

RAINWATER HARVESTING (B22EDO601)

OPEN ELECTIVE- SEMESTER-VI

MRS. MINAKSHI MISHRA
SCHOOL OF CIVIL
ENGINEERING



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Course Title	Rainwater Harvesting				Course Type	OE		
Course Code	B22EDO601	Credits	3		Class	Semester-VI		
	TLP	Credits	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment in Weightage	
	Theory	3	3	3				
	Practice	-	-	-	Theory	Practical	CIE	SEE
	Tutorial	-	-	-				
	Total	3	3	3	48	-	50	50





Course Overview

Course Overview

- Rainwater harvesting (RWH) is the technique of **capturing, conserving, and utilizing** rainwater for various purposes to ensure sustainable water management.
- The course provides an understanding of traditional and modern RWH methods, emphasizing the **design, implementation, and maintenance** of RWH systems.





Course Outcomes

Course Outcomes

1. Recognize the importance and **benefits** of rainwater harvesting and water conservation techniques.
2. Understand the **design and components of RWH systems** for urban and rural applications.
3. Analyze water conservation and **recycling techniques** for sustainable water management.
4. Evaluate the **effectiveness of RWH systems** through case studies and practical applications.



Course Outcomes

5. Apply advanced RWH technologies such as **IoT-based monitoring and smart systems**.
6. Interpret **government policies**, guidelines, and case studies to develop sustainable RWH solutions.





Course Content

Unit -1

- **Global and Indian Scenario for Water Resources:** Surface Water and Groundwater Global and Indian Scenario-Quality of water resources. Usable water resources by continent and Country-Water footprint.
- Water use and Sustainable Reuse Methods.
- **Introduction:** Concept and Necessity of Rainwater Harvesting, Benefits of Rainwater Harvesting (Social, Environmental, and Economic), Rainwater Harvesting in ancient India and worldwide.



Unit -2

- **Introduction:** Advantages of Rainwater Harvesting, Natural Water Resources.
- **Agricultural Practices,** integrated farming, Soil erosion and conservation techniques.
- Concept of Arid and Semiarid Regions. **Drought Management-** introduction, Drought assessment and classification, drought mitigation planning, Concept of watershed, introduction to watershed management.



Unit -3

- **Rainwater Harvesting:** Types of Rainwater Harvesting, Components of domestic Rainwater Harvesting system, Principles of design of roof top Rainwater Harvesting System. Conveyance Systems- Material selection and installation.
- **Water Conservation and Recycling:** Perspective on recycle and reuse, Wastewater reclamation, Rain Water Harvesting Techniques- in Urban areas and Rural areas, a case study of both techniques, maintenance and monitoring of Rainwater Harvesting Structures.



Unit -4

- **Advancement and Policies of RWH:** Government policies and schemes for RWH in India, guidelines and regulations (e.g., building codes, municipal policies), Incentives and subsidies for RWH.
- **Smart RWH systems,** Integration with IOT for monitoring and management. Role of RWH in achieving water sustainability, Case Studies in Urban and Industrial.





Textbooks

Textbooks

- **Rainwater Harvesting for Drylands and Beyond**, Volume 1: Guiding Principles to Welcome Rain into Your Life and Landscape by Brad Lancaster, Rain source Press, 2019.
- **Rainwater Harvesting: Principles and Practices** by H.S. Ramesh, New India Publishing Agency, New Delhi, India, 2020.
- **Rainwater Harvesting and Utilisation**: Blue Drop Series, United Nations Environment Programme, UNEP and IETC, 2009.





Important Dates

Important Dates

S. No.	Description	Tentative Dates	No. of Contact Hours
1	Unit 1	03/02/25 to 20/02/25	08
2	Unit 2	20/02/25 to 11/03/25	08
3	Assignment 1 Submission by	07/03/25	
4	IA 1	17/03/25 to 20/03/25	
5	Unit 3	25/03/25 to 17/04/25	09
6	Unit 4	17/04/25 to 08/05/25	08
7	Assignment 2 Submission by	05/05/25	
8	IA 2	12/05/25 to 15/05/25	
9	SEE	26/05/25 to 06/06/25	



Unit -1

- **Global and Indian Scenario for Water Resources:** Surface Water and Groundwater Global and Indian Scenario-Quality of water resources. Usable water resources by continent and Country-Water footprint.
- Water use and Sustainable Reuse Methods.
- **Introduction:** Concept and Necessity of Rainwater Harvesting, Benefits of Rainwater Harvesting (Social, Environmental, and Economic), Rainwater Harvesting in ancient India and worldwide.





Global and Indian Scenario for Water Resources

Water Metrics

- Water is the most common or major substance on earth, covering more than **70% of the planet's surface**. All living things consist mostly of water. For example, the human body is about two third water.
- **It is said that “If third world war take places it will be on water”.**
- Already so many water disputes are going on in our country between neighboring states for sharing river water.



Active River Water Dispute Tribunals in India

- Krishna Water Disputes Tribunal II (2004) – Karnataka, Telangana, Andhra Pradesh, Maharashtra
- Mahanadi Water Disputes Tribunal (2018) – Odisha & Chhattisgarh
- Mahadayi Water Disputes Tribunal (2010) – Goa, Karnataka, Maharashtra
- Ravi & Beas Water Tribunal (1986) – Punjab, Haryana, Rajasthan
- Vansadhara Water Disputes Tribunal (2010) – Andhra Pradesh & Odisha.

The resolution of water dispute is governed by the **Inter-State River Water Disputes Act, 1956**

Water Metrics

- Same situation of sharing river water also exists with neighboring countries like Pakistan, China, Nepal and Bangladesh.
- The basic reason of all these disputes is **scarcity of water** and increasing **requirement for human consumption** as well as for **industrialization**.

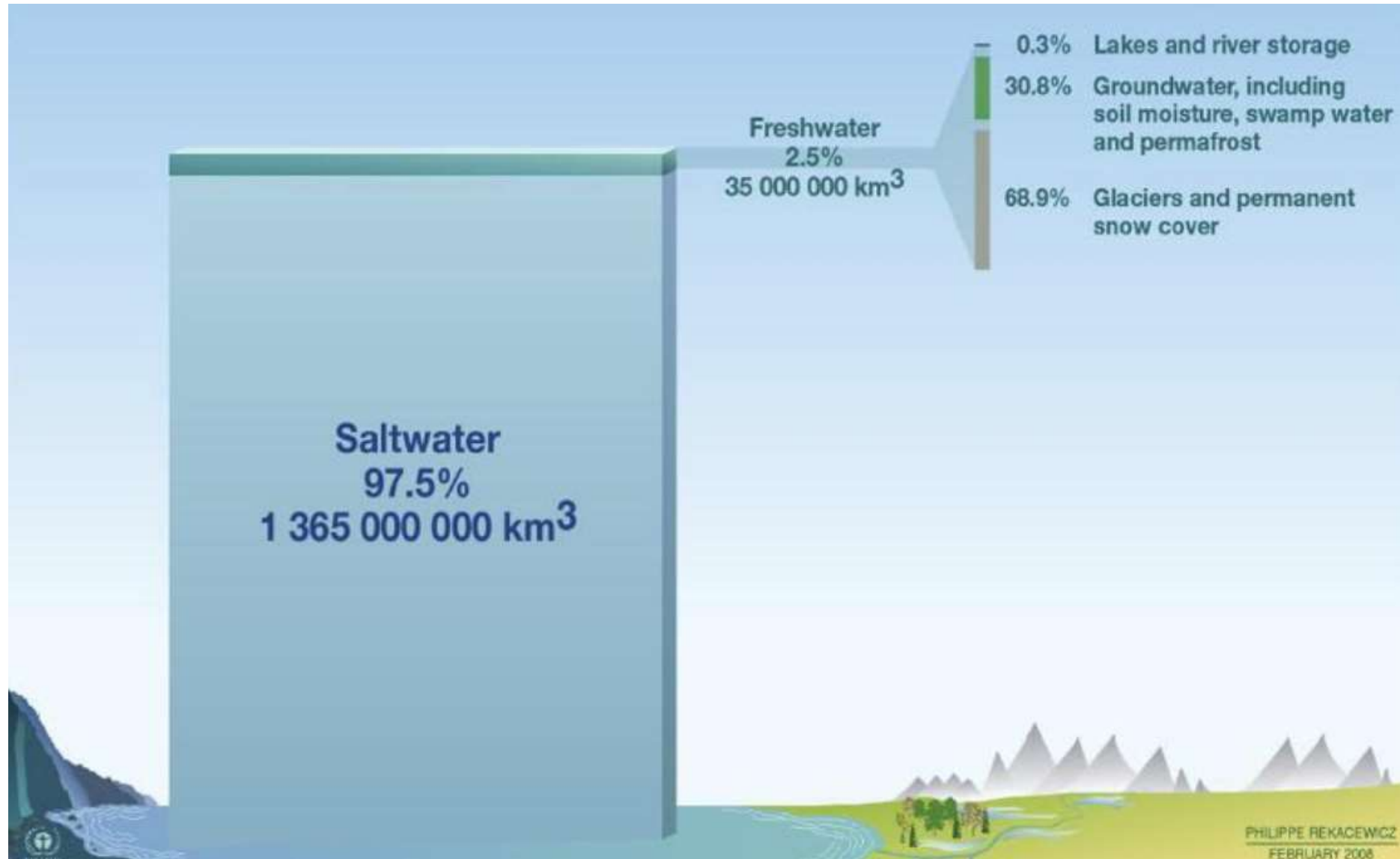


Water Metrics

- Few basic facts we should know:
- **Only 3%** of water on earth is available **for human use**.
- **Only 10% rainwater is harvested currently**. This can be enhanced to 50% if adopted as habit or movement. This can **solve water problems** of major part of country.
- On an average rains, occur only for about 100 hours every year.



Water Metrics



Water Metrics

World-wide distribution of water

S N	Water Type	Volume (1000km ³)	Percentage of total Global Volume
1	Ocean	1,370,323	94.200
2	Ground water (fresh & saline)	60,000	4.100
3	Glaciers	24,000	1.650
4	Lakes and reservoirs	280	0.019
5	Soil moisture	85	0.006
6	Atmospheric water	14	0.001
7	River water	1.2	0.001
	Total	1,454,703.2	100.000



Water Metrics

World-wide distribution of fresh water

S N	Water Type	Volume (1000km ³)	Percentage of total Global Volume
1	Glaciers	24,000	85.000
2	Ground water	4,000	14.000
3	Lakes and reservoirs	155	0.600
4	Soil moisture	83	0.300
5	Atmospheric water	14	0.050
6	River water	1.2	0.004
	Total	28,253.2	100.00



Per Capita Water Availability in India

Year	Population (Million)	Per capita water availability (m ³ /year)	Remarks
1951	361	5178	
1955	395	4732	
1991	846	2210	
2001	1027	1820	
2011	1211	1651	water stressed#
2015	1326*	1508 ^s	water stressed#
2021	1345 ^a	1486 ^s	water stressed#
2031	1463 ^a	1367 ^s	water stressed#
2041	1560 ^a	1282 ^s	water stressed#
2051	1628 ^a	1228 ^s	water stressed#

Source: Government of India, 2009 (NCIWRD Report, 1999), *projected from 2011 census



Water Stress in India

Area of the country as % of world area	2.4%
Population as % of world population (Census, 2011)	17.1%
Water as % of world water	4%
Average annual rainfall (India Meteorological Dept.)	1160 mm (world average 1110 mm)
Range of distribution	150-11690 mm
Range Rainy days	5-150 days

Source: Water Resources Information System of India



Categories of Water

Category of water	Source	Potential for use in agriculture or remarks
Blue water	Sea, lakes, rivers, canals, etc.	Extensively used for irrigation. Its availability is likely to decrease with increasing competition from other sectors.
Green water	Soil moisture and water in plants	Mostly used by plants and agricultural crops particularly forest, grass lands and rain fed agriculture.
Fossil water	Groundwater	Used for domestic and agricultural uses. Its availability to agriculture would decrease with time as a result of competitive demand from other sectors.



Categories of Water

Grey water	Wastewater from bathroom, kitchen and washbasins.	Potential for use in crop production. Suitable for kitchen gardening and irrigating lawns.
Black water	Domestic sewage/Industrial waste	Potential for use in crop production. 21 st century water resource for agriculture. Cleaner technologies required to avoid heavy metals/pathogens entering human chain.
Virtual water	Water used in producing grains/animal product	Export-import of food grains/animal product indirectly results in export-import of water. One kg of rice or wheat export means export of 2000 litres of water for rice and 800 litres of water for wheat. It is going to assume importance in export-import during the next few decades.





Water use and Sustainable Reuse Methods

Water use and Sustainable Reuse Methods

- Water recycling is reusing treated wastewater for beneficial purposes such as agricultural and landscape irrigation, industrial processes, toilet flushing, and replenishing a ground water basin.
- **Environmental Benefits of Water Recycling:** In addition to providing a dependable, locally-controlled water supply, water recycling provides tremendous environmental benefits. By providing an additional source of water, water recycling can help us find ways to **decrease the diversion of water from sensitive ecosystems.**



Uses of recycled water

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



Uses of water recycled from water treatment plant

Secondary Treatment: Biological Oxidation, and Disinfection

- Surface irrigation of orchards and vineyards
- Non-food crop irrigation
- Restricted landscape impoundments
- Groundwater recharge of non-potable aquifer
- Wetlands, wildlife habitat, stream augmentation
- Industrial cooling processes



Uses of water recycled from water treatment plant

Tertiary and advance treatment

- Landscape and golf course irrigation
- Toilet flushing
- Vehicle washing
- Food crop irrigation
- Unrestricted recreational impoundment
- Indirect potable reuse- Groundwater recharge of potable aquifer and surface water reservoir augmentation





Water Footprint

Water Footprint

- Water Footprint refer to an individual, a commodity, a business or a nation.
- It is an indicator that looks at both direct and indirect water use.
- The water **footprint of a commodity** is the total volume of freshwater used to produce the commodity throughout the various steps of the production chain



Water Footprint

- The **water footprint of a consumer** is defined as the total volume of freshwater that is used to produce the goods and services consumed by the person over a period of time.



Dimensions of a water footprint

- The water footprint is a multi dimensional indicator of water use.



Dimensions of a water footprint

- First, it has a **geographical dimension**. It contains information on both the use of water in volume and the location of that use.
- Geographical information is important because consuming one cubic meter of water in a water abundant area has a different significance than consuming the same volume in a water-scarce area.



Dimensions of a water footprint

- Second, it has a **time dimension**. Consuming water from a product that is produced in a wet season has a different implication than a product that is produced in a dry season.
- These geographical and time dimensions of water footprints of a product are not always obvious at a first glance, as water use data is often presented in total volume or in average volume. However, if you dig deeper, you will find the data details comprising these dimensions.

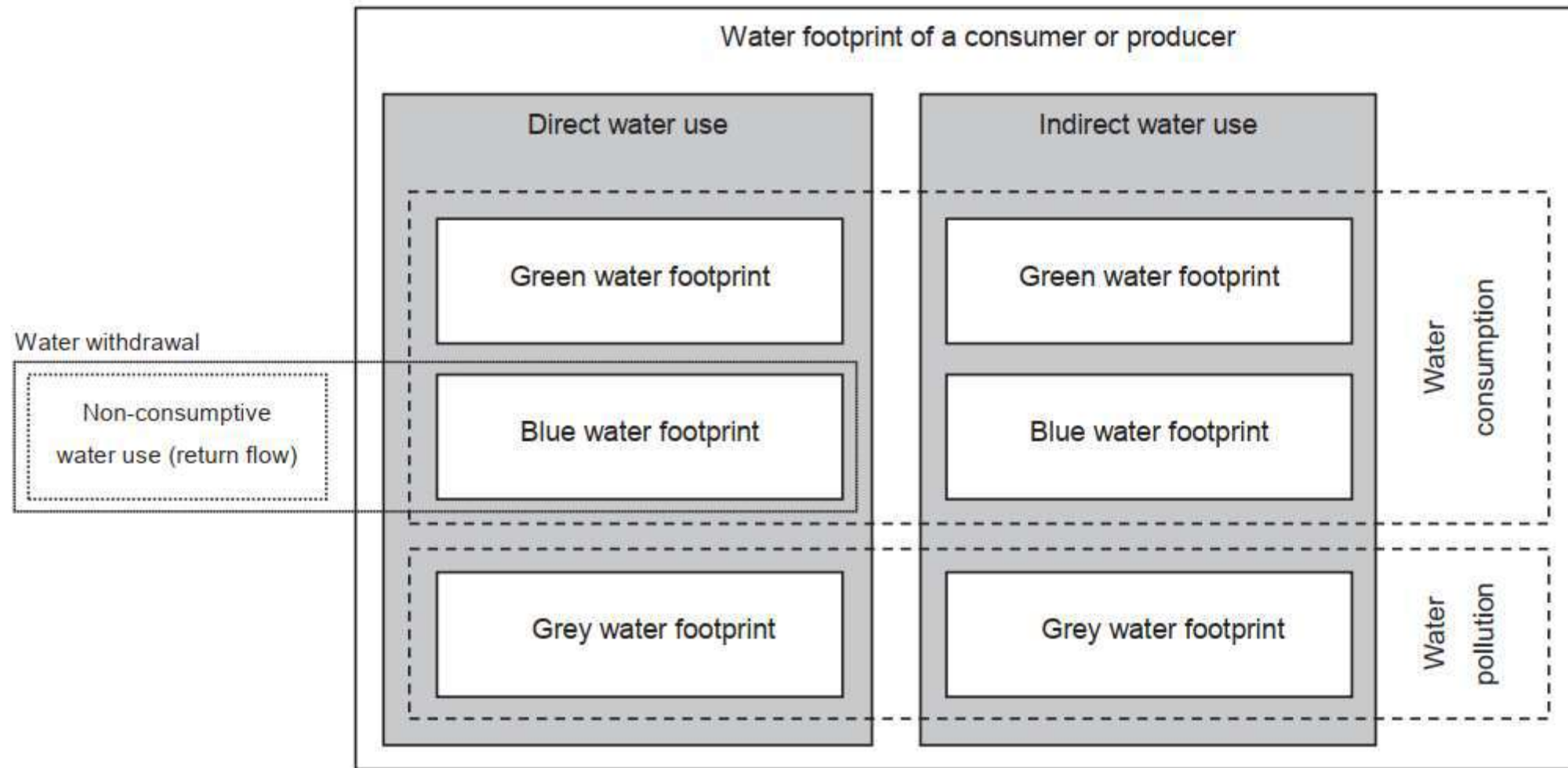


Dimensions of a water footprint

- Third, water footprint can reveal both the **direct and indirect water use** of producing a commodity, or by a consumer or a producer.
- Another dimension of water footprint is its “**colour**”: ‘Green water footprint’ refers to the use of rainwater in the production of a commodity; ‘Blue water footprint’ refers to the use of fresh water from rivers or groundwater aquifers; and ‘Grey water footprint’ refers to the volume of water needed to assimilate the pollutants that enter rivers or groundwater as a result of the production of a commodity.



Dimensions of a water footprint



Water Footprint



Water Footprint



Water Footprint



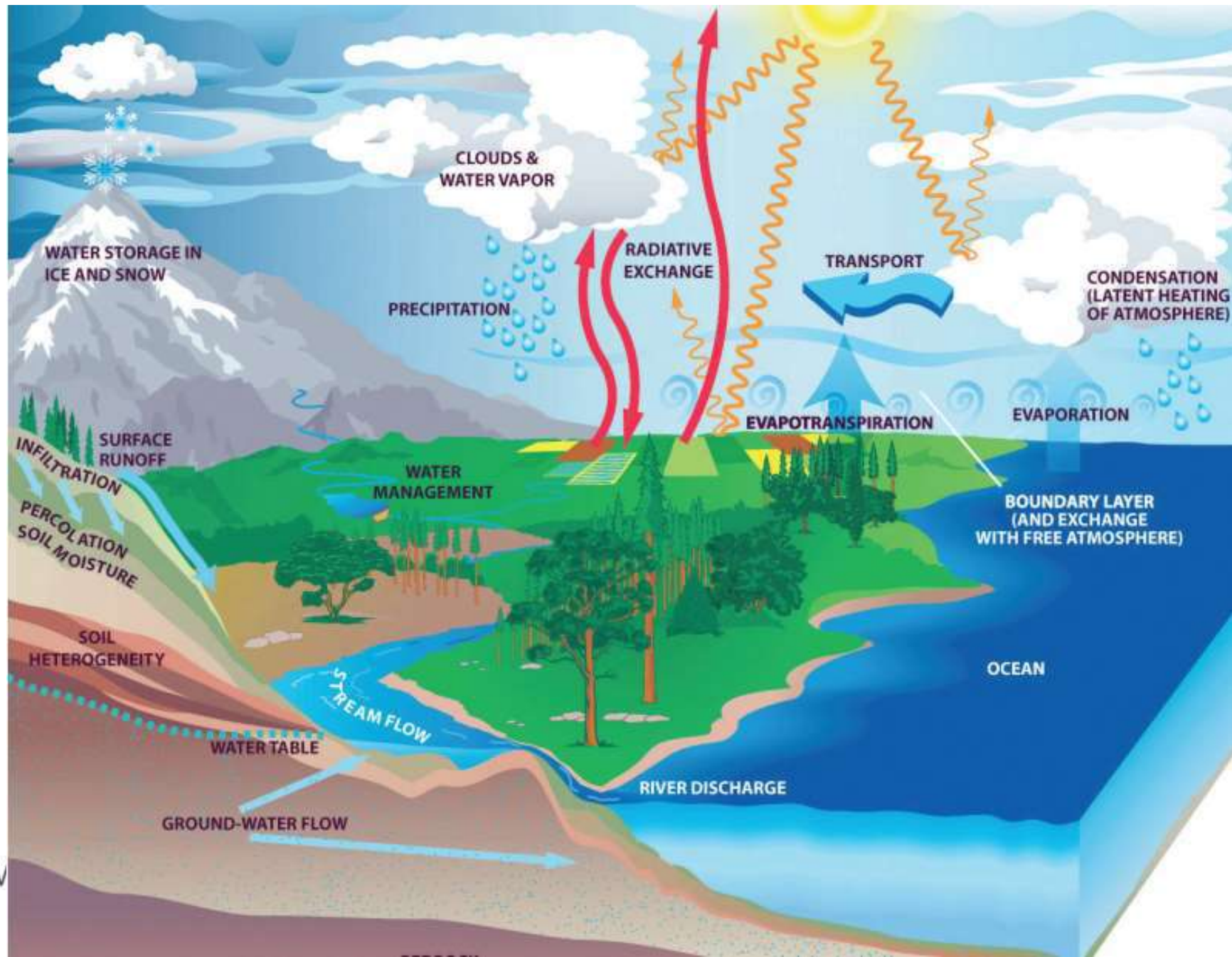
Water Footprint



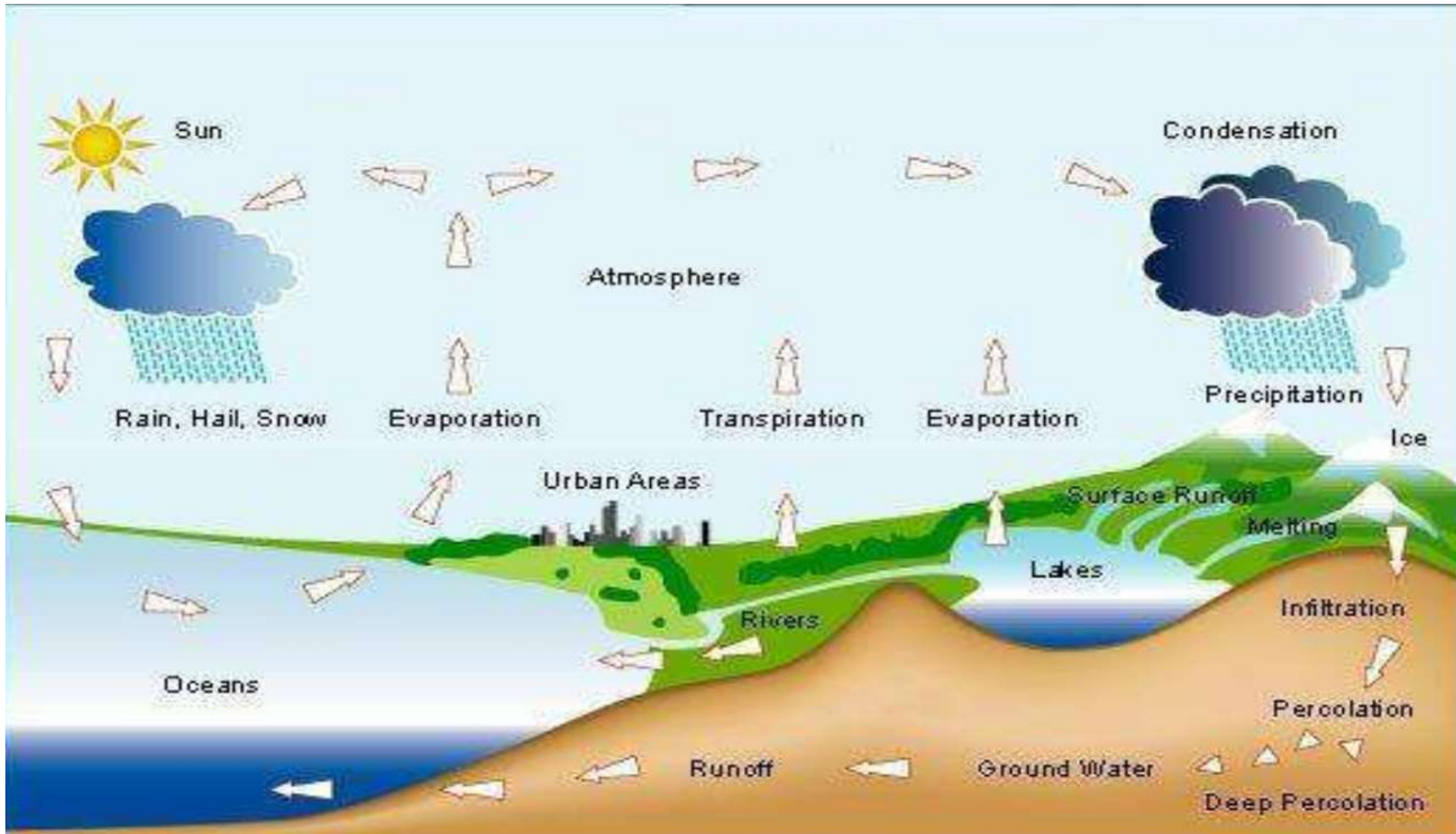


Water (Hydrological) Cycle

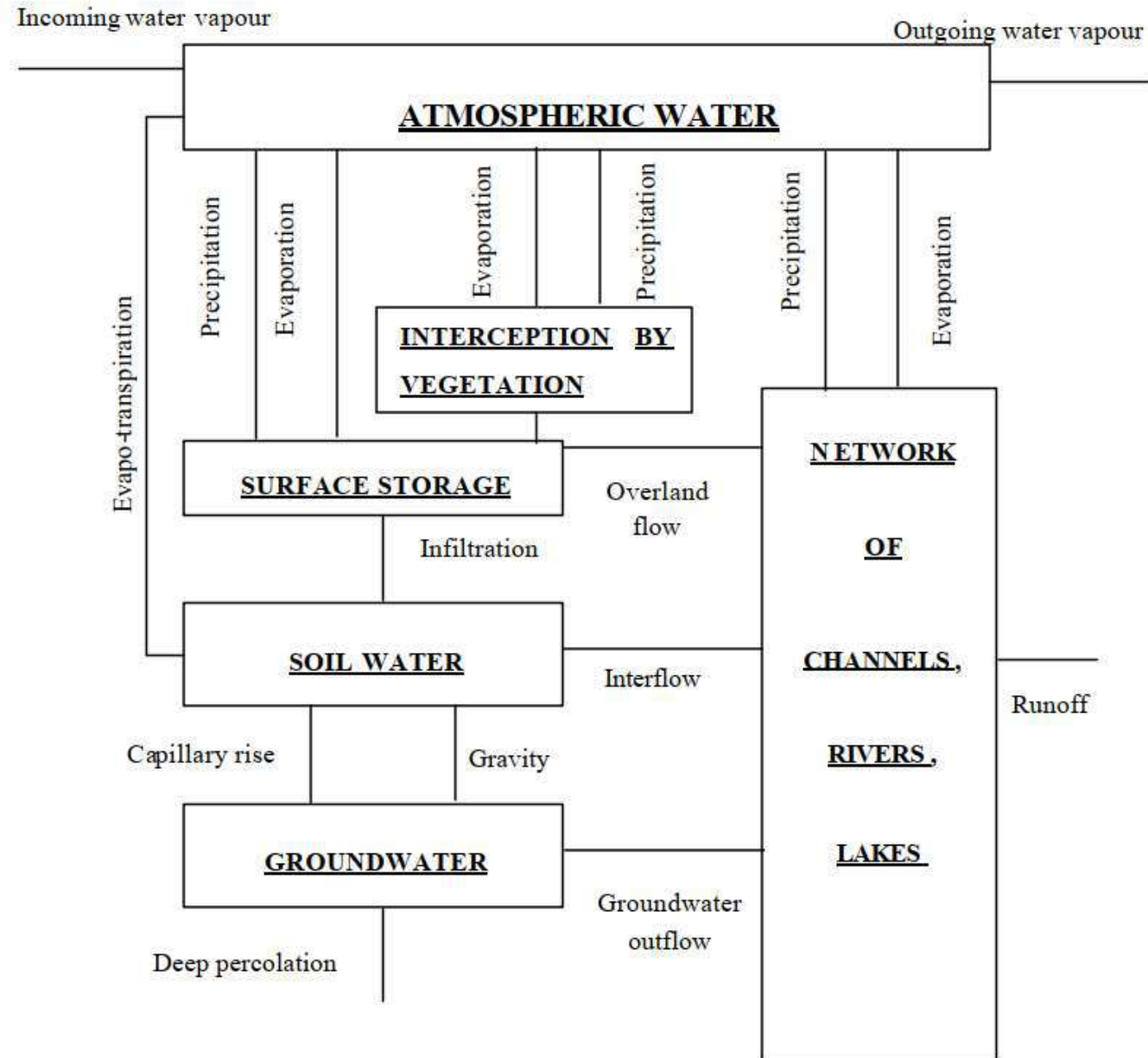
Water (Hydrological) Cycle



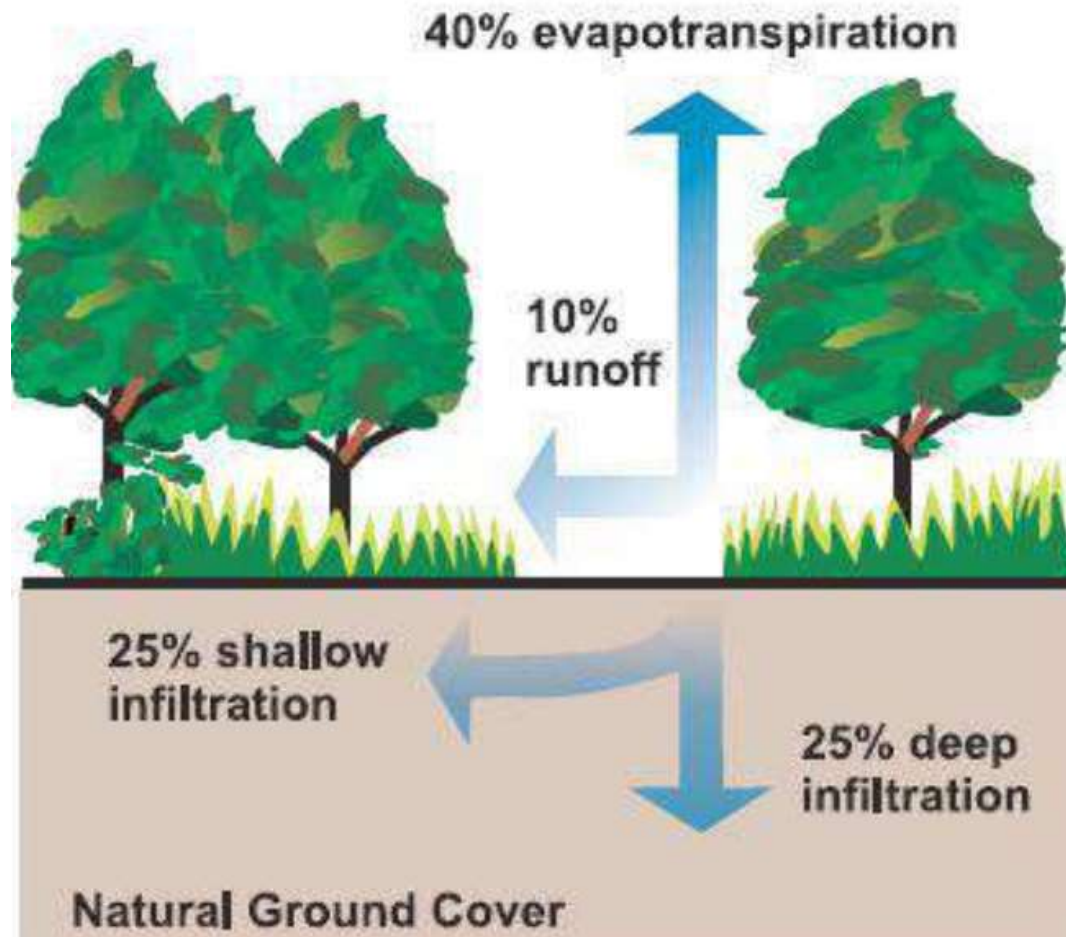
Water (Hydrological) Cycle



Water (Hydrological) Cycle



Water (Hydrological) Cycle



Stages in Hydrological Cycle

- **Evaporation-** Water from soil surface, ponds, lakes, rivers and oceans gets transferred as moisture. The factors which affect evaporation are: temperature, relative humidity, wind velocity, amount of rainfall or snowfall, quality of water, surface area of the water source, sunshine etc.
- **Transpiration-** Transpiration refers to loss of water in vapour form from plant leaves. The water taken into the roots of the plants from the soil replaces the transpired water. In a way, transpiration is like the action of a pump absorbing water from the soil and leaving the vapour into the atmosphere.



Stages in Hydrological Cycle

- **Interception** is the retention of precipitation by thick vegetation (of trees and plants) or by shrubs that is evaporated back to atmosphere.
- **Precipitation** Water returns to the land and sea from the atmosphere by means of **condensation, deposition and precipitation**.
- Condensation is the process of conversion of water vapour into liquid state (in the form of dew droplets).



Stages in Hydrological Cycle

- Deposition is the process by which water vapour changes into ice crystals. In the atmosphere, tiny droplets of water and ice crystals form clouds. Precipitation signifies rainfall and snowfall.
- **Run off**-Some of the rainfall is soaked into the soil as ground water. The excess water flows over the land surface along the natural slope of the area and is known as run off.





Rainwater Harvesting

Rainwater Harvesting

- Rainwater harvesting is the technique of collection & storage of rainwater at surface or in subsurface aquifers.
- As most of rainfall water goes **waste in form of surface run off to stream**, river and sea, simple technique need to be developed to **collect and store** this water in **storage tank** or direct this water to recharge ground water **aquifers** (water bearing strata) to be tapped later on for use in dry periods.



Need for Rainwater Harvesting

- To meet the ever-increasing demand for water.
- To reduce the runoff which chokes storm water drains.
- To avoid flooding of roads.
- To augment ground water storage.
- To reduce the soil erosion.
- To supplement domestic water requirement during crisis.

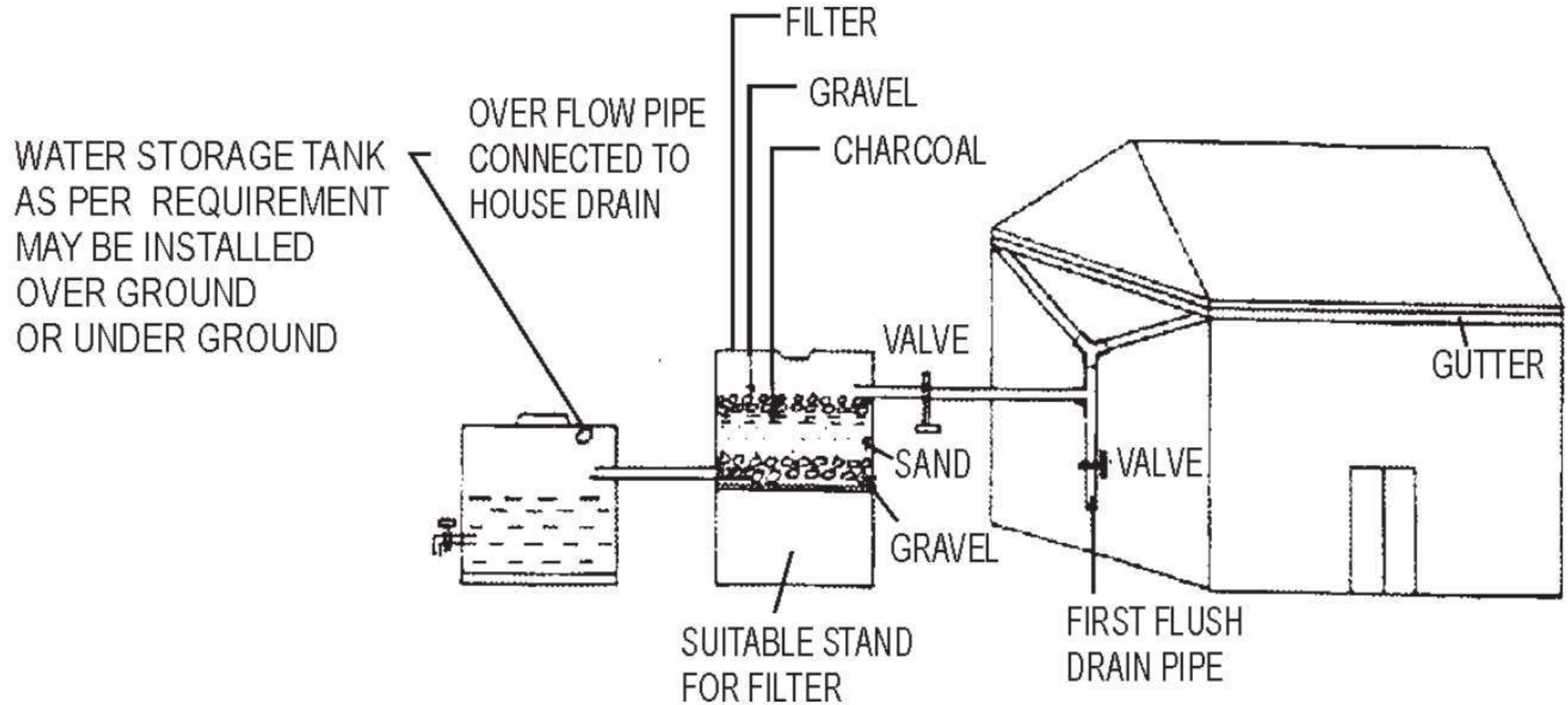


Rainwater Harvesting

- Rainwater harvesting is in two ways:
- **Direct Use:** The process of collecting and storing the rainwater by construction of sump through filters for future productive use.
- **Artificial recharge to groundwater:** Recharge the rainwater in a scientifically planned way by construction of rain / roof top water harvesting structures to augment the groundwater.



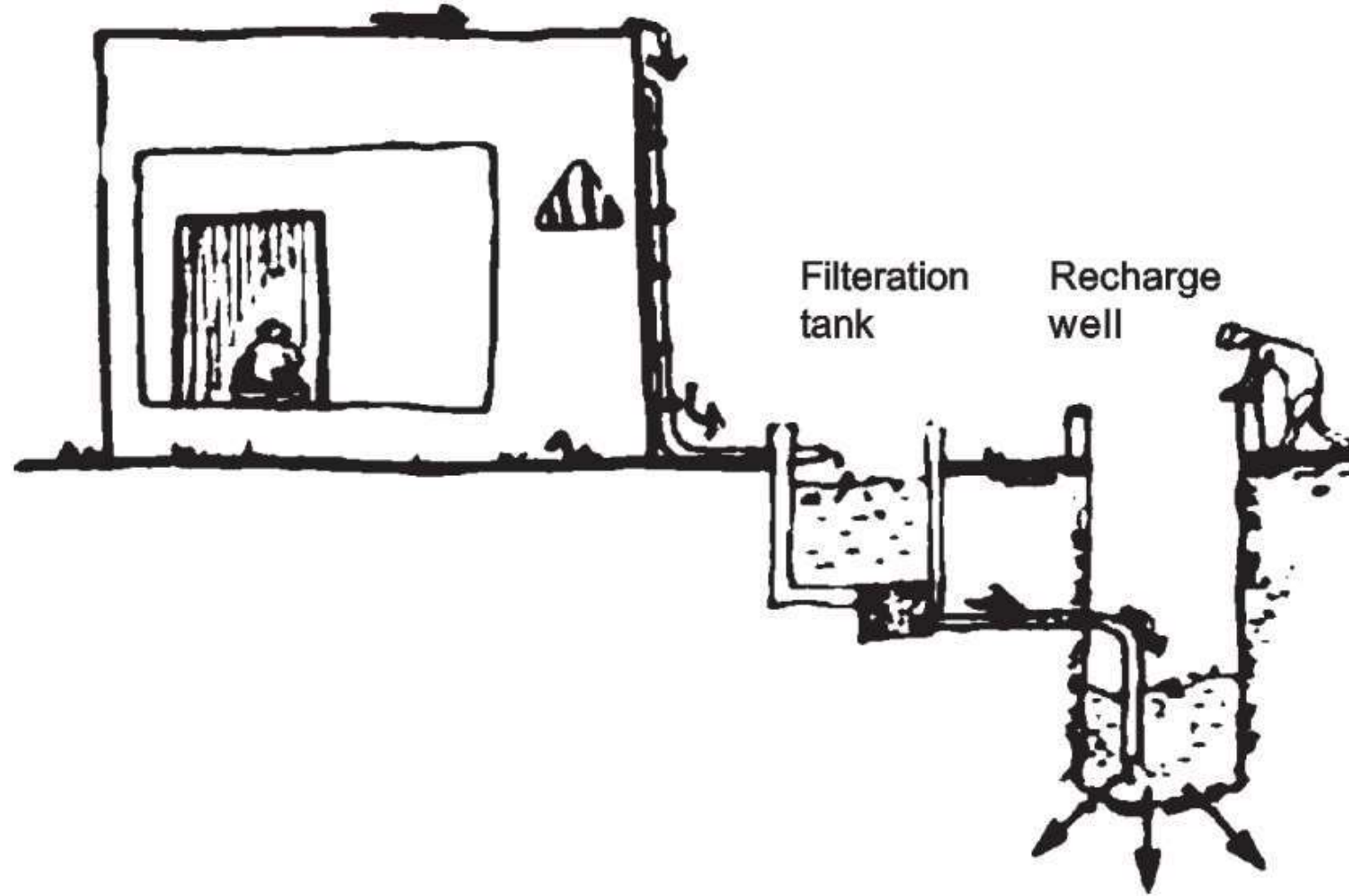
Rainwater Harvesting-Direct Use



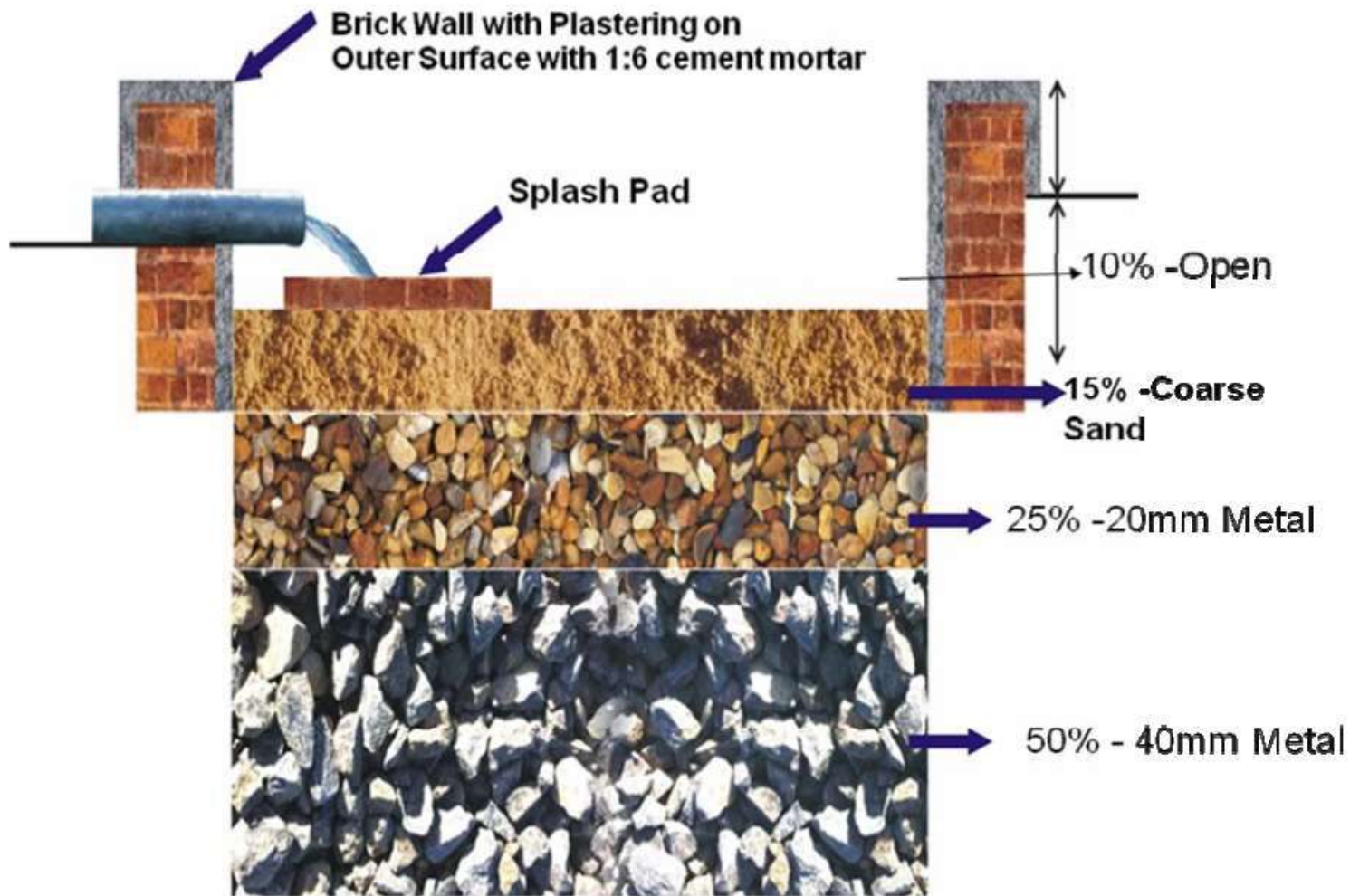
Rainwater Harvesting-Direct Use



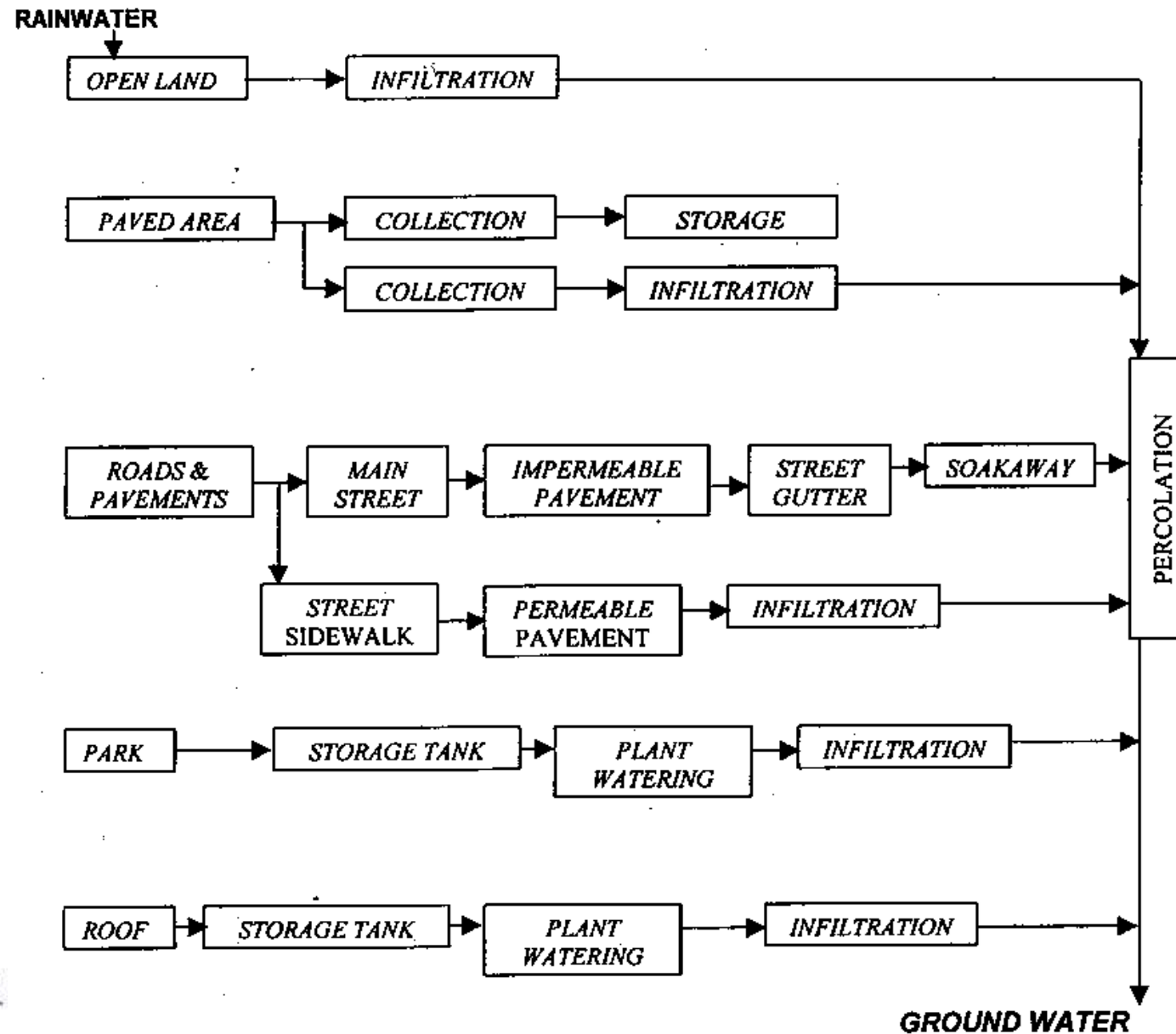
Rainwater Harvesting-Artificial recharge



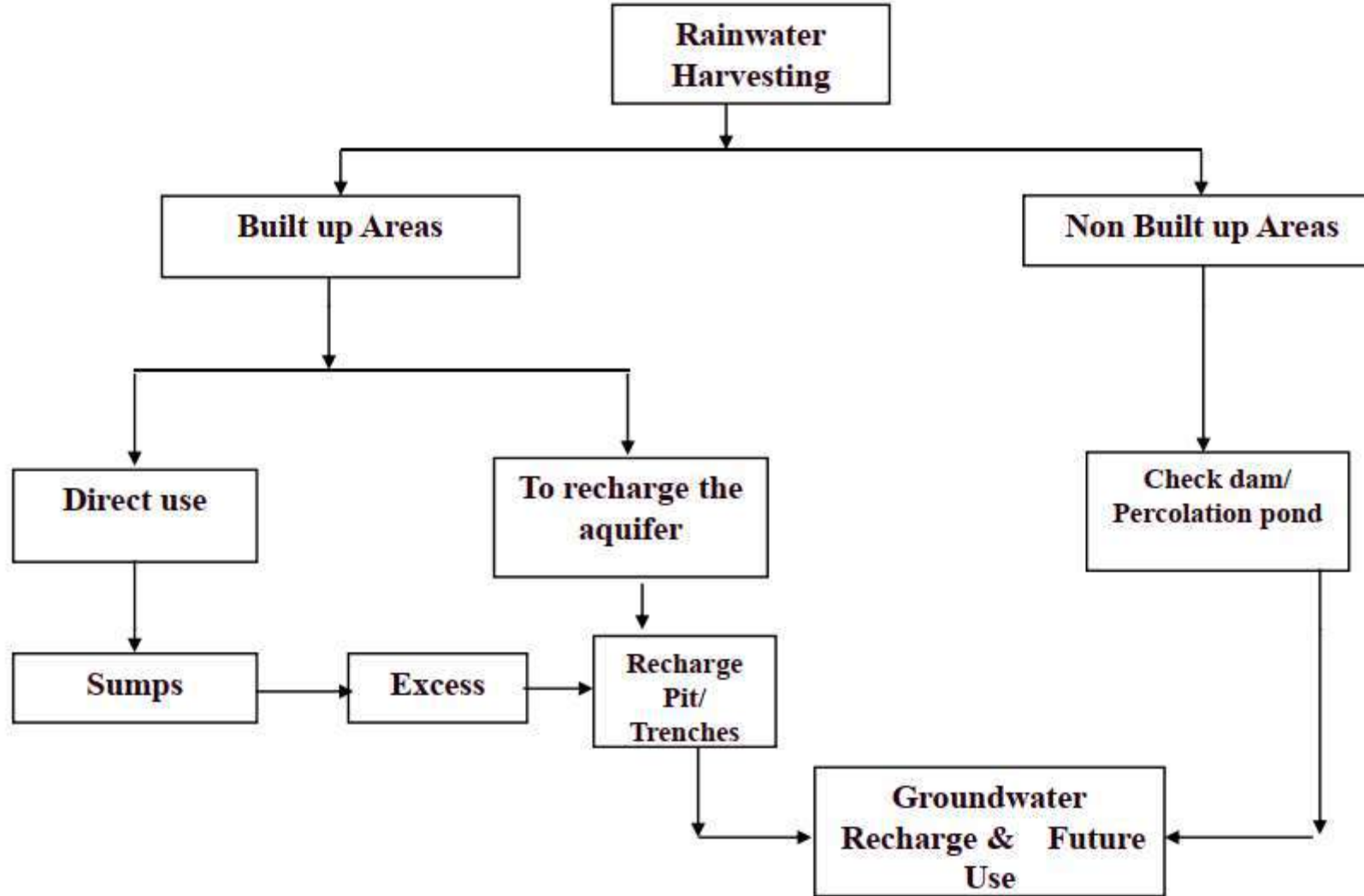
Rainwater Harvesting-Artificial recharge



Systems of Rainwater Harvesting



Integrated Rainwater Harvesting System



Advantages of Rainwater Harvesting

- Promotes adequacy of underground water.
- Mitigates the effect of drought.
- Reduces soil erosion as surface run-off is reduced.
- Decreases load on storm water disposal system.
- Reduces flood hazards.
- Improves ground water quality / decreases salinity (by dilution).



Advantages of Rainwater Harvesting

- Prevents ingress of sea water in subsurface aquifers in coastal areas.
- Improves ground water table, thus saving energy (to lift water).
- The cost of recharging subsurface aquifer is lower than surface reservoirs.
- The subsurface aquifer also serves as storage and distribution system. No land is wasted for storage purpose and no population displacement is involved.



Advantages of Rainwater Harvesting

- Rainwater is bacteriological pure, free from organic matter and soft in nature.
- Rainwater can be harnessed at place of need & time of need.
- Recharged aquifers also serve as distribution system & water can be harnessed by just putting a hand pump at convenient location.
- The infrastructure required for rainwater harvesting are simple & economical.



Legislation on Rainwater Harvesting in India

- Under the **sec 15 of Environment (protection) Act 1986** central ground water authority (ministry of water resources) has made mandatory to adopt rainwater harvesting system for certain types of buildings/institutions.
- RWH is mandatory since June 2001 if roof area = 100 sqm or plot area = 1000sqm.





Rainwater Harvesting in ancient India

Rainwater Harvesting in ancient India

- Tanka
- Khadins/Dhora
- Bandharas
- Ahars
- Johads
- Saza Kuva
- Kund/Kundi
- Kuis/Beris
- Baoris/Bers
- Kere
- Surangam



Rainwater Harvesting in ancient India-Tanka

- Traditional underground tanks known as tankas (little tanks) are most Bikaner homes in Rajasthan. These can be erected in the courtyard or the main home.
- Rainwater was collected in the ground in circular holes lined with finely polished lime.
- Tiles were frequently used to embellish tankas, which assisted to retain the water cool.



Rainwater Harvesting in ancient India-Tanka

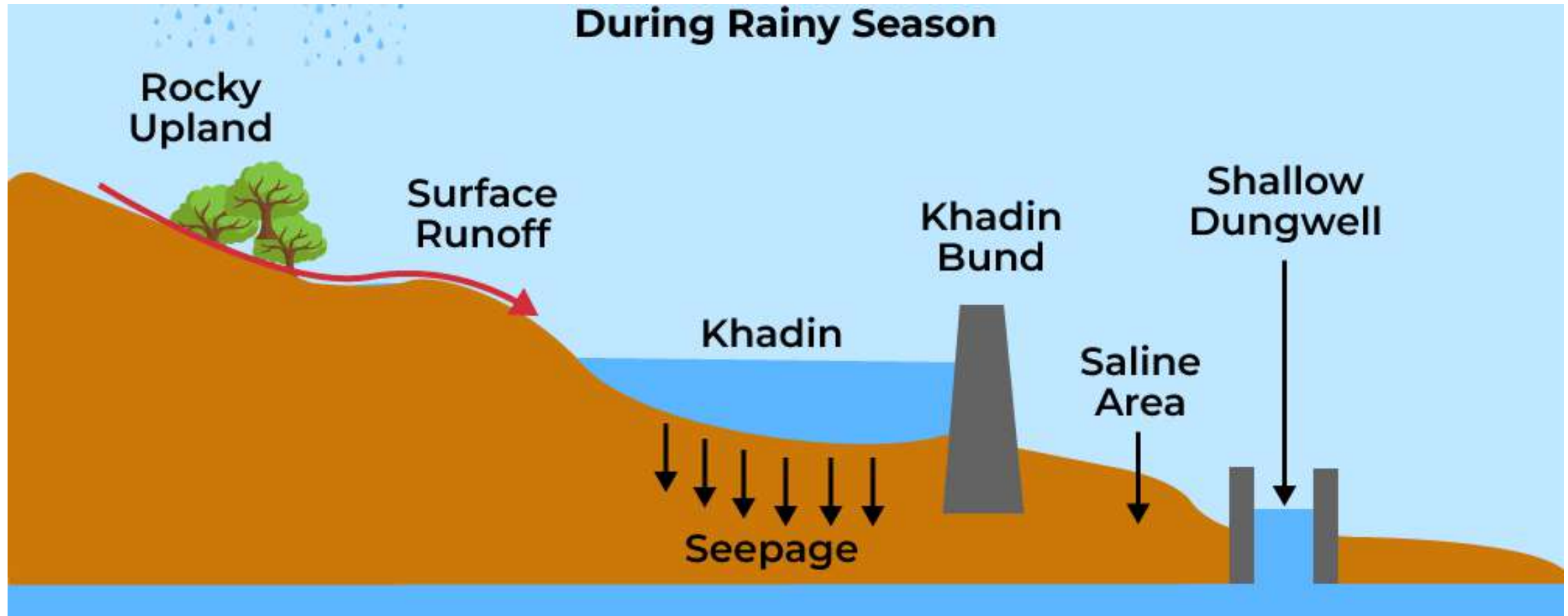


Rainwater Harvesting in ancient India- Khadins/Dhora

- Khadins/Dhora is constructions that gather surface runoff water for agricultural use particularly in very low rainfall areas of Jaisalmer district of Rajasthan. .
- A long (100–300 m) earthen ridge constructed beneath gravelly uplands that spans the lower hill slopes is the area's most recognizable feature.



Rainwater Harvesting in ancient India- Khadins/Dhora



Rainwater Harvesting in ancient India- Bandharas

- Check dams, also known as diversion weirs, are built across rivers. Rivers rise in level as a result of their existence, leading them to flow into channels according to a traditional Maharashtra system.
- These can also be used to hold water and create a large reservoir.



Rainwater Harvesting in ancient India- Bandharas



Rainwater Harvesting in ancient India- Ahar-Pynes

- Traditional irrigation systems in South Bihar, known as Ahars and Pynes, were developed nearly 5000 years ago during the reign of the Magadh dynasty and are still widely used in the Gaya district.
- Wherein 3 m high earthen bunds are constructed with 1:2 ratio of upstream and downstream slope. Runoff water is collected behind the bund. Gates are also provided to drain out water from the bund in sufficient quantity for pre sowing irrigation.



Rainwater Harvesting in ancient India- Ahar-Pynes



Rainwater Harvesting in ancient India- Johads

- Johads generally used in Rajasthan are small earthen check dams used to capture/ conserve rainwater and improve ground water recharge resulting in rise in ground water level and increase in the forest covers.



Rainwater Harvesting in ancient India- Johads



Rainwater Harvesting in ancient India- Saza Kuva

- Saza Kuva, an open well with multiple owners (saza = partner) is the most important source of irrigation in the Aravalli hills of Mewar in eastern Rajasthan.



Rainwater Harvesting in ancient India- Saza Kuva



Rainwater Harvesting in ancient India- Kund

- These structures harvest rainwater in Gujarat from a saucer-shaped catchment area gently sloping towards the well.
- The harvested rainwater is generally used for drinking purposes.



Rainwater Harvesting in ancient India- Kund



Rainwater Harvesting in ancient India- Kuis/Beris

- Kuis/Beris are 10-12 m deep pits dug near tanks to collect the seepage and harvest rainwater in areas with meager rainfall.
- The entrance of the pit is typically built narrow; as a result, the water does not evaporate. As the crater sinks deeper into the earth, it spreads, allowing water to seep onto a sizable surface.



Rainwater Harvesting in ancient India- Kuis/Beris



Rainwater Harvesting in ancient India- Baoris/Bers

- Baoris, also known as bers/Vav/Vavdi/Baoli/Bavadi, are community wells which are primarily used for drinking water purposes.
- The majority of the Baoris were very ancient and constructed for the drinking water needs of banjaras (mobile trading communities). Because water evaporation is nearly non-existent, they can clutch water for an extended time.



Rainwater Harvesting in ancient India- Baoris/Bers



Rainwater Harvesting in ancient India- Kere

- In the Central Karnataka Plateau, tanks were the most common traditional irrigation method. These are known as Kere's in Kannada.
- They were irrigated either by rivers in valleys or by channels that branched out from check dams constructed across streams.
- The tanks were frequently constructed in succession and a few kilometers apart; excess flow from one tank fed the next. This ensured that discharge from a higher-ranking tank was collected in the lower-ranking tank and that no water was wasted due to overflow.



Rainwater Harvesting in ancient India- Kere

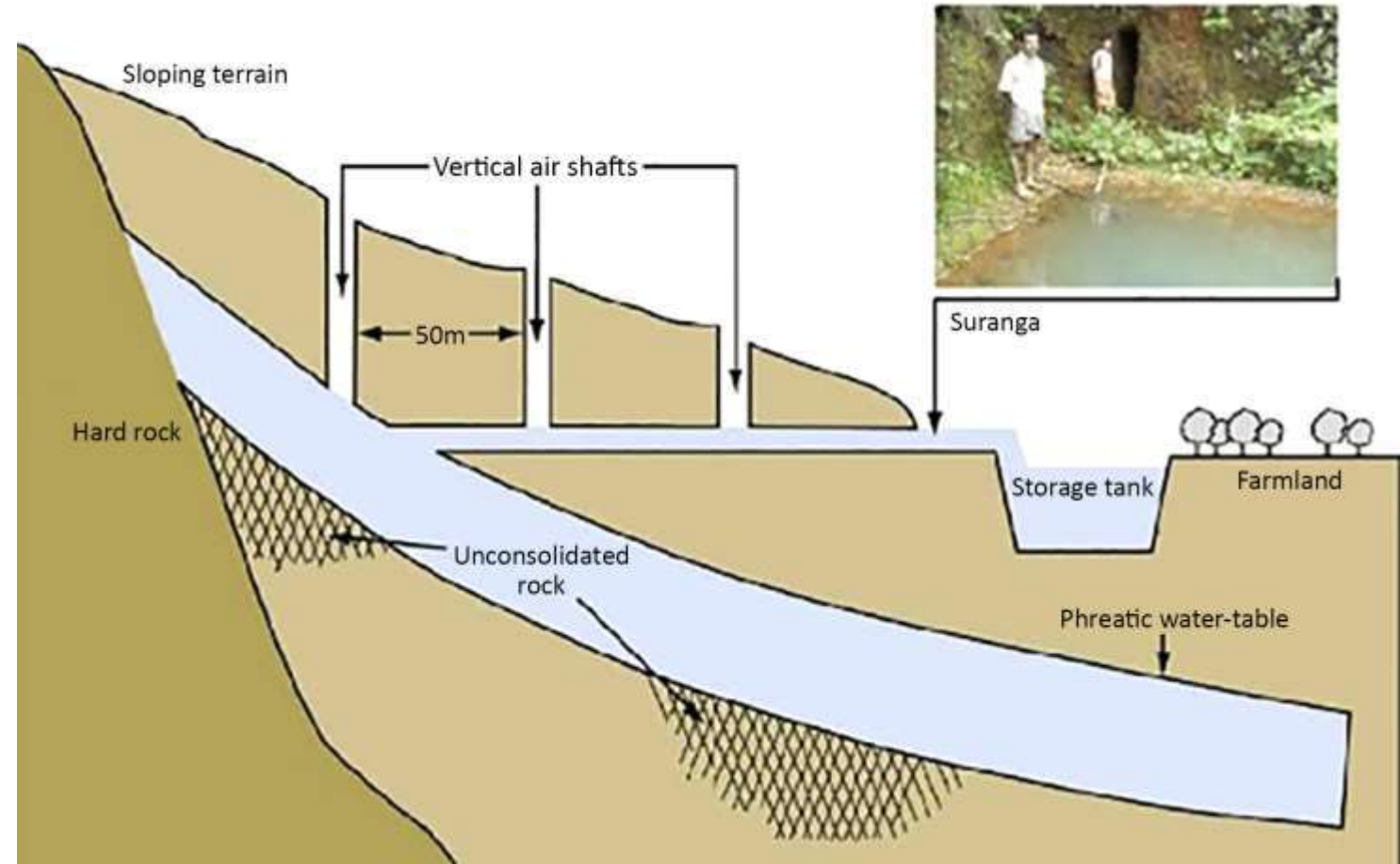


Rainwater Harvesting in ancient India- Surangam

- In Kerala, northern Malabar area, the Kasaragod district is a site where surface water is scarce. Because of the terrain, rivers have during the monsoon, there is a high discharge, while during the dry months, and there is a low discharge.
- The word surangam means “tunnel.” Surangams measure roughly 0.45–0.70 m in width and 1.8–2.0 m in height. The length ranges from 3 to 300 m.



Rainwater Harvesting in ancient India- Surangam



Rainwater Harvesting in ancient India

Eco-zone	Traditional water harvesting system	Salient feature	Location
1. Trans-Himalayan region	Zing	Tanks that use melted ice to collect water	Ladakh
2. Western Himalayas	Kul	Waterways in mountainous regions	Jammu, Himachal Pradesh
	Naula	Small pond	Uttaranchal
	Kuhl	To redirect water from a natural stream for irrigation, build a headwall across a ravine	Himachal Pradesh
	Khatri	Carved water storage chambers in hard rock	Himachal Pradesh



Rainwater Harvesting in ancient India

Eco-zone	Traditional water harvesting system	Salient feature	Location
3. E. Himalayas	Apatani	Interconnected by inlet and outlet channels are terraced parcels	Arunachal Pradesh
4. NE hill ranges	Zabo	Impounding runoff	Nagaland
	Cheo-oziihi	Channels from rivers	Nagaland
	Bamboo drip irrigation	Drip irrigation is used to bring water from streams in the highlands to the plains through bamboo pipes	Meghalaya
5. Brahmaputra valley	Dongs	Pond	Assam



Rainwater Harvesting in ancient India

Eco-zone	Traditional water harvesting system	Salient feature	Location
	Dungs/Jampois	Small irrigation canals linking rice fields and a stream	W. Bengal
6. Indo-Gangetic plain	Ahar-pynes	Embanked catchment basin and channel	S. Bihar
	Bengal's inundation channels	Inundation canal	W. Bengal
	Dighis	Canals from rivers feed a small square or circular reservoir	Delhi
	Baolis	Stepwell	Delhi
7. Thar desert	Kunds/Kundis	Underground storage	W. Rajasthan
	Kuis/Beris	Deep pits near tanks	W. Rajasthan



Rainwater Harvesting in ancient India

Eco-zone	Traditional water harvesting system	Salient feature	Location
	Baoris/Bers	Community well	Rajasthan
	Jhalaras	Tank	Rajasthan, Gujarat
	Nadi	Village pond	Jodhpur, Rajasthan
	Tankas	Underground tank	Bikaner, Rajasthan
	Khadins	Embankment across lower hill slopes	Jaisalmer, W. Rajasthan
	Vav/Vavdi/Baoli/Bavadi	Step well	Gujarat, Rajasthan



Rainwater Harvesting in ancient India

Eco-zone	Traditional water harvesting system	Salient feature	Location
8. Central highlands	Virdas	Shallow well	Rann of Kutch, Gujarat
	Paar	Area where water has percolated, accessed by kuis	—
	Talab/Bandhis	Reservoir	Bundelkhand, Madhya Pradesh
	Saza Kuva	Open well	Mewar, E. Rajasthan
	Johad	Earthen check dam	Alwar district, Rajasthan
	Naada/bandh	Stone check dam	Mewar, Thar desert
	Pat	Diversion bund across stream	Jhabua district, Madhya Pradesh



Rainwater Harvesting in ancient India

Eco-zone	Traditional water harvesting system	Salient feature	Location
	Rapat	Percolation tank	Rajasthan
	Chandela tank	Tank	Rajasthan
	Bundela tank	Tank	Rajasthan
9. Eastern highlands	Katas/Mundas/ Bandhas	Earthen embankments across drainage lines	Orissa and Madhya Pradesh
10. Deccan plateau	Cheruvu	Reservoir to store runoff	Chitoor, Cuddapah districts, Andhra Pradesh
	Kohli tank	Tank	Maharashtra



Rainwater Harvesting in ancient India

Eco-zone	Traditional water harvesting system	Salient feature	Location
	Bhandara	Check dam	Maharashtra
	Phad	Check dam and canal	NW Maharashtra
	Kere	Series of tanks	Central Karnataka
	Ramtek Model	Surface and underground canals connect a complex network of groundwater and surface waterbodies	Ramtek, Maharashtra
11. Western Ghats	Surangam	Horizontal well	Kasaragod, Kerala
12. Western coastal plains	Virda	Shallow well	Rann of Kutch, Gujarat



Rainwater Harvesting in ancient India

Eco-zone	Traditional water harvesting system	Salient feature	Location
13. Eastern Ghats	Korambu	Temporary wall of brushwood, grass and mud laid across channels to raise the level of water	Kerala
14. Eastern coastal plains	Yeri	Tank	Tamilnadu
	Ooranis	Pond	Tamilnadu
15. The Islands	Jack wells	Bamboo pipes are used to lead water into shallow pits	Great Nicobar Island



Thank You



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