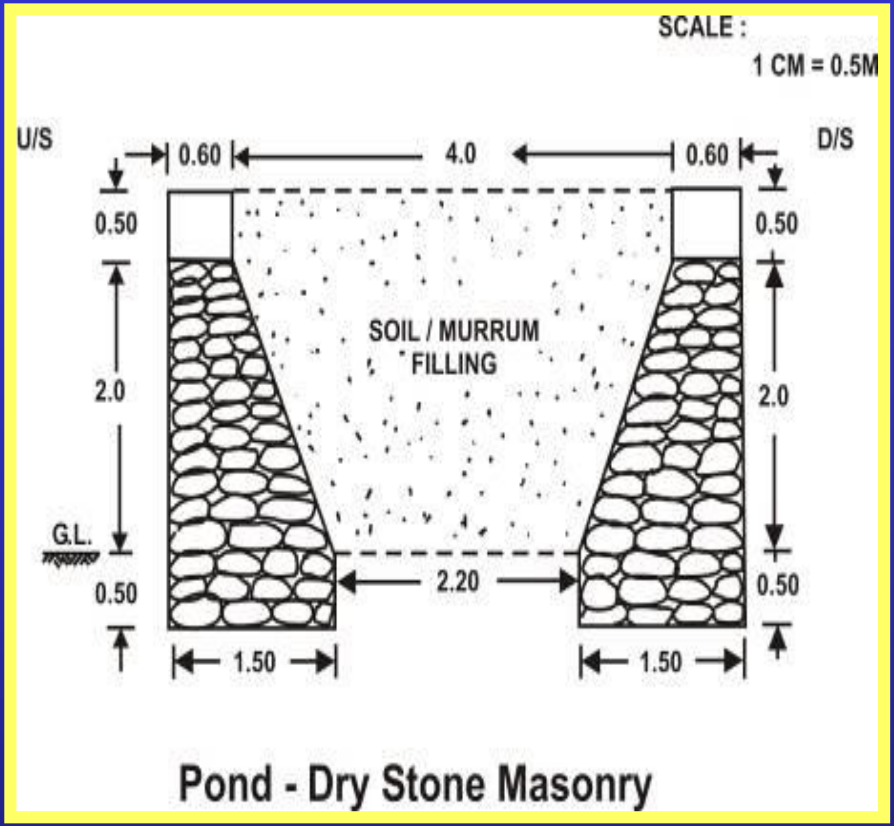
Status of Water Availability per person per year

1951	2028
1971	1725
1991	1042
2008	840
2025	567
2035	506
2045	457

INDIGENOUS AND LOW COST WATER HARVESTING STRUCTURES

- Constructed by Local Community
- Local Available Materials
- Local Skill is required for construction
- Low Cost and high level of adoptability
- Constructed by Group of village Community in the Small Streams
- The stored water can be utilized for life saving irrigation and ground water recharging



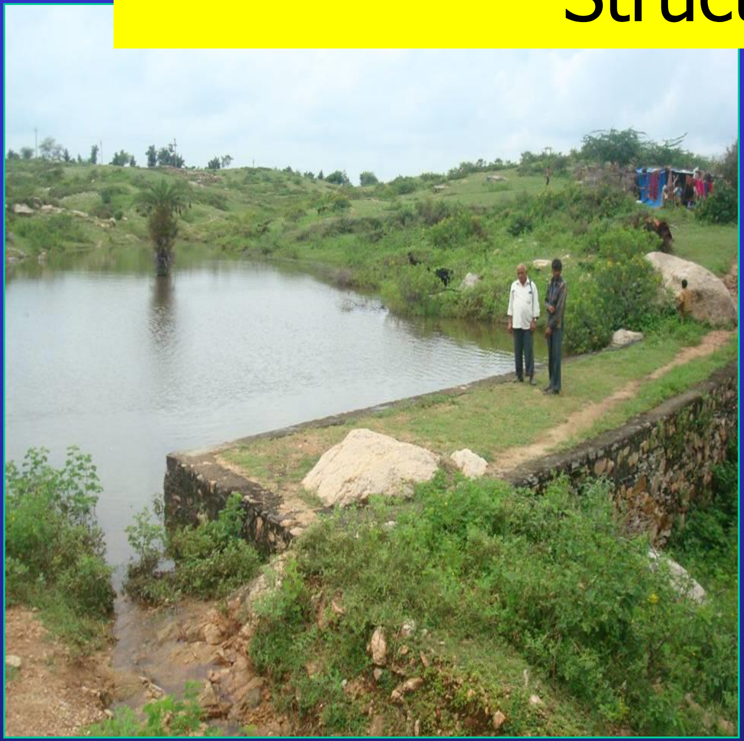


Dry Stone masonry pond

Low Cost Water Harvesting Structure

Dry stone masonry pond

Low Cost Dry Stone Masonry Type Groundwater Recharging Structure



Suitable for hilly regions of southern Rajasthan

Cost: Rs. 45000 for 2 m height of structure with average span of 10 m

Av recharge rate 7.55 cm/day

Net recharge volume 3918.44 m^3

News

कम लागत में चेक डैम बनाने के निर्देश

उदयपुर| जलग्रहण विकास एवं भू संरक्षण विभाग के निदेशक एम.एस. काला ने पंचायत समिति गिर्वा के जलग्रहण क्षेत्र चणावदा तथा पंचायत समिति सराड़ा के जलग्रहण क्षेत्र का निरीक्षण किया। जिसमें उन्होंने गिर्वा के लूज स्टोन चैकडेम कार्य, वानिकी पौधरोपण एवं एनीकट निर्माण कार्य देखे। इस मौके पर उन्होंने उदयपुर जिले के अधिकारियों को अधिक से अधिक कम लागत वाले चैकडेम बनाने के निर्देश दिए। इस मौके पर अतिरिक्त निदेशक अरुण सुराणा (प्रशासन), अतिरिक्त निदेशक राजेश भंडारी (आईडब्ल्यूएमपी), अधीक्षण अभियंता जलग्रहण उदयपुर के मदन छाजेड़ मौजूद थे।

Adopted under MGNREGA and NRM projects by Govt. and Non-Govt. Organizations

Comparison on cost effectiveness of designed low cost water harvesting structures

Heights (m)	Dry stone masonry type WHS		Cement masonry on upstream type WHS		Masonry Anicut	
	Total cost (Rs.)	Cost/m (Rs.)	Total cost (Rs.)	Cost/m (Rs.)	Total cost (Rs.)	Cost/m (Rs.)
1.0	10400	416	19825	793	85000	3400
2.0	25750	1030	48000	1920	155000	6200
2.5	35500	1420	67550	2702	210000	8400

Semi masonry dam

Cross Sectional Area : 0.52 m^2

Earthen Field Bunds

Stone wall terraces

Indigenous Loose Stone Check Dam

Wheat Crop cultivation on residual moisture

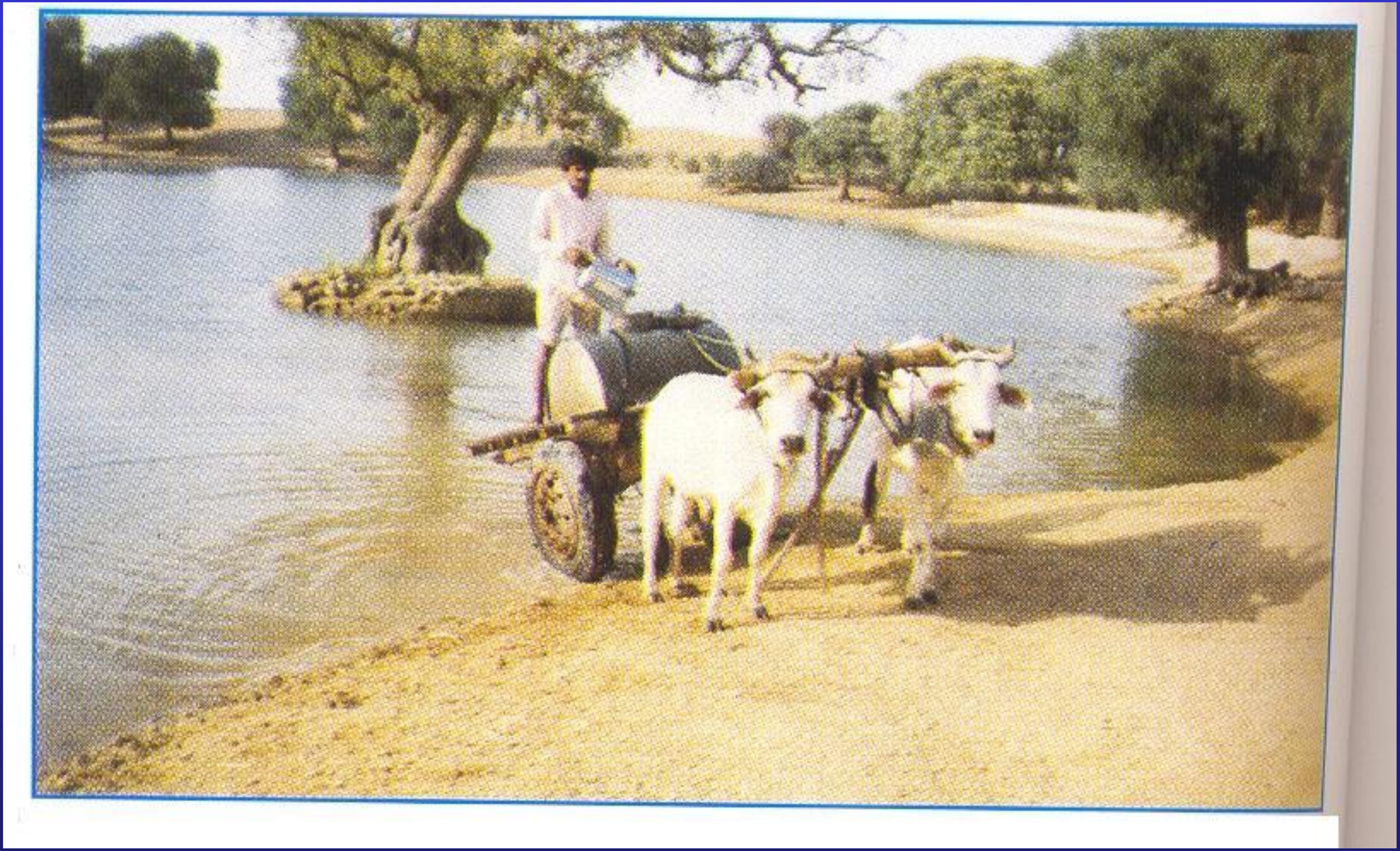
Cultivation of Gram on Residual Moisture

Percolation Ponds

- Percolation ponds are artificially created surface water bodies, sub-merging a land area with adequate permeability to facilitate sufficient percolation of impounded surface run-off to recharge the ground water.

- Evaluation studies carried out on the functioning of the percolation ponds in India have indicated that a properly located, designed and constructed percolation pond can have a efficiency ranging from 78 to 91% with respect of recharge of ground water.

Percolation Ponds in Semi-Arid Region



Percolation Pond-Nadi

Traditional water harvesting structures

1. In arid regions rainfall is erratic, scanty and insufficient for production of crops and drinking purpose.
2. This problem can be mitigated upto a certain extent by constructing rain water harvesting structures which will increase the production as well as the stored water can be used for drinking purposes.
3. The structures commonly used for harvesting rainwater in arid regions are:

   1. Khadin 2. Nadi 3. Tanka

Nadi

1. These are small excavated or embanked village ponds constructed for harnessing the meager precipitation to mitigate the scarcity of drinking water in the desert.

2. These nadis hold water from two months to a full year after rains depending upon the catchment characteristics, amount of rainfall received, its intensity and distribution.

3. Capacity of such nadis is reduced in due course of time due to sediment deposition. The design of nadis is similar to the design of dug cum embankment type farm ponds

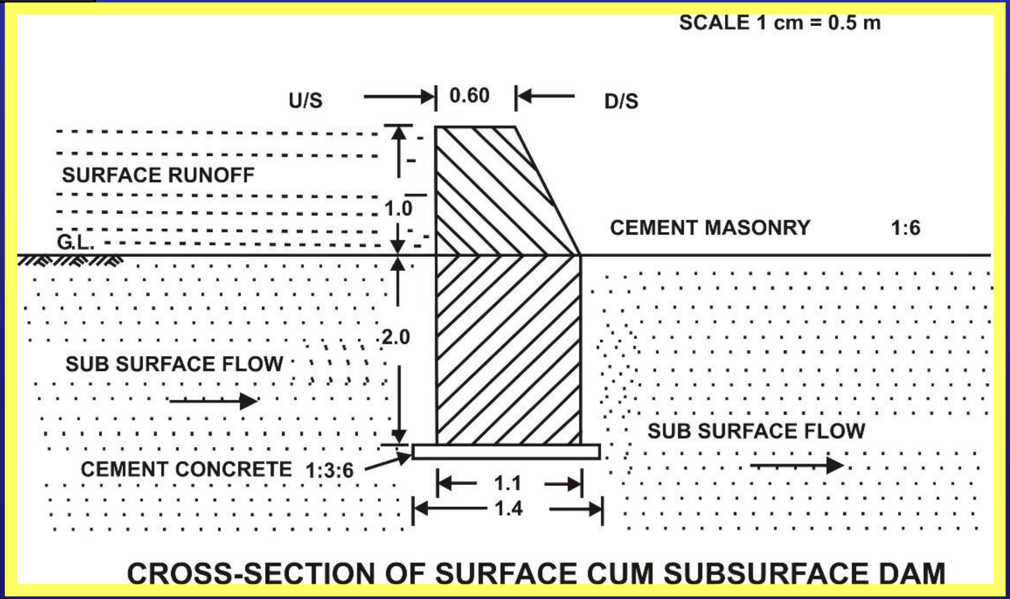
Construction of Tanka in Arid Regions

Collection of water through surface rainwater harvesting

Tanka - water collected through rooftop harvesting

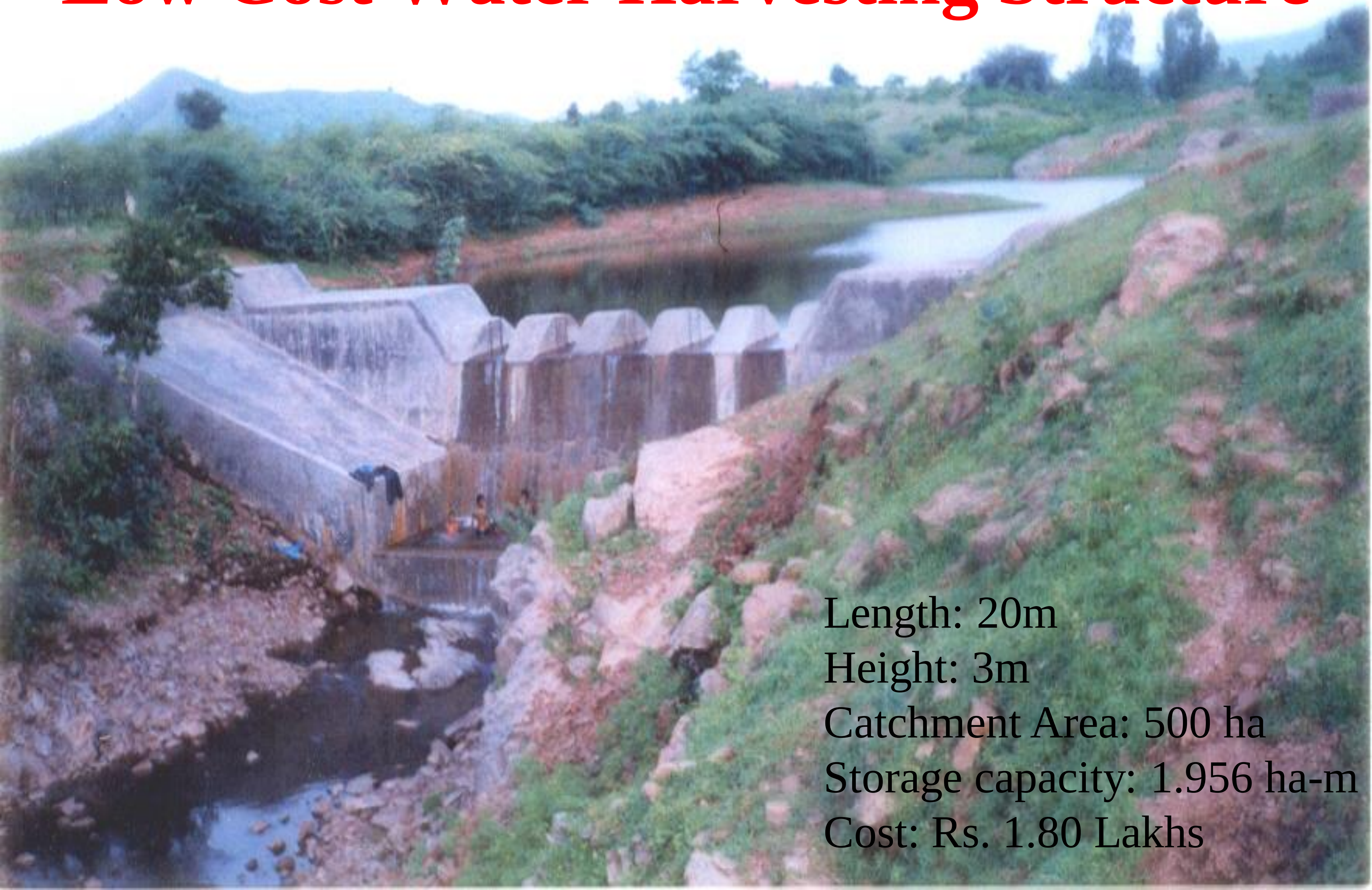
Sub-surface Harvesting

- Sub-surface barriers are used to retain seasonal sub-surface flows and facilitate the abstraction of water through lined, shallow wells.
- The objective is to place an impermeable barrier– either of clay, thick plastic or masonry-across the river bed from the surface down to an impermeable layer below.
- This can actually raises the level of the river bed, catching sand from the upstream and, in the process creating the ground water reservoir. The dam is raised in successive stages, each stage of 50 cm, to achieve this effect.
- The clay dam is best built where all layer of clay underlies the sandy river bed. A masonry dam can be built where a bedrock layer occurs between 2- 4 meters beneath the surface of the river bed.



Surface Cum Subsurface Dyke

Low Cost Water Harvesting Structure



Length: 20m
Height: 3m
Catchment Area: 500 ha
Storage capacity: 1.956 ha-m
Cost: Rs. 1.80 Lakhs

Low Cost Masonry Dam

Bori dam

THANKS

Rejuvenation of Ponds, Lakes and Canals

Sandeep Narulkar
Milind Dandekar
S.G.S.I.T.S., Indore

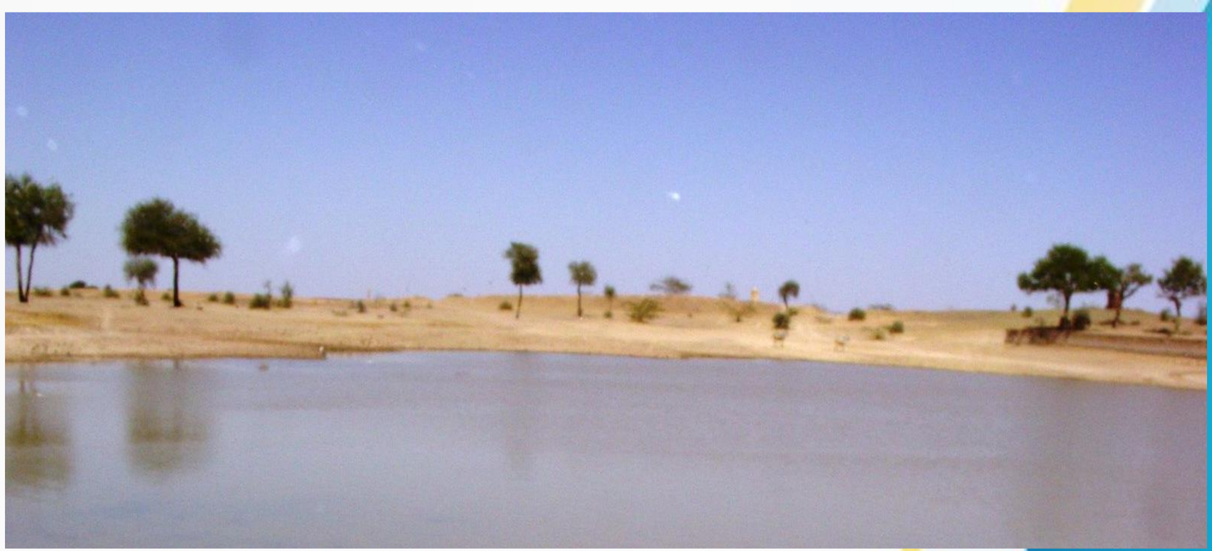
Purposes Served By Ponds and Lakes in Villages

Direct Purposes

1) Irrigation
2) Drinking Water for Cattle
3) Bathing and cleaning
4) Bathing of Cattle
5) Aquaculture
6) Biodiversity Development
7) Development of wetlands in the surrounding
8) Shelter and home for migratory and local birds
6) Farming water chestnuts and other aquatic plants
7) Cleaning of carts and other vehicles

Indirect Purposes

1) Ground Water Recharge
2) Flood Reduction
3) Serene atmosphere
4) Recreation
5) Religious importance



Significance of Ponds and Lakes in Rural Life

Indian villages have been surviving with their traditional water management. The most significant feature was village tanks (also called village ponds) which is often overlooked in modern times. The ponds are also known as known as talab, taal, talai, johad, Pukoor, Pokhar, Kere, Eri, piyaka, ceruvu, tale, sarovar, etc. There are between 1.2 to 1.5 million tanks still in use and sustaining everyday life in the 0.66 million villages in India.Rural Life has a special way which includes Agriculture and Cattle Raring as principal occupation. The ponds or lakes in rural India play a vital Role in their life. In almost all the parts of the country the Kings, Nobles and common people have created ponds. Ponds are important hotspots for biodiversity. In recent times these water bodies are grossly neglected.

Present Situation of Ponds and Tanks

Engineering Issues

1) Most of the emabkments of these ponds and tanks are in miserable state as on today due to excessive settlements, slope erosion, growth of vegetation, growth of cracks and fissures, vanishing stone rip rap, weakening of toes

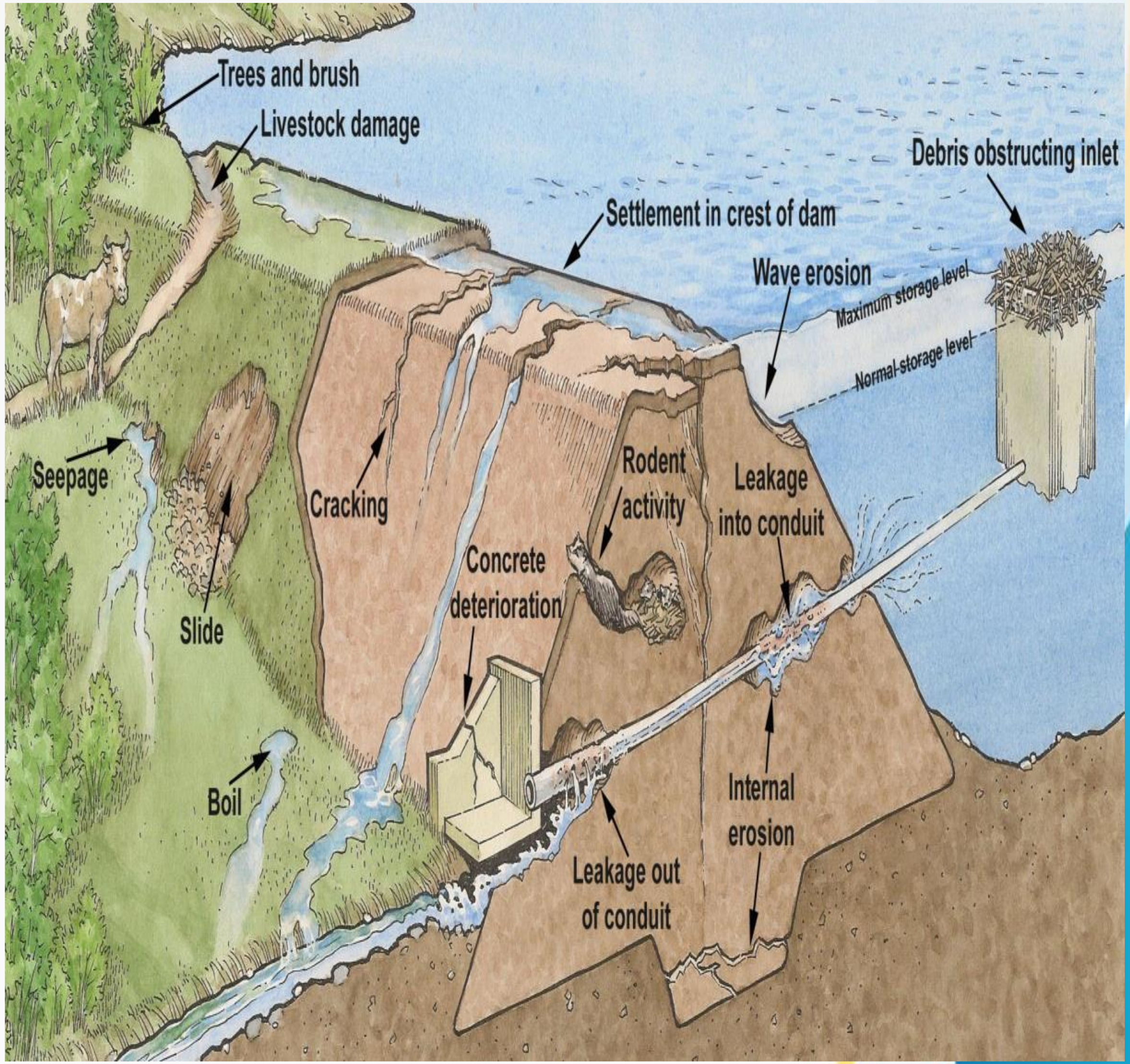
2) The seepage of water from most of the earthen dams is quite prominent.

3) The spillways/ waste weirs or flush bars (spilling arrangements) are in bad condition engendering the safety of main structure

4) The reservoirs are subjected to severe silt deposition resulting into reduction in the capacity and eutrofication

5) If the pond is having irrigation system supported by it then the condition of the outlets and sluices is pathetic

Engineering Problems with Earth Dams



Present Situation of Ponds and Tanks

- Ecological Issues

1) Excessive pumping of water in irrigation season leave the pond dry restraining the biological activities and the cycles in the lake eco-system

2) Eutrofication due to influx of nutrient laden water from the agricultural catchments. In a few cases sewage or industrial waste is also dumped in the pond

3) Dumping of solid waste like plastics, metals, idol submersion during festivals, the demolition and construction waste in the

Failure Problems of Earthen Dams

Rodent Action causes Burroughs and holes in the embankment dams causing instability.

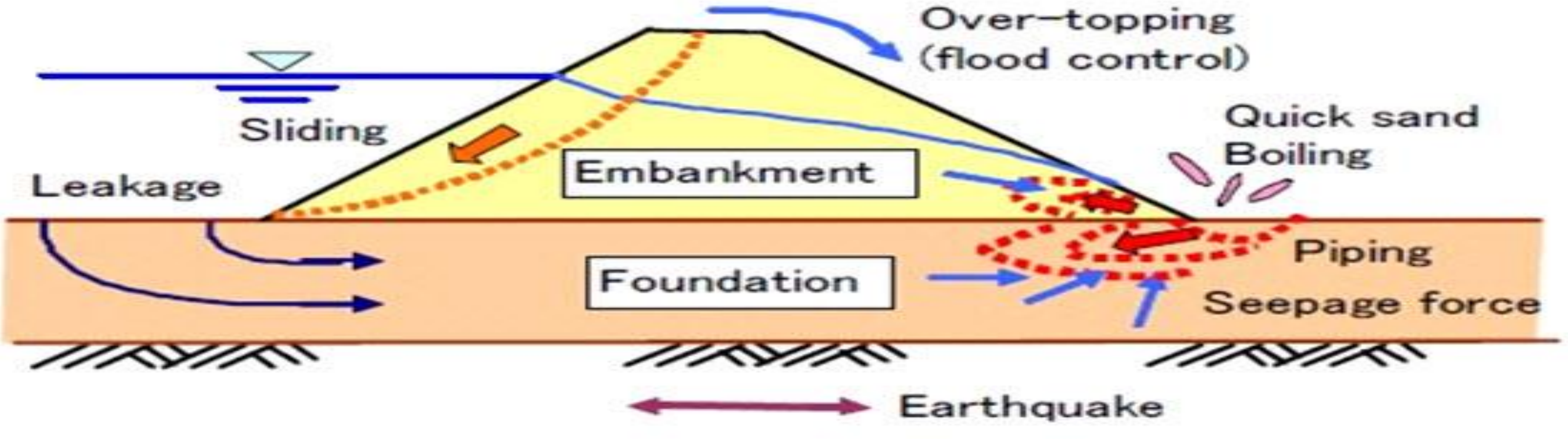
Failure Problems of Earthen Dams

Breach in the embankment is caused generally due to inadequate spillway capacity or weaker dam section

Failure Problems of Earthen Dams

Downstream Slope Failure including top of bund. One of the common causes of failure occurring with internal seepage in the body of the dam.

Failure Problems of Earthen Dams



◎ Damage of embankment

- Sliding (by pore-water pressure, earthquake)
- Deformation (settlement and lateral deflextion)
- Leakage
- Hydraulic fracture (quick sand and piping)

◎ Damage of foundation

- Bearing capacity
- Settlement
- Leakage
- Hydraulic fracture
- Liquefaction

Fig. 23.4. Damages in Embankment and Foundation.

Most Common Problems in Existing Earthen Bunds and their Solutions to be Executed by Villagers

Most of the existing dams are either quite old or have been construed under the corrupt government machinery. In either of the cases one may find the failures and requirement of maintenance and repairs. The villagers are required to be trained for these so that they can put their joint effort for the revival. Experience from Jhabua suggests that this can be done and the embankments can be renovated to protect the water in the pond. The problems are enlisted as below:

1) Absence of Impervious Key or Cut-off in foundation causing excess seepage

2) Absence of Impervious Hearting or Shell in the main body causing seepage

3) Breaches in the dam body

4) Settlement, pot holes, burrow holes or holes due to erosion

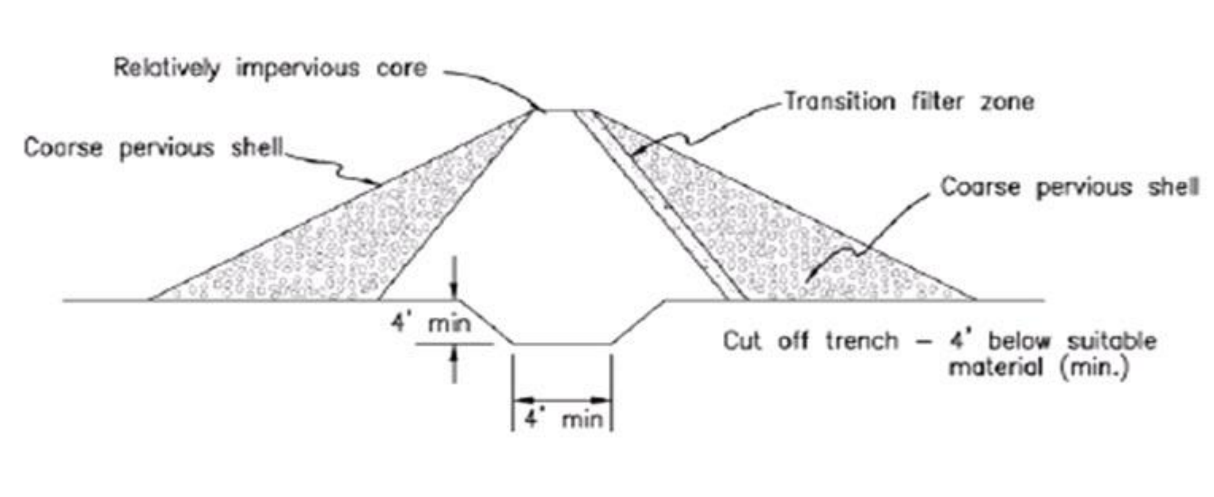
5) Malfunctioning or absence of toe filter

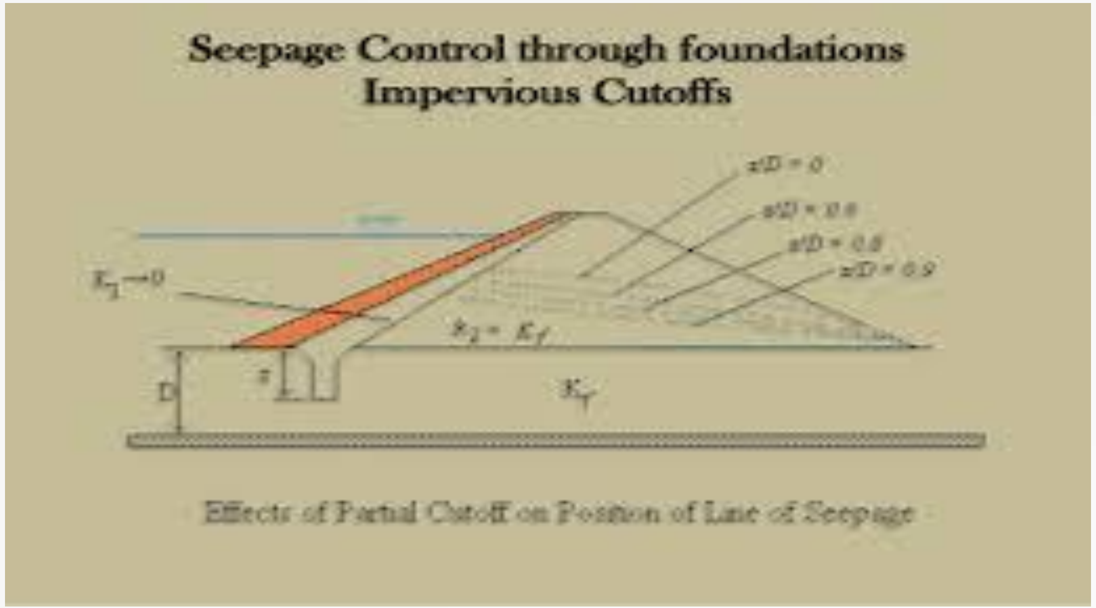
6) Improper/ deteriorated upstream and downstream slopes

7) Rip rap Failure

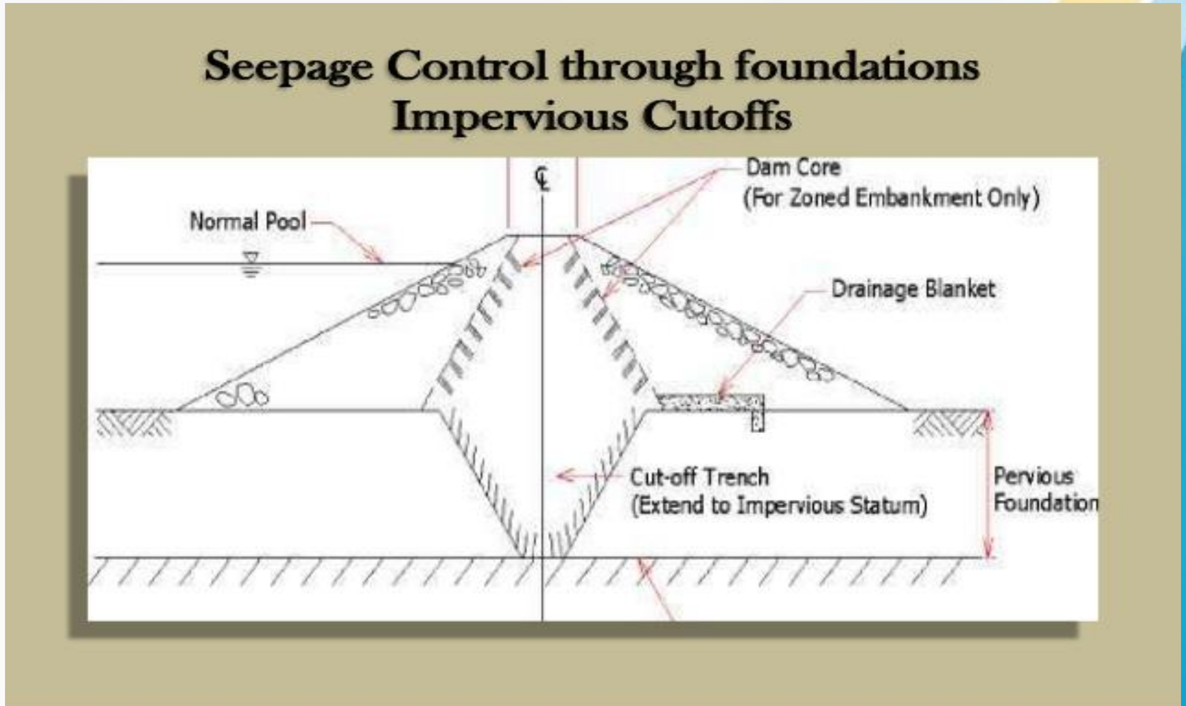
Absence of Impervious Key or Cut-off in Foundation

This is one of the major problems in the old dams or newly constructed dams. In absence of it the key has to be created. This has to be done in upstream portion of the dam in the form of partial cut-off by an additional structure as shown below

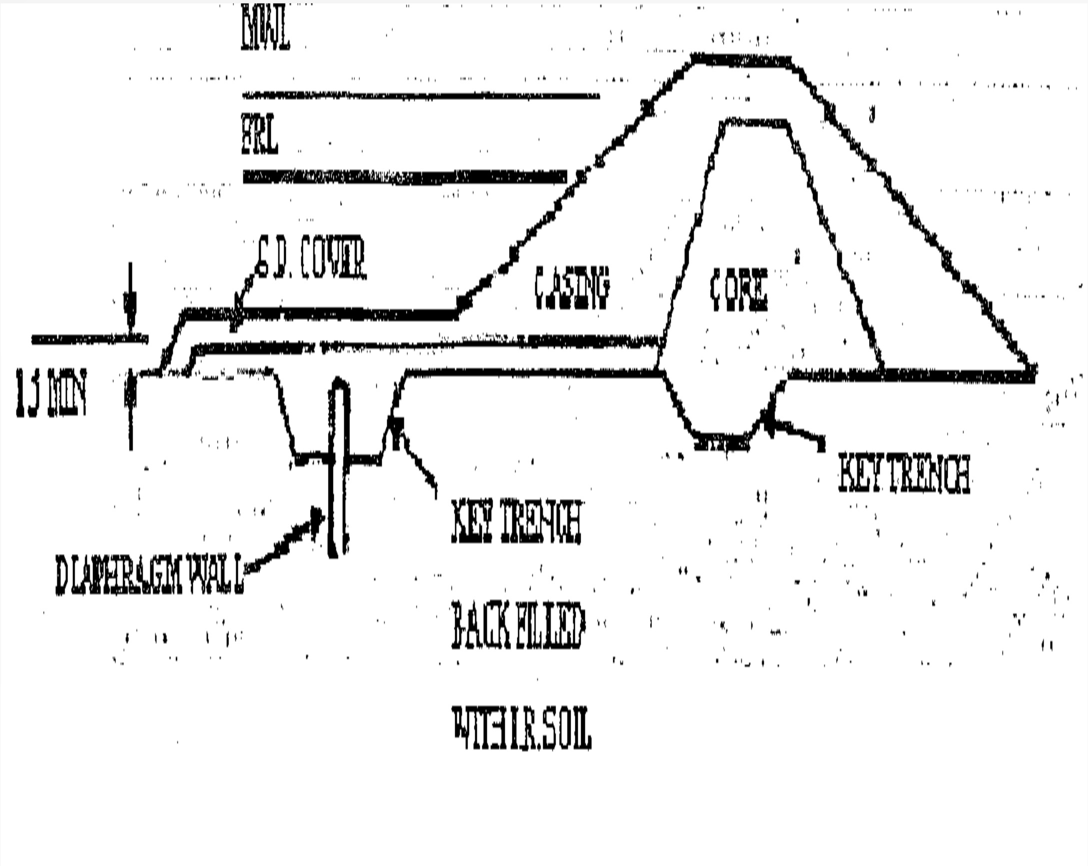




Effects of Partial Cutoff on Position of Line of Seepage

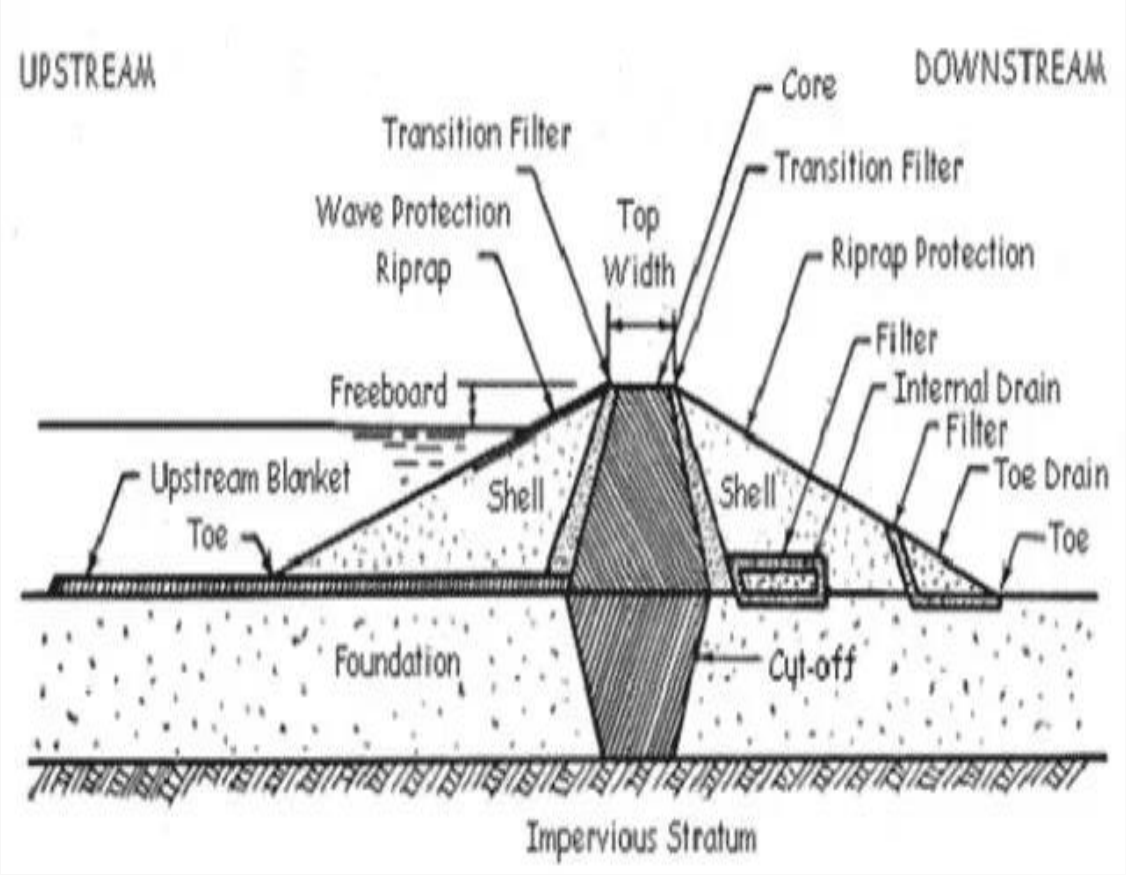


Absence of Impervious Key or Cut-off in Foundation



- If the dam is small the cut-off trench can be dug upstream of the body of the dam wall. For large dams the cut-off is also accompanied by the diaphragm wall of RCC

Absence of Impervious Key or Cut-off in Foundation



- Another alternative is laying of an upstream clay blanket of about 5 to 10 m from the upstream end of the dam. This can also be embedded in to the dam.

Absence of Impervious Hearting or Shell

Many old dam structures are homogeneous constructed with good soil and proper compaction. However in modern government construction many a times it is found that the dam doesn't have proper Impervious Hearting or its height is less. In this case the dam has to be excavated from top and a puddle of shell can be built.

In Jhabua Saad Dam was having similar story. The dam was 20 m high dam at the deepest ground level. The impermeable core was not having sufficient height. The volunteers applied an idea of digging the dam up to 8 m height and the puddle was filled

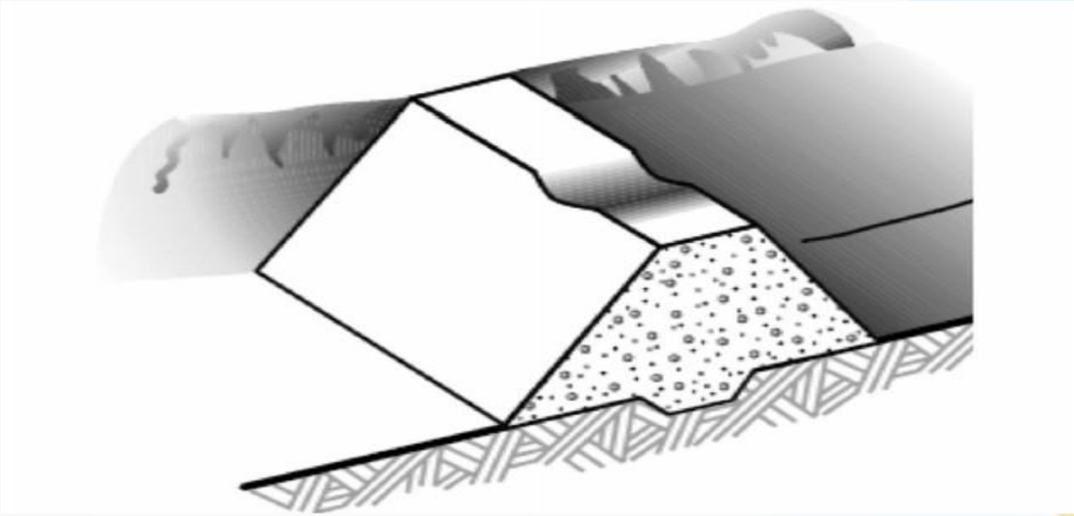
Breaches in the dam body

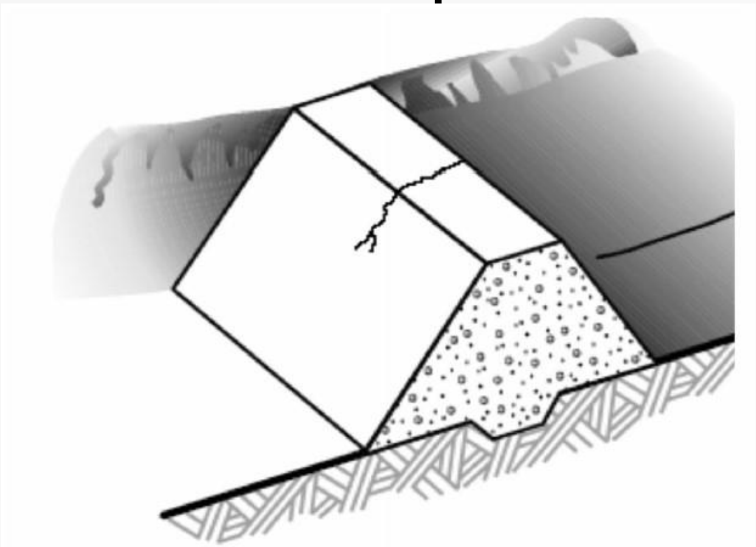
In many of the cases a section of the dam is breached due to either weakness or over topping. Looking to the section of the remaining dam portion the breaches can be plugged in the similar manner as dam is to be constructed.

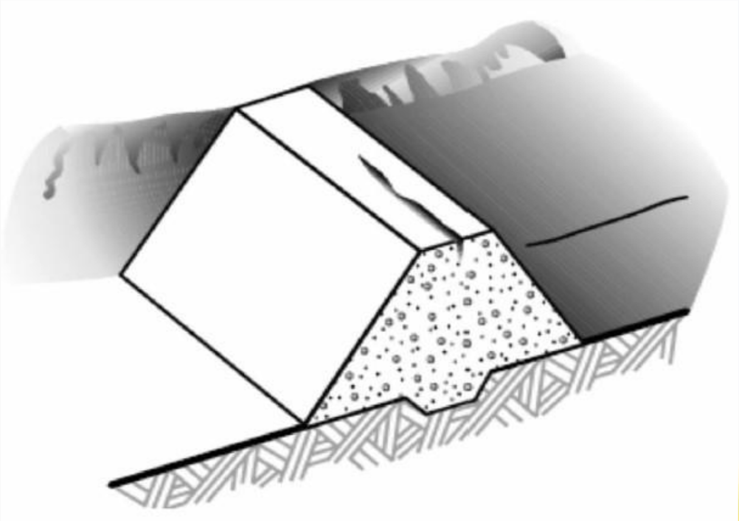
In case of Saad Dam there existed a breach of about 25 m length opposite to spillway. This was recreated suing the similar techniques

Settlement, pot holes, burrow holes or holes due to erosion

All these kinds of holes and settlements are to be treated by putting proper soils along with some stone pieces to repair the dam. The compaction efforts need







Malfunctioning or absence of toe filter

The toe of the dam is having maximum stress and the seepage is directed towards the toe. If the toe filter is missing then the dam failure due to sloughing starts. Hence the toe filter for small dams is a must and if it is not functioning it has to be replaced by the stacking of the boulders in proper triangular prism form.This will prevent the Phretic Line from reaching the toe and filter will offer a free drainage path.

In large dams there are chimney filters, blanket filters etc.. but small dams may not have such filters.

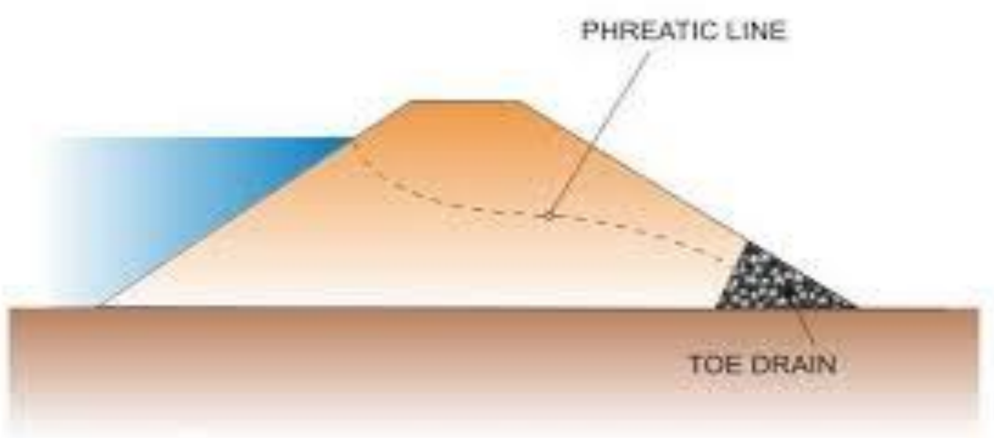


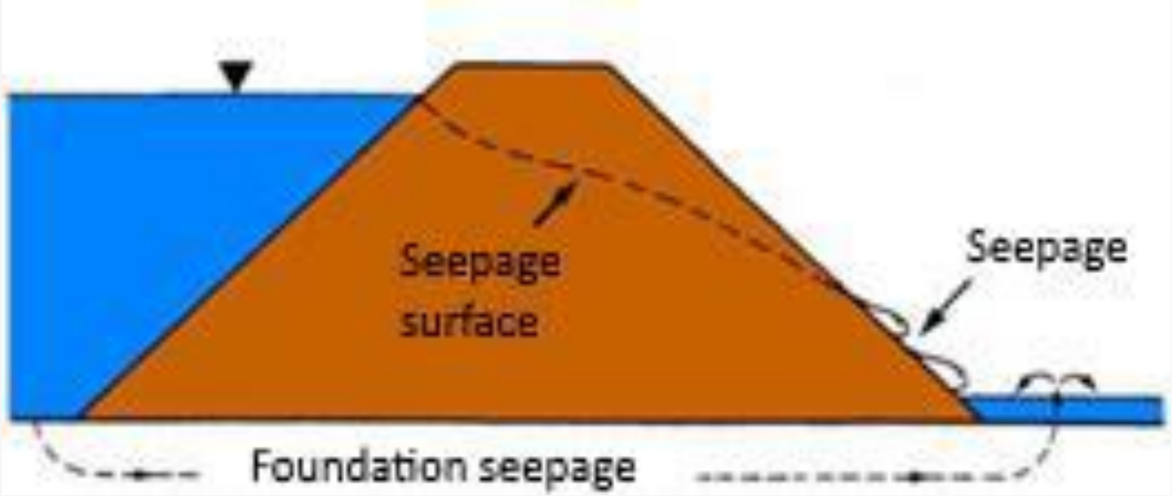
FIGURE 2. Homogeneons earthen embankment dam with toe drain

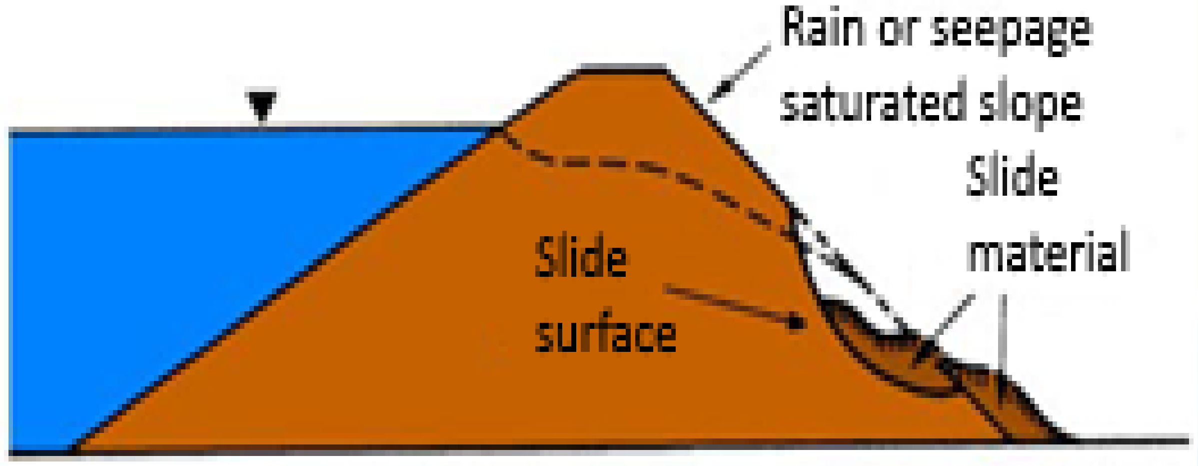
Improper/ deteriorated upstream and downstream slopes

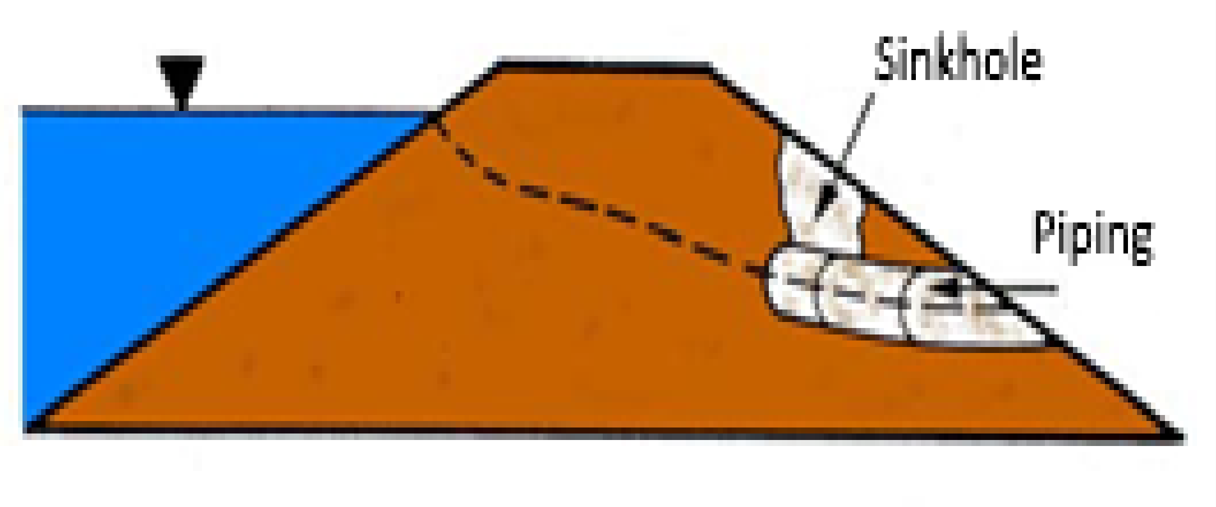
The slope of embankment dam is quite important structural element. Usually walking over the slope to see the entire surface area. The downstream slope can be seen in all the seasons. The surface conditions such as roughness of the surface, vegetation, or other surface conditions giving greater importance to the downstream slope below the pool elevation.

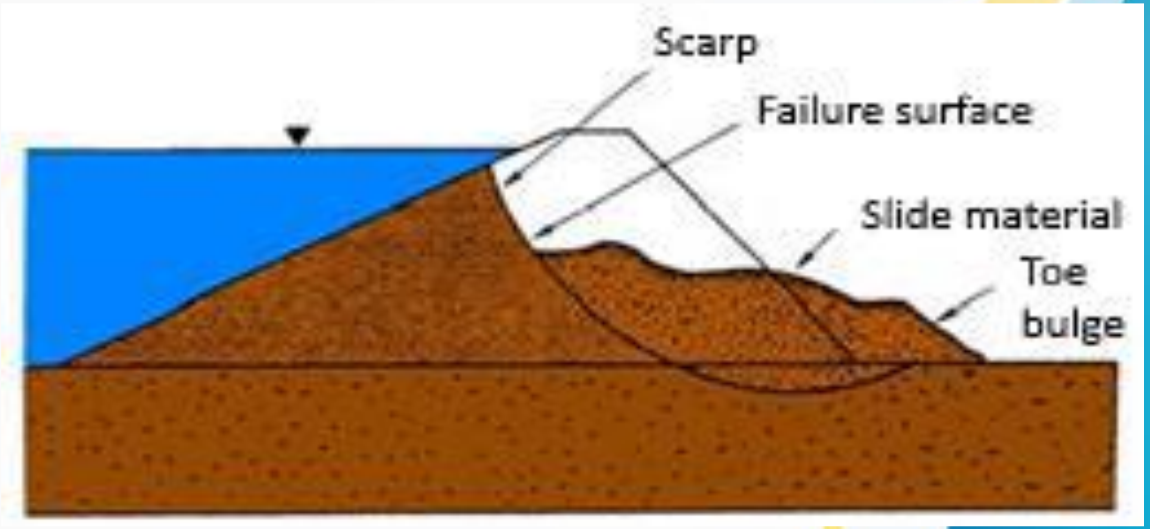
The upstream slope needs a thorough visual inspection, because the slope protection, vegetation, debris, and reservoir water can hide problems. Any time the reservoir is emptied, the slope should be thoroughly in-inspected for settlement areas, animal burrows, sink-holes, or slides. Also, the bottom of the impoundments should be inspected for sink holes or settlement any time it is emptied. Any irregularity should be noticed and if required corrected.

Improper/ deteriorated upstream and downstream slopes



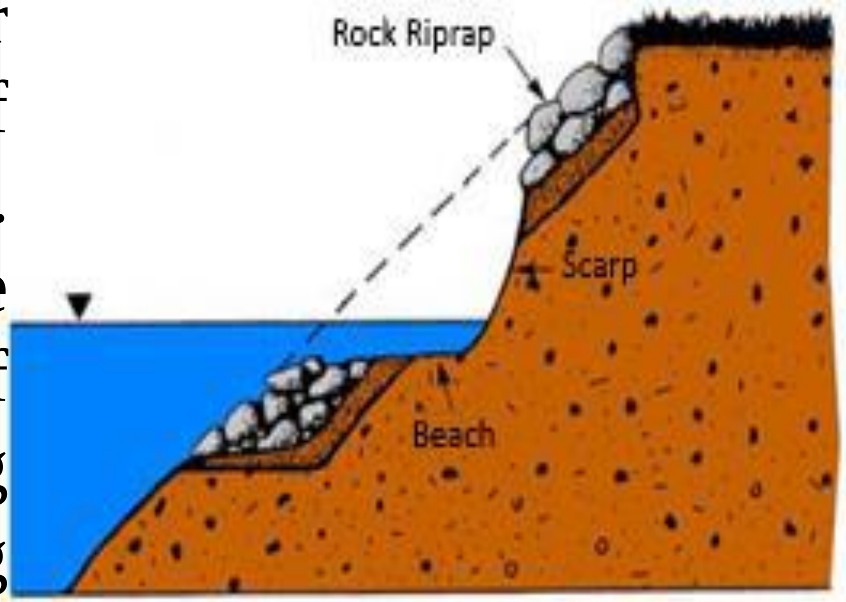


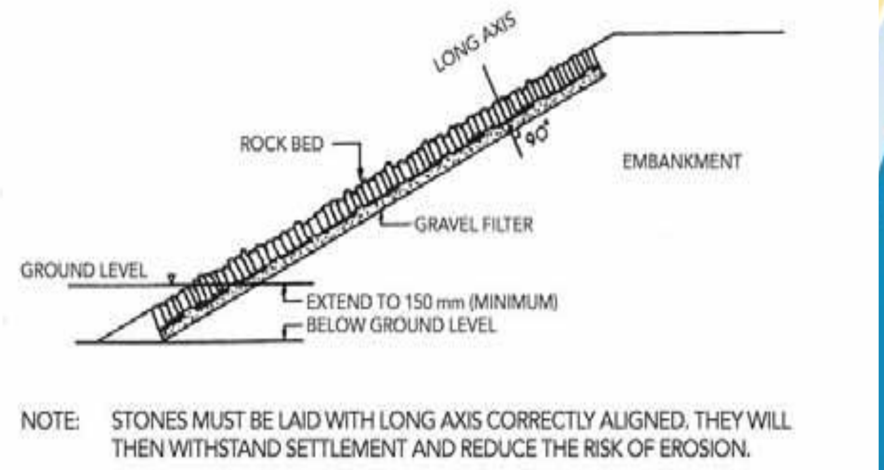




Rip rap Failure

Rip rap of proper size should be placed for protection from wave action, surface run-off erosion, and scour resulting from the wind. Properly designed upstream rip rap slope protection is made up of at least two layers of material: (1) an inner filter layer or bedding to keep the underlying soil from washing away; and (2) an outer rock layer to prevent erosion. The inner filter layer could be sand or fine aggregate, or a geotextile. Close to spillways or waste weirs the Rip rap is a must and properly checked before every monsoon to avoid erosion of soil dye to dynamic action of flow





Spillway/ Waste Weir/ Flush Bar

The most significant component for safety of any dam is the spillway with proper size and dimension. It allows the excess water to flow out in to the river downstream. The spillway of the smaller earthen dams is also quite important because the stability of the dam rests and relies on the spillway. Normally the spillway may be a masonry or RCC structure. But many times in small dams side channels are dug to act as spillway channel. The spillway is needed to clean properly of any derbies, vegetation and encroachment. The junction of the dam and spillway also need attention. The observations and correction should be frequently done.

Silt Deposition and De silting

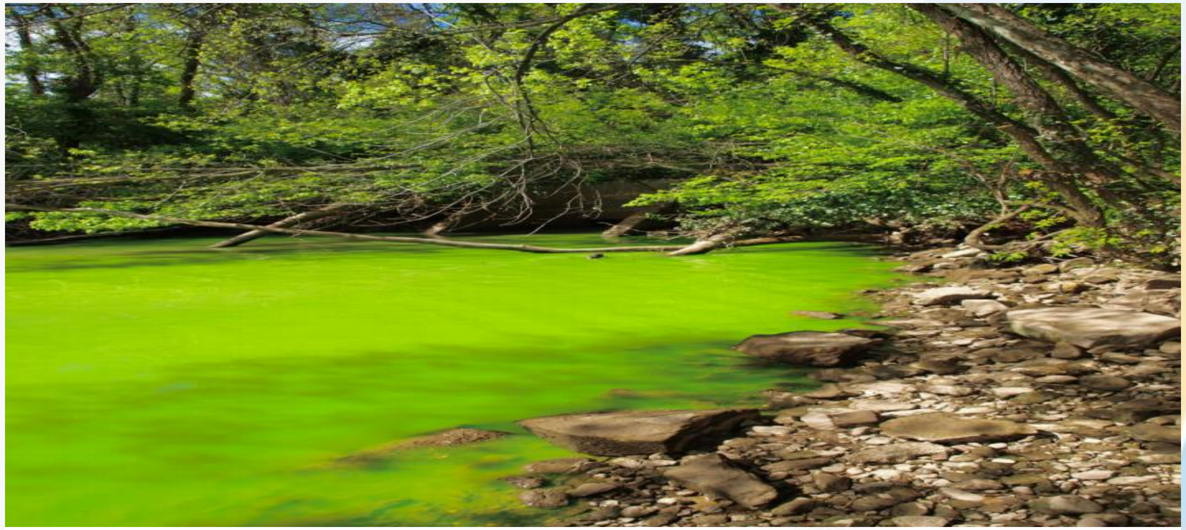
In almost all the ponds with the passage of time the silt gets deposited. This silt is coming from the catchment area as eroded material. This process is continuous and can only be reduced if proper water harvesting is carried out in the catchment area. This silt fills the ponds, reducing their capacity. For this de silting operation is carried out. The desisting operation takes place during summer months. At this time ponds or tanks are dry. The silt can be used as clay blanket, upstream puddle filling and other major and minor repairs of the dam

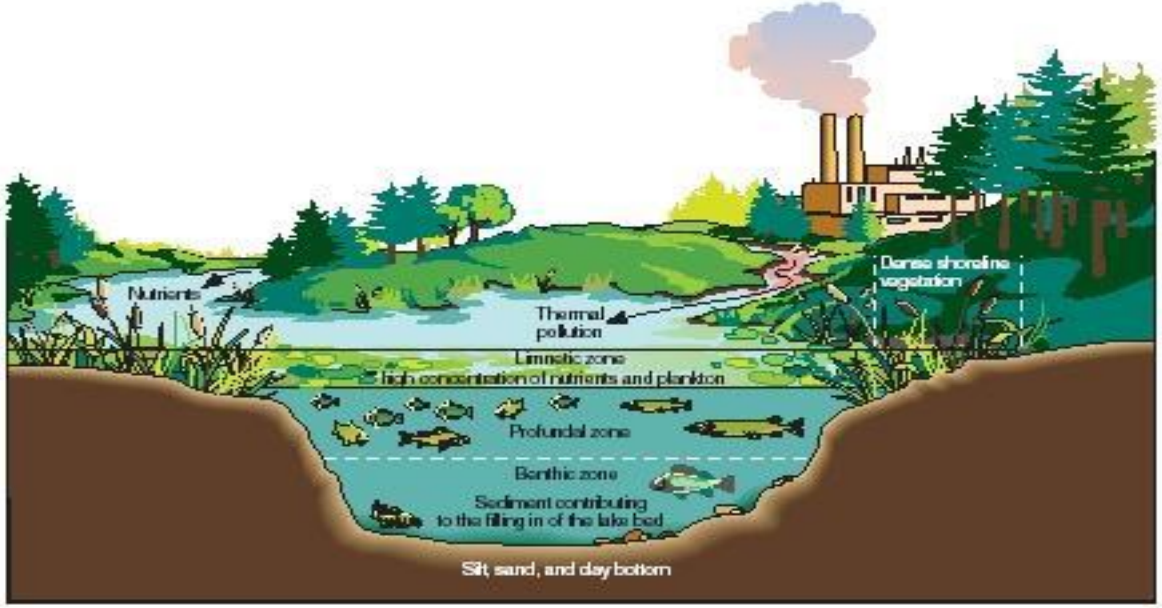
With a mix of manual and mechanical means, the silt is dug out and then transported on tractors to the nearby fields. This silt is nutritious and useful for the farmers. The excavation operation should be carefully done. It should be away from the dam proper and digging should not exceed a particular depth otherwise the pond gets a percolation channel and water storage is lost.

Silt Deposition and De silting

Other Issues with Ponds and Lakes: Pollution and Eutrophication

More than necessary utilization of chemical fertilizers, insecticides and pesticides in the fields within the catchment of a pond or lakes cause pollution and also eutrofication of lakes. This process also attracts silt deposition and affects the capacity ultimately. Domestic and Industrial Pollution is also one of the other causes of pollution. Proper water harvesting and watershed management may solve this problem.





Other Issues with Ponds and Lakes: Encroachments

Because the lakes and ponds are public property they are liable to be encroached by the socio-politically mighty people of the villages. This is true in India. The government also allows farming in the dry season on selected land portions within the sheet (spread) area of water which gets emptied after the wet weather crops are harvested. This issues should be discussed in the GramSabha or at

Rehabilitation of Check Dams

Since ancient times in different regions of the country the check dams have been built. In modern times also lots of check dams are constructed on rivulets in flatter regions. The construction has been done by the government agencies as well as NGOs and other religious institutions. These check dams are quite useful surface water source if

There are certain issues with the check dams:

1) Deterioration with Ageing

2) Hydraulic Failures

3) Structural Failures/ Poor quality of construction

5) Thefts or misplacement of gates

Damaged Check Dam

Deterioration with Ageing

Many of the check dams get deteriorated with the age. The components of the check dams like masonry or RCC get deteriorated with the passage of time since it experiences floods every year and dry spells. Long Term negligence and carelessness accelerates this deterioration. It is required to encourage the people to revive the assets for their benefits.

Hydraulic Failures: Side Cutting

The major cause of check dam failure is hydraulic. The check dams restrict waterway of natural flood. The flood wave finds its water way by eroding the sides beyond abutment of the check dam. The adjoining picture shows severe erosion on the right hand side of the check dam. This will progressively cut open a channel in the side and the dam will become useless. This requires that

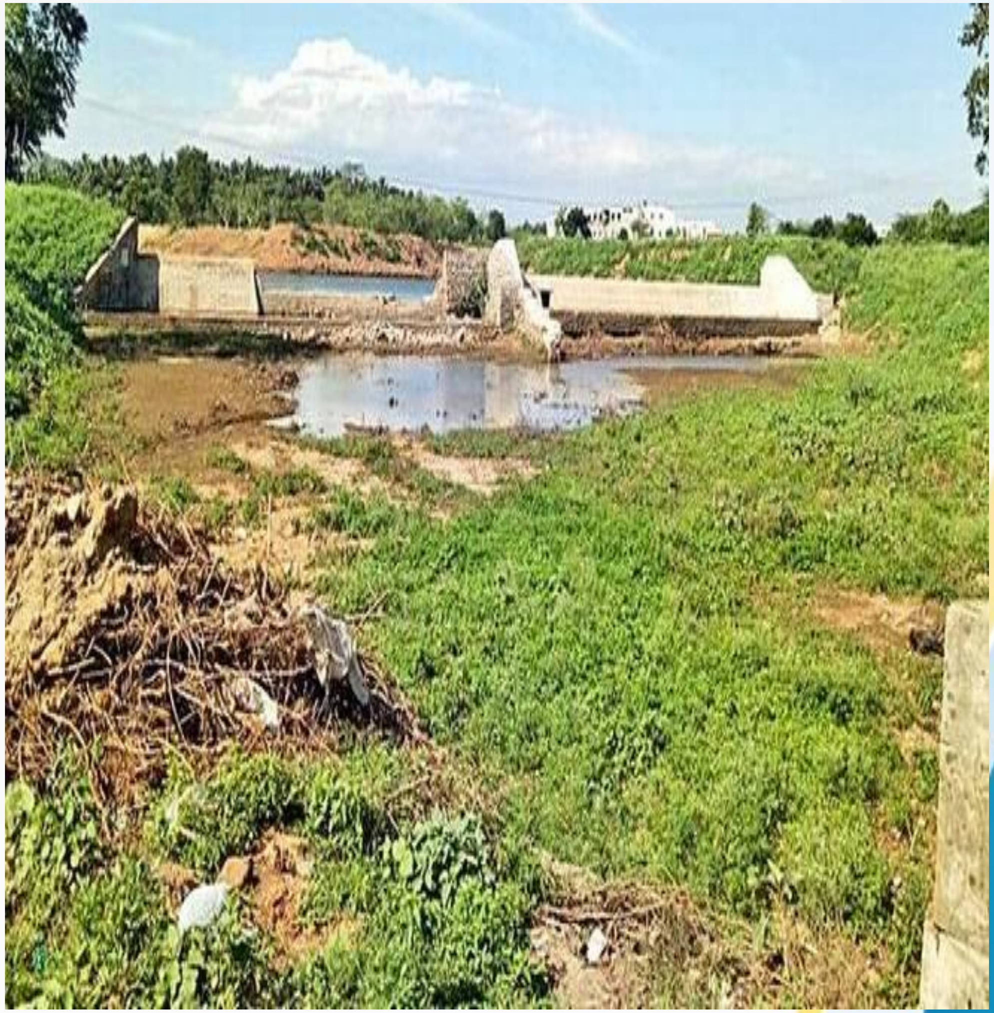
Hydraulic Failures: Erosion Downstream

The check dams are not designed based on extensive hydrologic/ hydraulic assesment in general. The floods have eroding effect in the downstream side which sometimes deteriorates the foundation weakening the structure and causes massive seepage also. Though the structure is provided with some arrangement like downstream floor or cistern to reduce the effect but beyond the structure the erosion starts. This has to be repaired always and the villagers are required to be told about the technology to prevent erosion.

Hydraulic Failures: Erosion Downstream

Structural Failures

Mostly the check dams fail due to hydraulic reasons but the results are seen in the form of structural failures. The masonry dams get weakened due to deterioration of mortar of joints or nominally reinforced plain cement concrete dams fail due to thermal cracking or poor quality of materials used or poor construction etc. These



Thefts or Misplacement of gates

Gated stop dams are provided to facilitate space for excess flow. These gates are removed during monsoon and put back to position just before the monsoon ends to build storage. These gates are fabricated from mild steel with special anti rust coating. These are stolen usually by miscreants and or misplaced and the water storage remains to be a dream. The space for the gates has to be filled by either boulder packing or sand filled gunny bags.

Revival of Canal System

Many of the village tanks support irrigation through a canal system. In most of the cases the old system has got completely deteriorated due to many reasons significant of them are absence of maintenance, fiddling, thefts, encroachments, growth of vegetation et. Due to these the canal operation becomes non fucntional. This has to be revived

Revival of Canal System

Major Steps to be taken for the canal

1) cleaning

2) weeding

3) de silting,

4) re-shaping

5) executing minor repairs

6) Identifying leakage and repairs thereof

There are canal structures also which are constructed with civil and mechanical components they help in regulating the the flows and maintain the levels in the canals. These need maintainable and repair. The villagers under the supervision of an engineer can take up such works

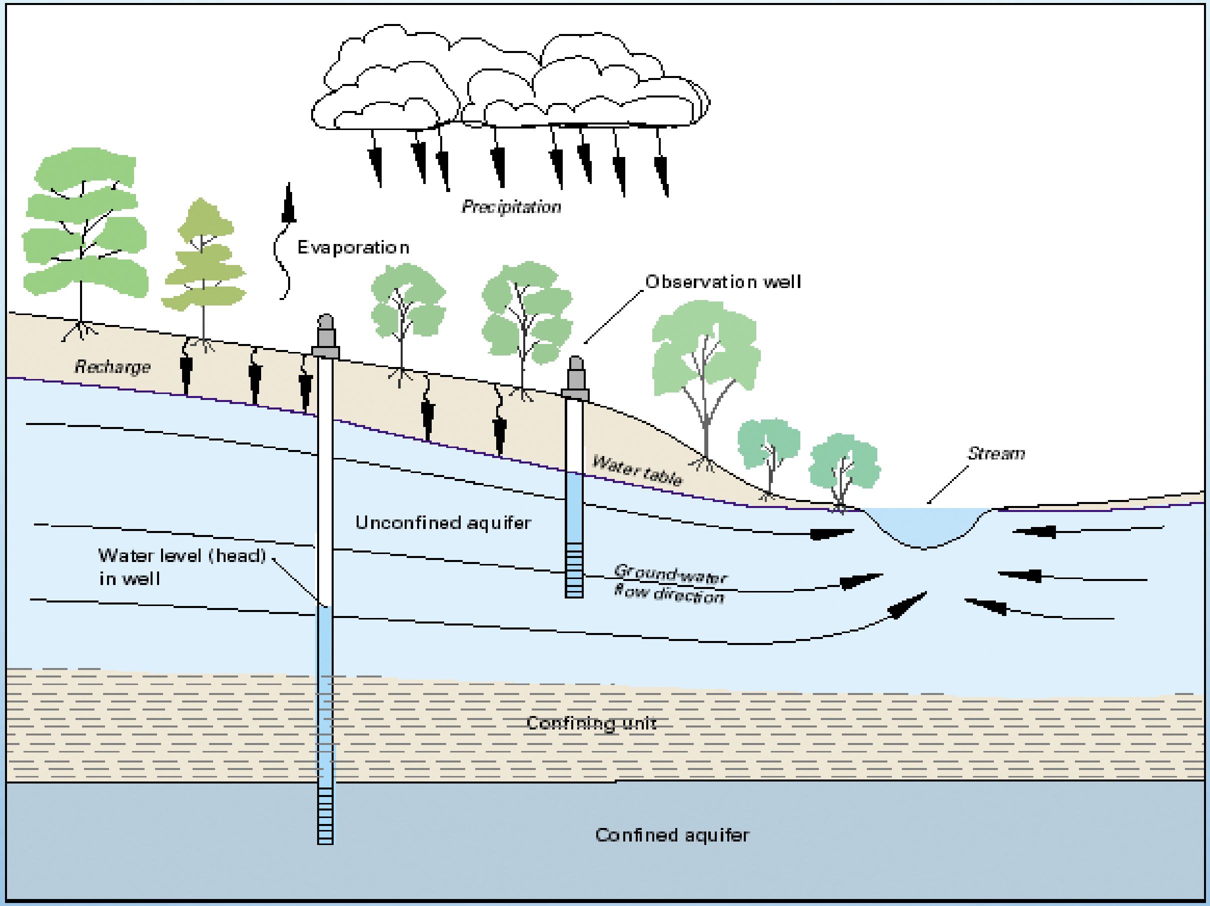
Government Schemes

The Government of India launched the scheme of Repair, Renovation and Restoration (RRR) of water bodies during X Plan to revive and restore vanishing water bodies resulting in major loss of irrigation potential. The scheme was launched as pilot scheme and based on its success, a full scale scheme was implemented during XI Plan. Keeping in view the benefits arising out of the implementation of the scheme, it was extended to XII Plan as well. Central Assistance (CA) for renovation of water bodies is provided under the scheme which is a component of Pradhan Mantri Krishi Sinchayee Yojana (PMKSY). The objectives of RRR of Water Bodies scheme are comprehensive improvement and restoration of water bodies thereby increasing tank storage capacity, restoration of lost irrigation potential, etc..

Thank You

POTENTIAL AND METHODS FOR GROUND WATER RECHARGE

Groundwater



Groundwater recharge or Artificial aquifer recharge is the process to seepage/ infiltrate extra water into the aquifer to store excess water for later use, while improving water quality by recharging the aquifer with better water.

Groundwater Recharge

- Ground water recharge includes recharge as a natural part of the hydrologic cycle and human-induced recharge, either directly through spreading basins or injection wells, or as a consequence of human activities such as irrigation and waste disposal.
- Artificial recharge with excess surface water or reclaimed wastewater is increasing in many areas, thus becoming a more important component of the hydrologic cycle.

Types of Natural recharge to the groundwater table

Diffuse recharge: widespread movement of water from land surface to the water table as a result of precipitation over large areas infiltrating and percolating.

Localized recharge: movement of water from surface water bodies to the ground water system and is less uniform in space than diffuse recharge.

Most ground water systems receive both diffuse and localized recharge. In general, the importance of diffuse recharge decreases as the aridity of a region increases.

Natural recharge to the groundwater table:

Typically, most water from precipitation that infiltrates does not become recharge. Instead, it is stored in the soil zone & returned to the atmosphere by evaporation and plant transpiration.

Percentage of precipitation that becomes diffuse recharge is highly variable, depends on

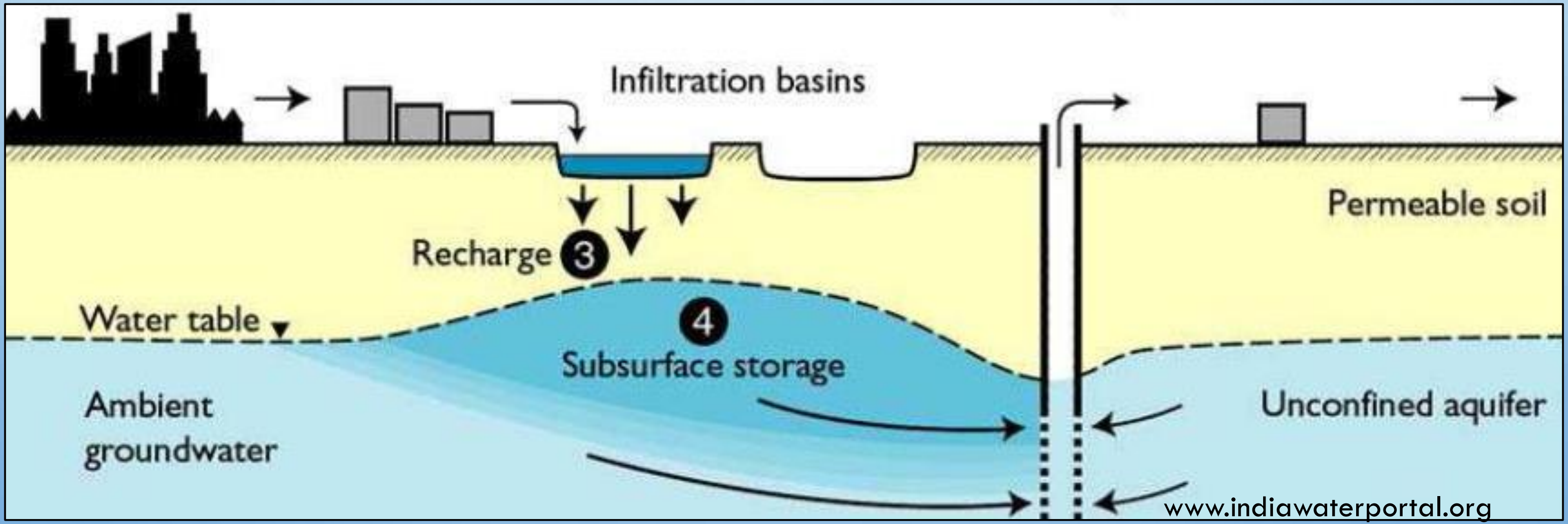
Weather patterns,
Properties of surface soils,
Vegetation,
Local topography,
Depth to the water table, and
Time and space scales

Methods:
Remedial Measures that Could be Taken

- Water conservation and rain water harvesting
- Renovation of traditional and other water bodies
- Reuse and recharge structure
- Watershed development
- Intensive forestation

Rain Water Harvesting System

- Technique of collection and storage of rainwater into natural reservoirs or tanks, or the infiltration of surface water into subsurface aquifers (before it is lost as surface runoff).



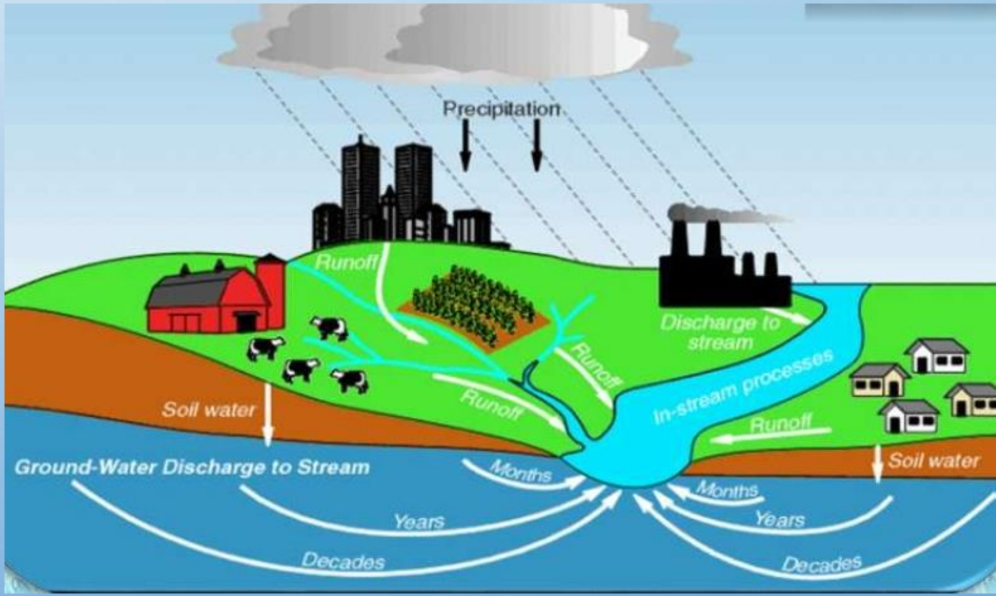
Methods of Rainwater Harvesting

Broadly there are two ways of harvesting rainwater

- Surface runoff harvesting
- Roof top rainwater harvesting

Surface Runoff Harvesting

- In rainwater flows away as surface runoff.
- This runoff could be caught and used for recharging aquifers by adopting appropriate methods.
- Capturing the rainwater can help recharge local aquifers and ensure water availability in water-scarce zones.



STREAM AUGMENTATION

- In this method, seepage from natural stream or river is artificially increased by putting some series of check dams across the river or stream.
- Where river have high bed slope and more deeper than ground water level, river erode the soil and pull the ground water table , it helps to counter the above problem.
- It helps in achieving increment in groundwater table & in saving power consumption in lifting of water

Ditch and furrow system

This method is used for uneven terrain. In this technique, a system of closely spaced flat bottom ditch or furrow is used to carry the water from the source. This system provides more opportunity to percolate the water into the ground. The spacing of the ditch depends on the permeability of the soil. For less permeable soil, more densely spaced ditch or furrow should be provided.

Contour bund

Contour bund is a small embankment constructed along the contour in hilly region to retain the surface runoff for longer time. This scheme is adopted for low rainfall area where internal subsurface drainage is good.

Dug well

Dug wells can also be used to artificially recharge the groundwater. Generally, water level of dug wells depletes during the non monsoon period. Sometime the dug wells even dried up in the non-monsoon period. These dug wells can be used for recharging groundwater. The water from various sources can be collected through a distribution system and can be discharged at the dug wells.

Recharge well

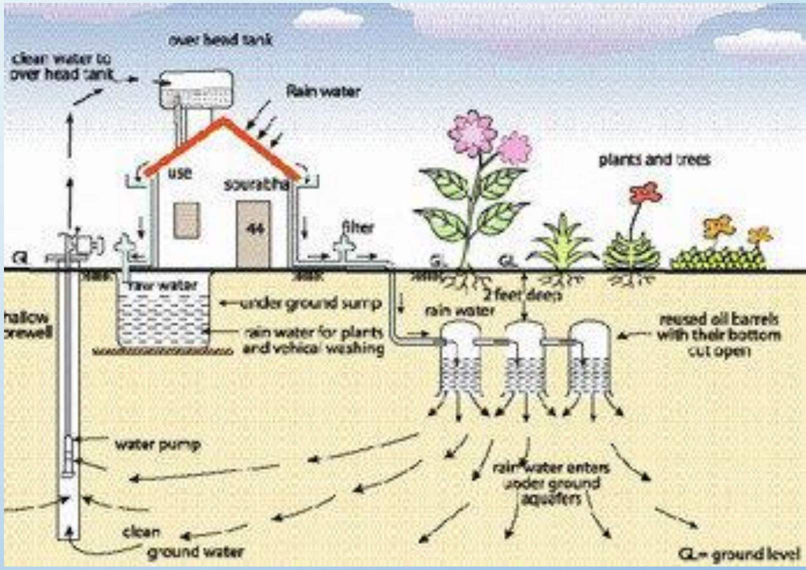
Recharge wells are used to recharge water directly to the aquifer. Recharge wells are similar to pumping wells. This method is suitable to recharge single wells or multiple wells. This method is costlier than the other method as wells are required to be bored. However, sometimes abandoned tube wells can be used for recharging water into the aquifer.

Renovation of Traditional and other Water Bodies

- Clean the existing well which used for drinking and agriculture purpose in past.
- Maintain the ponds and boost the aquaculture
- Maintain the canal system
- Maintain the drainage system
- Reduce the unnecessary rigid surfaces.

Rooftop Rainwater Harvesting

- It 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.
- It can either be stored in a tank or diverted to artificial recharge system.
- This method is less expensive and very effective and if implemented properly helps in augmenting the ground water level of the area.



Advantages of Rainwater Harvesting System

- RWH systems provide water at or near the point where water is needed or used.
- Rainwater is relatively clean and the quality is usually acceptable for many purposes with little or even no treatment.
- System is independent and therefore suitable for scattered settlements.
- Local materials and craftsmanship can be used in construction of rainwater system.
- Ease in maintenance by the owner/user
- Provides a water supply buffer for use in times of emergency or breakdown of the public water supply systems.

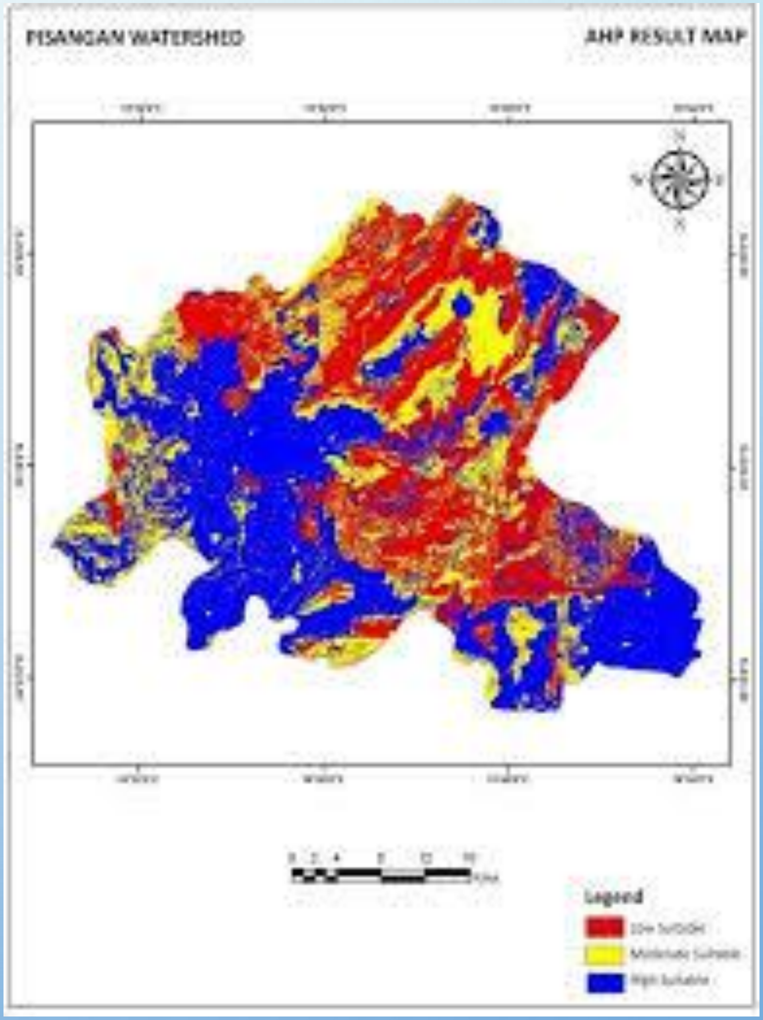
Use of GIS in Rainwater Harvesting

- Identifying potential project sites for rainwater harvesting.
- Making informed decisions about time and budget investments during project implementation.
- GIS technique can also be employed for locating boundaries of an area and for calculating the areas of various types of rooftops and roads.
- With the application of GIS, it is possible to assess the total potential of water that can be harvested.
- It also enable us to identify the suitable type of water harvesting structure along with the number of structures required

Steps Necessary to Conduct Rainwater Harvesting Through GIS

- <u>COLLECTING DATASETS FOR INPUT IN A GIS MODEL</u> –

Identification of demand and urgency of rainwater harvesting, population density, land use, access to other water source and aridity, annual rainfall, variation in rainfall and soil drainage, or additional data like groundwater quality, GDP per capita, or gender aspects, impact of climate change can be included.

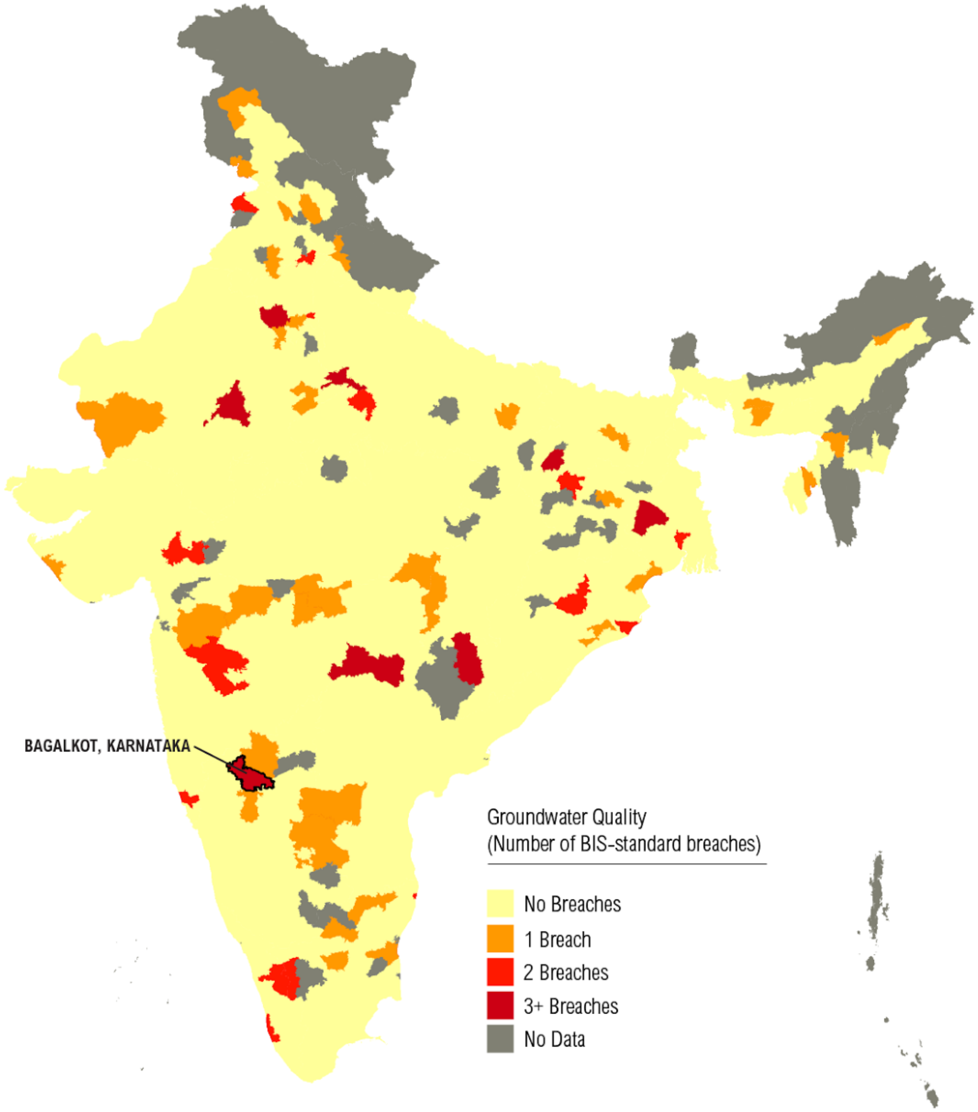


- ASSIGNING SCORES AND WEIGHTS - as not all datasets might be equally important for the analysis scores (based on suitability) and weights (based on relevance) are need to be assigned to the datasets that have been collected.
- COMBINING AND ANALYSING DATA – All datasets need to be converted into maps with the values assigned to the parameters. For each map, the suitability score is multiplied with its corresponding weight. The different layers can then be combined into one overlay: a map that shows the potential and feasibility for rainwater harvesting in a specific area or country.
- PRESENT THE RESULTING MAPS

More than

100 MILLION

People Live in Areas of Poor Water Quality



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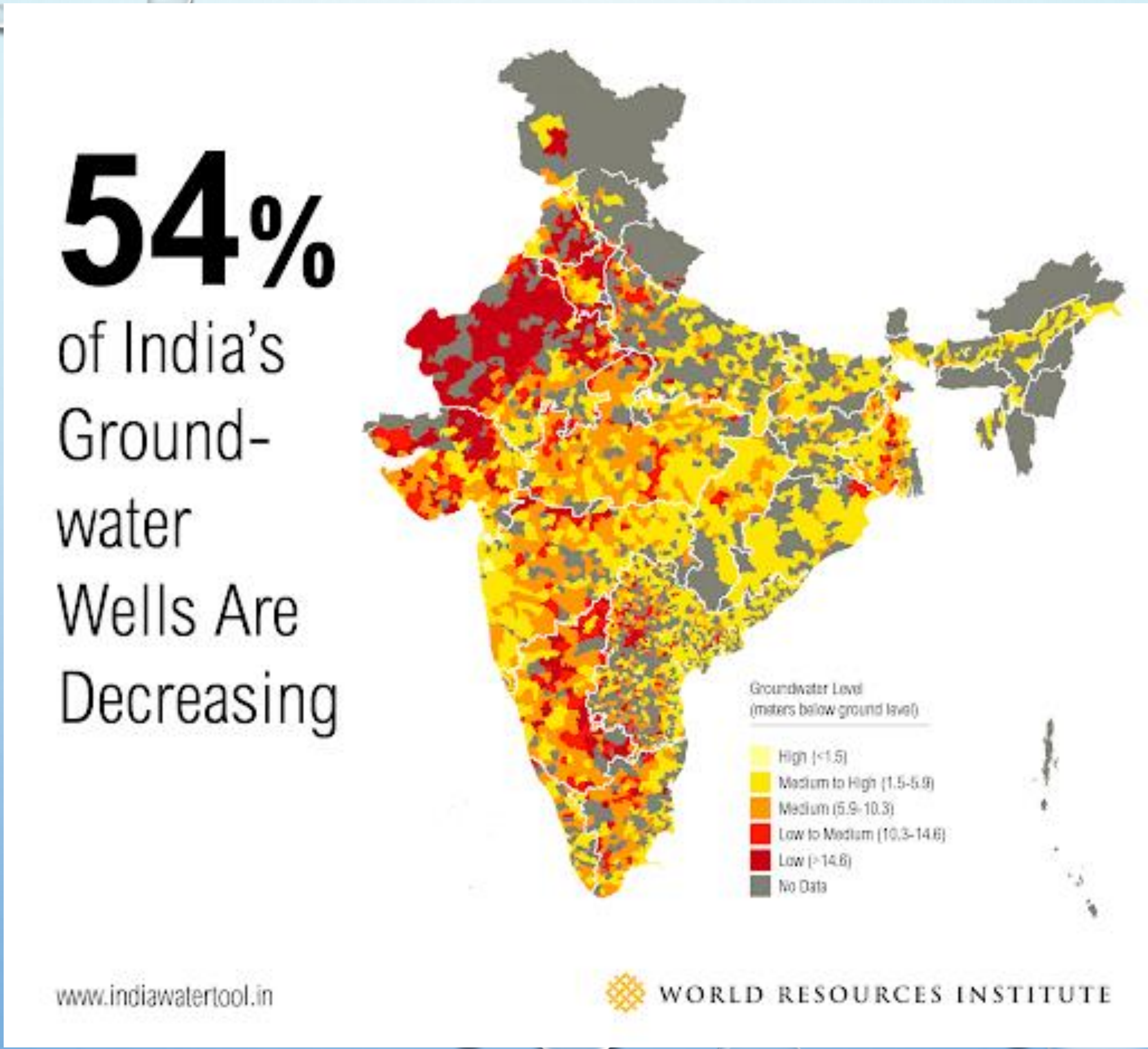

54%
of India's Ground-water Wells Are Decreasing
Groundwater Level
(meters below ground level)
High (<1.5)
Medium to High (1.5-5.9)
Medium (5.9-10.3)
Low to Medium (10.3-14.6)
Low (>14.6)
No Data
www.indiawatertool.in
WORLD RESOURCES INSTITUTE

THANK YOU

UBA Web-Seminar on Water Resources Management

May 14-15, 2020

Presentation on

Water Use Efficiency Enhancement in Agriculture

by

Dr. Ashish Pandey
Professor
Department of Water Resources Development and Management &
UBA Regional Coordinator

INTRODUCTION

- Major concerns in irrigated agriculture is the poor water use efficiency which is estimated to be about 38 to 40% for canal irrigation & about 60% for GW irrigation schemes.
- Area wise it is necessary to provide irrigation to at least 130 m ha for food crops alone and in an area of 160 m ha for all crops to meet the demands of the country in 2050 AD when food grain requirement shall be 450 MT
- In the majority of river basins in India, the present utilization is high and in the range of 50 to 95%.

Irrigation Efficiency in different methods

Irrigation Efficiencies	Methods of Irrigation		
	Surface	Sprinkler	Drip
Conveyance efficiency	40-50 (canal) 60-70 (well)	100	100
Application efficiency	60-70	70-80	90
Surface water moisture evaporation	30-40	30-40	20-25
Overall efficiency	30-35	50-60	80-90

Source: Sivanappan, R. K. (1998) Status, Scope and Future Prospects of Microirrigation in India. Proc. Workshop on Microirrigation and Sprinkler Irrigation System. CBIP New Delhi, April 28-30, 1998: 1-7

- Great challenge for the coming decades is increasing water use efficiency and to achieve higher productivity of water.

Losses in irrigation network

Scrutiny of literature related to studies in different parts of India during last 25 years show the major deficiencies related to following aspects (CBIP Pub.No.14)

Engineering

- Silting of Reservoirs
- Excessive seepage losses on canals and distribution network (alluvial plains North India)
  - ✓ Main Canal & Branches : 17 percent (Water entering at canal head)
  - ✓ Distributaries at canal head: 8 percent
  - ✓ Water courses at canal head :20 percent
  - ❑ Total loss : 45 percent, w.r.t. to canal head discharge
- Further losses in the field: 30 % supply at field or 17 % of head discharge
  - ❑ Total losses 62% of water at head gate

❖ Total Project Efficiency = 38%

❑ Overall project efficiency attainable = 60% or 50% more land irrigated from initial supply

Outcome of the irrigation efficiency studies carried out in LBC Command Area of Bargi Project (Chauhan, 2009):

Jamuniya Command Area: Application efficiency = 55.4%, Distribution efficiency =80.64 %, and Conveyance eff. = 65.41 %, but the Overall efficiency=29.22 %.

Jhansi Command Area: Application efficiency = 50.05 %, Distribution efficiency = 80.96 %, and Conveyance efficiency = 71.80 %, but the Overall efficiency =29.09% which very inequitable for a canal irrigation system.

Pipariya Command Area: Application efficiency = 49.69 %, Distribution efficiency = 71.78 %, and Conveyance efficiency = 75.13 %, but the overall efficiency =26.80 % which is lowest among the four selected minor and un-inequitable for a canal irrigation system.

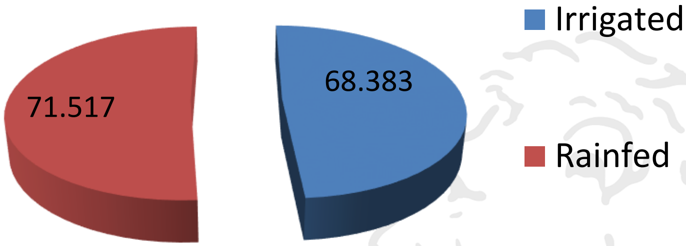
Dhulakheda Command Area: Application efficiency = 57.90 %, Distribution efficiency = 80.33 %, and Conveyance efficiency = 75.38 %, but the Overall efficiency =35.06 % which is highest among the four selected minor and very un-inequitable for a canal irrigation system.

Thus, the above mentioned studies shows that

Overall irrigation efficiency varies between 26.80 % to 35.06 % in various command areas of its distributaries/minors of the left bank canal command area of In general, efficiency decreases from head reach to tail reach which is very inequitable for a canal irrigation system.

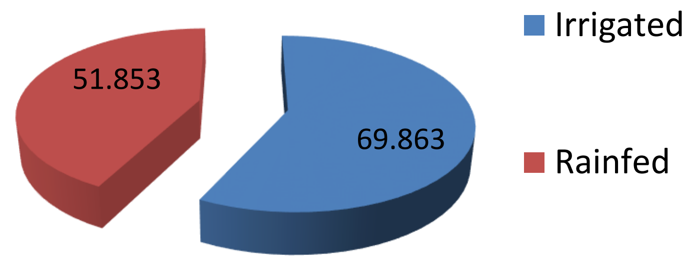
Agricultural water consumption in India and China

Net Sown Area (Mha) India



Nearly equal net irrigated area

Net Sown Area (Mha) China



554 BCM

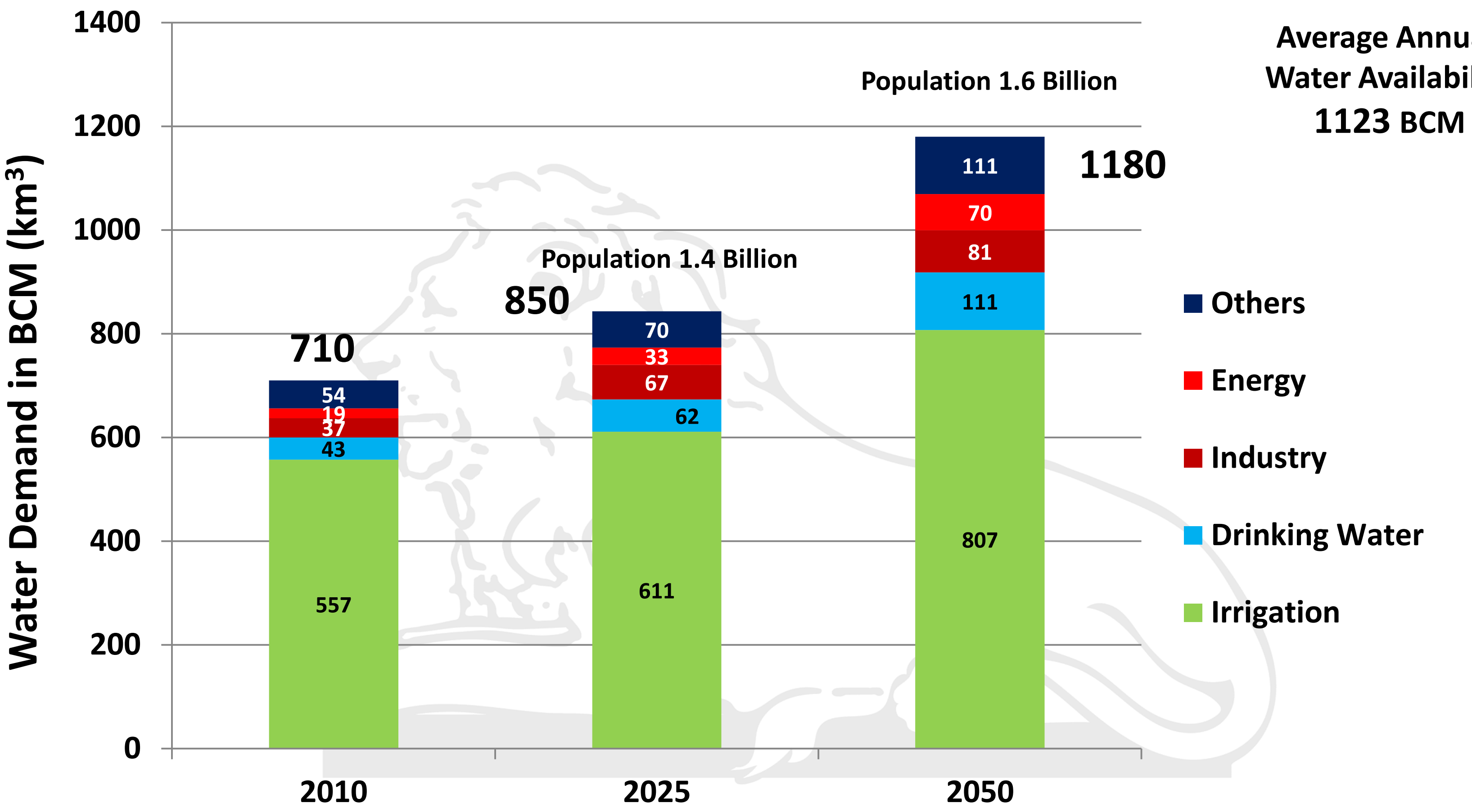
1.7 times water consumption in India

385 BCM

Food grain production in India is only half

Source: Aquastat Database of FAO

Increasing Demands of Water for Various Purposes



Average Annual Water Availability **1123** BCM

Food Grain Demand: 278 MT (2018) 450 MT (2050)

Source: Press Information Bureau, MoAFW/ NCIWRD

CHALLENGE

The problems are many but central challenge for a country like ours with limited water and land resources is:

"How to produce more food and increase income of farmers with less water"

Bottom Line is

OPTIMAL WATER USE

GOALS OF National Water Mission (NWM)

Goal I: Comprehensive water data base in public domain.

Goal II: Promotion of citizen and state actions for water conservation, augmentation and preservation.

Goal III: Focused attention to vulnerable areas including over-exploited areas.

Goal IV: Increasing water use efficiency by 20%, and

Goal V: Promotion of basin level integrated water resources management.

Irrigation Efficiency

Conveyance Efficiency (E_c): Measure the efficiency of water conveyance systems associated with the canal network, water courses and field channels. It is represented as follows:

$$E_c = 100(V_f/V_d)$$

V_f = the volume of water that reaches the farm or field (m^3)
V_d = the volume of water diverted from the source (m^3)

Application Efficiency (E_a): Actual storage of water in the root zone to meet the crop water needs in relation to the water applied to the field. It is represented as follows:

$$E_a = 100(V_s/V_f)$$

V_s = the volume of water stored in root zone (m^3),
V_f = the water delivered to the field or farm (m^3).

Overall irrigation scheme efficiency (E_o) = $E_c \times E_a$

Factors influencing water use & their evaluation

Factors influencing water use

- Terrain parameter evaluation (land use, soil, slope) using RS and GIS
- Cropping practices
- Rainfall
- Irrigation supplementation
- Water distribution methodology
- Land development and field water application

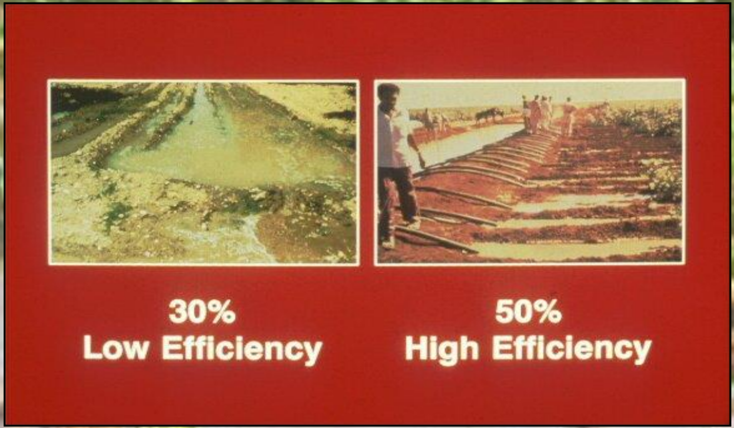
Factors to be evaluated

- Crop Water Need
- Representative Rainfall
- Irrigation Requirement
- Comparison with actual irrigation supplied
- Estimation of Water Use Efficiency using the above data

Approach for enhanced water use efficiency

- Monitoring of flows of distributaries/minors released through the outlet of the water course
- Monitoring of soil moisture, ground water levels and climatological variables at field level.
- Assessment of crop water requirement.
- Develop irrigation scheduling considering the crops, soil moisture and climatological conditions.
- Establish the micro-irrigation system such as drips & sprinklers in the field and irrigate the fields as per the developed irrigation schedule.
- Digital elevation model to identify the fields at higher elevation for taking up minimal land levelling/shaping
- Conjunctive use of surface water & ground water
- Organize demonstrations and workshops for disseminating the developed OFWM practices to the farmers and other stakeholders for achieving the objectives envisaged under the project.

SOLUTIONS

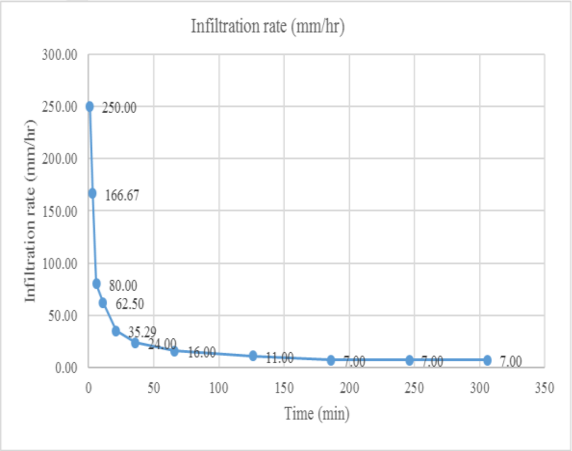


Because of the severe deficiencies in irrigation water management, benefits derived from many irrigation projects are far short of expectations. As a result, areas irrigated in both wet and dry seasons are smaller and crop yields lower than expected at the planning stage.

Monitoring &Measurement

Total suspended solid measurement

Flow measurement using hand held velocity metre



Soil moisture measurement

Infiltration capacity of soil

A well leveled farm land reduces irrigation cost, support weed control and easier for introducing mechanization.

Farm channel lining reduces water loss; promotes quick supply.

Benefits of Piped Irrigation Network (PIN)

- Significant improvement of WUE
- *Har Khet Ko Pani*
- Water at Tail end too
- Higher Crop Productivity
- No water-logging
- No affect on environment
- Less project completion time/Faster Implementation
- Less Maintenance
- Better control mechanism through various appurtenances like CV, PRV and Flow valves.
- No land acquisition and low R & R issues

Sprinkler irrigation

Drip irrigation

Clay pot irrigation

Sensor-based irrigation

Irrigation methods affects both yield as well as water use.

Realize extra yield due to micro-irrigation over & above traditional methods such as flooding

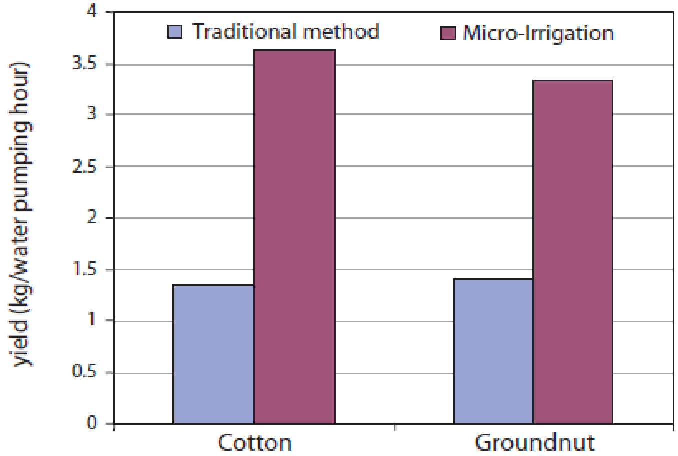
Micro-irrigation	Change in yield under micro-irrigation (t/ha)		
	Banana	Groundnut	Cotton
Low-cost drip	+14.2	-	+0.7
Micro-tube drip	-	+0.4	+0.5
Conventional drip	+18.1	-	+0.9
Micro-sprinklers	-	+0.7	-
Conventional sprinklers	-	+0.5	-

Source: IWMI RR 93

WATER PRODUCTIVITY UNDER DRIP vs CONVENTIONAL

Crop	Water productivity (kg/m^3)	
	Conventional	Drip
Cotton	3.1	11.6
Sugar beet	85.0	132.0
Sweet potato	6.7	23.4
Beetroot	0.7	5.0
Radish	2.25	11.0
Papaya	0.06	0.32
Mulberry	138.6	375.0

Source: Cotton: Sivanappan et al., 1987; Sugar beet: Agarwal and Goel, 1981; Sweet potato, Beetroot and Radish: Sivanappan and Padmakumari, 1980; Papaya: Sivanappan, 1977; Mulberry: Muralidhara et al., 1994



Source: IWMI RR 93

Land and water productivity of selected crops under conventional and drip irrigation systems in India

Crop	Yield (t/ha)		Yield (kg/m^3)	
	Conventional	Drip	Conventional	Drip
Banana	57.5	87.5	3.3	9.0
Grapes	26.4	32.5	5.0	12.0
Sugar cane	128.0	170.0	6.0	18.1
Tomato	32.0	48.0	10.7	26.1
Watermelon	24.0	45.0	7.3	21.4
Cotton	2.3	3.0	0.3	0.7
Chillies	4.2	6.1	0.4	1.5
Papaya	1.3	2.4	0.1	0.3

Source: NCPA, 1990

DIAGNOSTIC ANALYSIS

- Cutting of canal bank to draw more water than one's share causes damage to the canal bank.

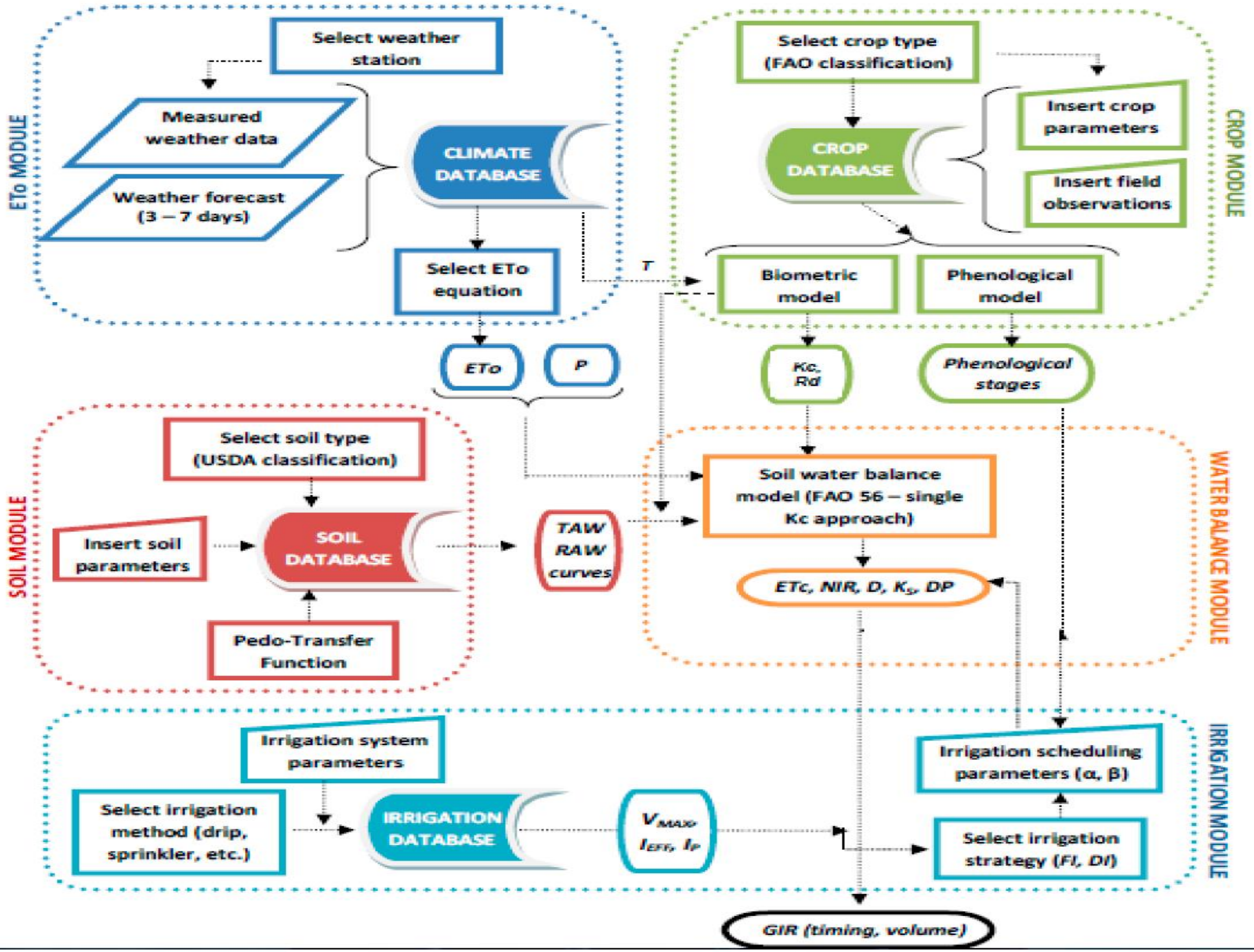


- Direct use of canal for animal drinking and bathing purpose without any proper provision and rainfall causes erosion in the bank of canal.

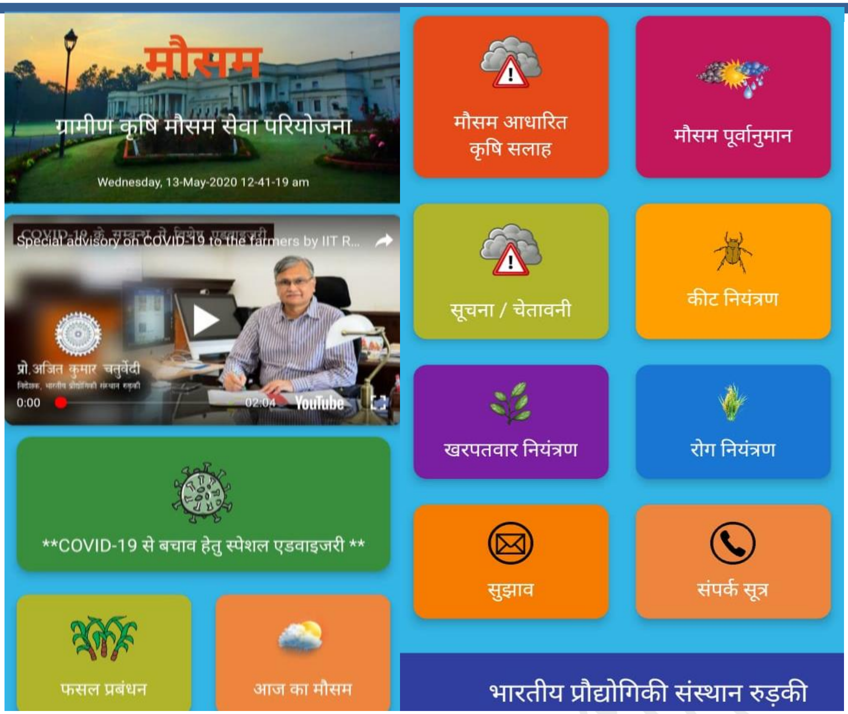

- Cracks in lining of canal cause leakage of water and waterlogging in adjoining field



Internet of Things (IoT) Based Irrigation System



Use of Agro Advisory Services



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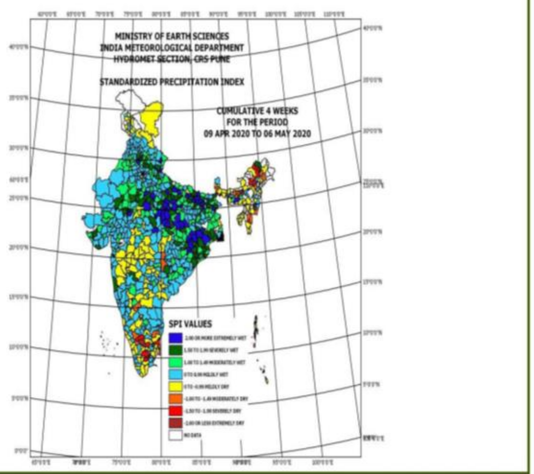
Standardised Precipitation Index
Cumulative 4 weeks for the period 9th April to 6th May 2020



- Extremely/ Severely wet conditions exist in Upper Siang district of Arunachal Pradesh; Begusarai, Bhagalpur, East Champaran, Darbhanga, Gopalganj, Jamui, Khagaria, Kishanganj, Lakhisarai, Madhepura, Muzaffarpur, Patna, Purnea, Samastipur, Saran, Sitamarhi, Siwan, Vaishali districts of Bihar; Jamnagar, Gir Somnath district of Gujarat; Ambala, Kurukshetra, Kaithal districts of Haryana; Bhind, Datia, Gwalior, Morena, Neemuch, Sheopur, Shivpuri, Chhatarpur, Dindori, Katni, Narsinghpur, Panna, Rewa, Sagar, Satna, Shahdol, Umaria, Singrauli districts of West Madhya Pradesh; Ratnagiri, Osmanabad districts of Maharashtra; West Khasi Hills districts of Meghalaya; Angul, Bargarh, Bhadrak, Boudhgarh, Cuttack, Deogarh, Ganjam, Jagatsinghpur, Jajpur, Jharsuguda, Keonjhargarh, Mayurbhanj, Nayagarh, Sambalpur, Sonepur, Sundargarh districts of Orissa; Patiala district of Punjab; Pali, Chittorgarh, Sawai Madhopur, Tonk, Dholpur, Dausa districts of Rajasthan; Perambalur district of Tamilnadu; Dadara & Nagar Haveli districts of Union Territory; Allahabad, Ambedkar Nagar, Bahraich, Ballia, Banda, Barabanki, Basti, Deoria, Fatehpur, Gonda, Lucknow, Pratapgarh, Rae Bareilly, Sultanpur, Unnao, Varanasi, Sahuji Maharaj Nagar, Sant Ravidas Nagar, Amethi, Bareilly, Bijnor, Hamirpur, Muzaffarnagar, Saharanpur districts of Uttar Pradesh; Malda, East Midnapore, West Midnapore districts of West Bengal; Koderma, Sahibganj, East Singhbum, West Singhbhum, Simdega, Seraikela-Khar, Khunti districts of Jharkhand; Nainital, Udham Singh Nagar, Bageshwar districts of Uttarakhand; Koriya, Surguja, Bijapur, Baloda Bazaar, Balrampur, Surajpur districts of Chhatisgarh.
- Extremely/Severely dry conditions exist in Papumpara, West Siang districts of Arunachal Pradesh; Darrang, Lakhimpur, Morigaon districts of Assam; Chamarajanagar district of Karnataka; Cuddalore, Dindigul, Erode, Madurai, Namakkal districts of Tamilnadu.
- Moderately wet to moderately dry conditions were experienced in remaining districts in the country.

https://play.google.com/store/apps/details?id=com.gkms.mausam

21 और 22 फरवरी को भारी बारिश का पूर्वानुमान

जागरण संवाददाता, रुड़की: जिले में एक बार फिर से मौसम के करवट लेने की संभावना है। मौसम विशेषज्ञों के अनुसार 21 और 22 फरवरी को हरिद्वार

21 और 22 फरवरी को मौसम विशेषज्ञों के अनुसार हरिद्वार जिले में कुल सात मिमी बरसात का पूर्वानुमान

रफ्तार से हवा चलेगी।

डॉ. श्रीवास्तव के अनुसार किसानों को इस दौरान वे सिंचाई कार्य न करने की सलाह दी। क्योंकि तेज हवाओं के

Media Coverage: Use of Agro Advisory Services

सलाहकारी सेवाओं के लाभों पर चर्चा

ग्रामीण कृषि-मौसम सेवा परियोजना के तहत लगाई किसान चौपाल

जागरण संवाददाता, रुड़की: आइआइटी रुड़की के जल संसाधन विकास एवं प्रबंधन विभाग में संचालित ग्रामीण कृषि-मौसम सेवा परियोजना के तहत किसान चौपाल लगाई गई। इस दौरान किसानों ने मौसम सलाहकारी सेवाओं से हुए लाभ को लेकर अनुभव साझा किए।

हरिद्वार जिले के लक्सर विकास खंड के पुरवाला गांव में कृषि मौसम सलाहकारी सेवाओं के बारे में जागरूकता कार्यक्रम आयोजित किया गया। इस मौके पर ग्रामीण कृषि मौसम सेवा परियोजना के नोडल अधिकारी प्रो. आशीष पांडेय ने किसानों को परियोजना के तहत प्रदान की जा रही सेवाओं के बारे में चर्चा की। उन्होंने सेवा को और अधिक किसानोपयोगी बनाने को लेकर सुझाव भी मांगे। जल संसाधन विकास एवं प्रबंधन विभाग में अतिथि प्राध्यापक प्रो. आरडी सिंह ने किसानों को मौसम आधारित खेती के लाभ, अंधाधुंध रासायनिक उर्वरकों के प्रयोग से धरती की उर्वरा शक्ति में हो रहे ह्रास और सिंचाई जल के दुरुपयोग से आने वाले समय में जल संकट की चुनौतियों पर विस्तार से बताया। इस दौरान किसान अनुज कुमार ने बताया कि उन्होंने लगभग तीन बीघे क्षेत्रफल में गेहूं की फसल बोई है। वे पहले से ही इस सेवा से जुड़े हुए हैं। इसलिए उन्हें मौसम की सूचना उनके मोबाइल पर प्रत्येक मंगलवार और शुक्रवार को प्राप्त होती है। इससे मिलने वाली सलाह लाभकारी साबित हो रही है। प्रगतिशील कृषक मोनू सैनी, बीर सिंह चौहान, ग्राम प्रधान ब्रह्म सिंह के प्रतिनिधि हरीश सैनी आदि ने कृषि-मौसम सलाहकारी सेवाओं के बारे में अनुभव साझा किए। कार्यक्रम का संचालन परियोजना के तकनीकी अधिकारी डॉ. अरविंद कुमार श्रीवास्तव ने किया। इस अवसर पर धनंजय पासवान दास, नितिन वर्मा, किसान आदित्य, मुल्हड़ सिंह, अमरपाल, सोरड़ सिंह, छतरपाल आदि उपस्थित रहे।

लक्सर विकास खंड के पुरवाला गांव में किसान चौपाल में हिस्सा लेने पहुंचे ग्रामीण कृषि मौसम सेवा परियोजना के नोडल अधिकारी (बाएं से) प्रो. आशीष पांडेय, प्रो. आरडी सिंह, किसान अनुज कुमार, किसान आदित्य और बीर सिंह चौहान ● आयोजक संस्था

किसानों के मोबाइल में इंस्टॉल किया मेघदूत ऐप

चौपाल में भारत मौसम विभाग की ओर से विकसित मेघदूत ऐप को किसान के स्मार्ट फोन में मौसम प्रेक्षक रोहित गिरी और उनकी टीम के सदस्यों ने इंस्टॉल किया। मेघदूत ऐप भारत सरकार के पृथ्वी विज्ञान मंत्रालय की ओर से भारत मौसम विभाग (आइएमडी) और भारतीय कृषि अनुसंधान परिषद (आइसीएआर) के संयुक्त प्रयास से बनाया गया है। यह ऐप किसानों को मौसम पूर्वानुमान के आधार पर उनकी खेती-किसानी के दिन-प्रतिदिन की गतिविधियों को लेकर सहयोग देता है। ऐप को वर्तमान में देशभर में कार्यरत लगभग 330 कृषि-मौसम प्रक्षेत्र इकाइयों से लिंक किया गया है। इन केंद्रों की ओर से प्रत्येक मंगलवार व शुक्रवार को जारी किए गए मौसम पूर्वानुमान व मौसम आधारित कृषि-परामर्श बुलेटिन को सीधे किसान अपने स्मार्ट फोन पर किसी भी समय देख सकते हैं। किसानों को मेघदूत ऐप के माध्यम से जल्द ही ब्लॉक स्तर पर जानकारी उपलब्ध हो सकेगी।

लक्सर के विकासखंड के पुरवाला गांव में आयोजित की गई किसान चौपाल

किसानों को मौसम सेवा परियोजना की जानकारी दी

रुड़की | कार्यालय संवाददाता

कार्यक्रम

- जल संसाधन विकास एवं प्रबंधन विभाग की ओर से हुआ कार्यक्रम
- कहा, मौसम की पूर्व में जानकारी मिलने से हुआ फायदा

लक्सर विकासखंड के पुरवाला गांव में किसान चौपाल लगाकर कृषि-मौसम सलाहकारी सेवाओं के बारे में ग्रामीणों को जागरूक किया गया। इस दौरान ग्रामीणों ने समय पर मौसम की जानकारी मिलने से होने वाले लाभ बताए।

आईआईटी रुड़की के जल संसाधन विकास एवं प्रबन्धन विभाग में संचालित भारत सरकार मौसम विज्ञान विभाग की ग्रामीण कृषि-मौसम सेवा परियोजना की ओर से किसान जागरूकता कार्यक्रम का आयोजन किया गया। परियोजना की ओर से किसानों को मौसम सलाहकारी सेवाएं दी जाती है। किसान अनुज ने बताया कि उन्होंने लगभग तीन बीघा क्षेत्रफल में गेहूं की फसल बो रखी है। बताया कि वे पहले से ही इस सेवा से जुड़े हुए हैं, इसलिए उन्हें मौसम की सूचना उनके मोबाइल फोन पर प्रत्येक मंगलवार व शुक्रवार को मिलती है। मौसम पुर्वानुमान की जानकारी मिलने से उन्हें आर्थिक लाभ हुआ है।

प्रगतिशील किसान मोनू सैनी, ग्राम प्रधान ब्रह्म सिंह के प्रतिनिधि हरीश सैनी ने भी मौसम की सही समय पर प्राप्त सूचना व एडवाइजरी सेवा द्वारा हुए आर्थिक लाभ के बारे में किसानों के साथ अपने अनुभव साझा किए। ग्रामीण कृषि-मौसम सेवा परियोजना के नोडल अधिकारी प्रो. आशीष पांडेय ने किसानों को परियोजना द्वारा प्रदान की जा रही सेवाओं तथा इन सेवाओं को आसानी से प्राप्त करने के तरीकों के बारे में बताया। राष्ट्रीय जल विज्ञान संस्थान के पूर्व निदेशक व जल संसाधन विकास एवं प्रबन्धन विभाग में अतिथि प्राध्यापक प्रो. आरडी सिंह ने किसानों को मौसम आधारित खेती के लाभ, अंधाधुंध रासायनिक उर्वरकों के प्रयोग से धरती की उर्वरा शक्ति में हो रहे ह्रास व सिंचाई जल के दुरूपयोग से आने वाले समय में जल संकट की चुनौतियों के बारे में बताया। कार्यक्रम का संचालन परियोजना के तकनीकी अधिकारी डॉ. अरविंद कुमार श्रीवास्तव ने किया। भारत मौसम विभाग द्वारा विकसित मेघदूत एप को किसानों के स्मार्ट फोन में मौसम प्रेक्षक रोहित गिरी व उनकी टीम के सदस्यों ने इंस्टाल किया।

आईआईटी की किसानों के लिए एडवाइजरी

संवाद न्यूज एजेंसी

रुड़की। आईआईटी स्थित ग्रामीण कृषि-मौसम सेवा परियोजना के नोडल अधिकारी प्रो. आशीष पांडेय, तकनीकी अधिकारी डॉ. अरविंद कुमार श्रीवास्तव समेत टीम के सदस्य लॉकडाउन अवधि में कृषि और मौसम से जुड़ी एडवाइजरी किसानों तक समय से पहुंचा रहे हैं। टीम किसानों को व्हाट्सएप, मोबाइल एप और वेबसाइट के अलावा फोन पर भी सुरक्षित तरीके से खेती-किसानी के टिप्स दे रही हैं। नोडल अधिकारी प्रो. आशीष पांडेय ने बताया कि किसानों को कोरोना से बचाव के लिए सुरक्षित तरीके से रबी की फसलों की कटाई और मड़ाई करने की सलाह दी जा रही है। इससे किसान संक्रमण से खुद के साथ परिवार और समाज को सुरक्षित रखकर कृषि कार्य पूरा कर सकते हैं।

फसलों की कटाई के दौरान ये करें

▸ फसलों की कटाई और आलू की खोदाई के दौरान मुंह व नाक को मास्क या गमछे से ढककर रखें। ▸ सरकार के तय नियम के मुताबिक कंबाइन, थ्रेशर के साथ तीन से अधिक श्रमिक एक साथ न रहें। ▸ किसान और श्रमिक आपस में कम से कम तीन मीटर दूरी बनाकर रखें। ▸ श्रमिकों को थ्रेसिंग कार्य पूरा होने तक खेत-खलिहान में ही रहना चाहिए, बार-बार घर नहीं जाना चाहिए। ▸ श्रमिकों को नियमित रूप से बीच-बीच में सैनिटाइजर का उपयोग करना चाहिए या हाथ धोते रहें। ▸ खेत में काम कर रहे किसानों के लिए पीने का पानी, खाद्य सामग्री अलग-अलग बर्तनों में ही देना चाहिए। ▸ कृषि उपकरणों को समय-समय पर सैनिटाइज करें, कोशिश करें कि उपकरण का प्रयोग दूसरा किसान न करे। ▸ कृषि उपकरणों को सैनिटाइज करने के लिए साबुन अथवा डिटर्जेंट के घोल का प्रयोग कर सकते हैं। ▸ जहां तक संभव हो किसी दूसरे गांव के श्रमिकों को कृषि कार्य के लिए नहीं बुलाना चाहिए।

व्यक्तिगत स्वच्छता का भी रखें ध्यान

- खेत-खलिहान में काम करने के दौरान एक कपड़े को एक बार ही पहनें।
- दोबारा उन कपड़ों अच्छी प्रकार धोकर और ठीक से सुखाकर ही पहनें।
- घर से खेत-खलिहान आने जाने के लिए व्यक्तिगत वाहन का प्रयोग करें।
- एक ट्रैक्टर या कंबाइन पर ज्यादा लोग एक साथ न बैठें।
- काम करने के दौरान किसान अपने पानी का अलग-अलग बर्तन ले जाएं।
- खाने में ताजा गर्म भोजन, हरी सब्जियों व उचित मात्रा में फलों का सेवन करें।
- खाने के बर्तन को बर्तन धोने के साबुन से अच्छी तरह साफ करना न भूलें।

Problems in irrigated areas

Passage Created by Farmers across the Canal

Lined Minor Canal with Silt and Damage

Problems in irrigated areas

Farmers obstruct the canal flow

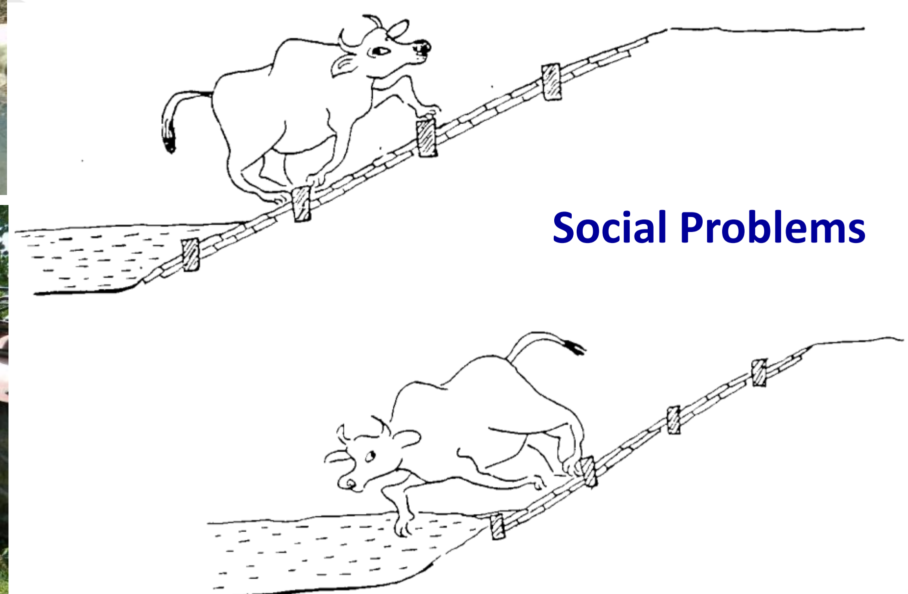
Heavy Weed Growth in Canal Bed

Illegal water withdrawal from canal irrigation

Social Problems

Farmers Discussions





Social Problems

OBJECTIVES OF PMSKY

- Achieve convergence of investments in irrigation at the field level (preparation of district level irrigation plan and, if required, sub district level water use plans).
- Enhance the physical access of water on the farm and expand cultivable area under assured irrigation (Har Khet ko pani),
- Improve on-farm water use efficiency to reduce wastage and increase availability both in duration and extent,
- Enhance the adoption of precision-irrigation and other water saving technologies (Per drop More crop).
- Enhance recharge of aquifers and introduce sustainable water conservation practices
- Ensure the integrated development of rainfed areas using the watershed approach towards soil and water conservation, regeneration of ground water, arresting runoff, providing livelihood options and other NRM activities.
- Promote extension activities relating to water harvesting, water management and crop alignment for farmers and grass root level field functionaries.
- Explore the feasibility of reusing treated municipal waste water for peri-urban agriculture, and
- Attract greater private investments in precision irrigation.

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Every drop of water counts