MODULE 2

HOW MUCH WATER

The topics covered in this module are:

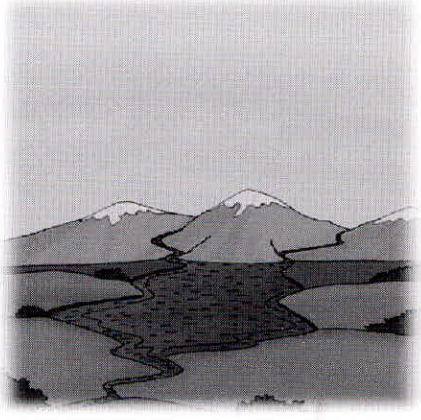
- ☐ River basins of India
- ☐ Water scarcity
- ☐ Water availability
- ☐ Water uses and demand

OBJECTIVE (S) OF THE MODULE

The trainer informs the following module objectives to participants:

- ☐ Understanding river basins and their classification.
- ☐ Conceptualizing the amount of water present in the river basins in the Indian subcontinent and the availability of water on planet Earth.

RIVER BASINS OF INDIA



River Basin

WHAT IS A RIVER BASIN?

River basin is the portion of land drained by a river and its tributaries. It covers the entire land surface dissected and drained by many streams and creeks that flow downhill into one another, and eventually into one river. The final destination is an estuary or an ocean. Historically many of the great early civilizations flourished around rivers and major waterways. As a bathtub catches all the water that falls within its sides, a river basin sends all the water falling on the surrounding land into a central river and out to the sea.

River basin is considered as the basic hydrological unit for planning and development of water resources. There are 12 major river basins with catchment area of 20000 km^2 and above. The total catchment area of these rivers is 25.3 lakh km^2. The major river basin is the Ganga-Brahmaputra-Meghna, which is the largest with catchment area of about 11.0 lakh km^2 (more than 43% of the catchment area of all the major rivers in the country). The other major river basins with catchment area more than 1.0 lakh km^2 are Indus, Mahanadi, Godavari and Krishna. There are 46 medium river basins with catchment area between 2000 and 20000 km^2. The total catchment area of medium river basins is about 2.5 lakh km^2. All major river basins and many medium river basins are inter-state in nature, which cover about 81% of the geographical area of the country.

Did You KNOW

The Ganga River has the largest basin in India. Its total length is approx. 2500 km. and covers almost 25% area of the country.

Activity

Observe a hilly slope after a heavy rain. Where does all the flowing water meet downhill? Where does it go? This is how the seasonal rivers and river basins are formed. Discuss.

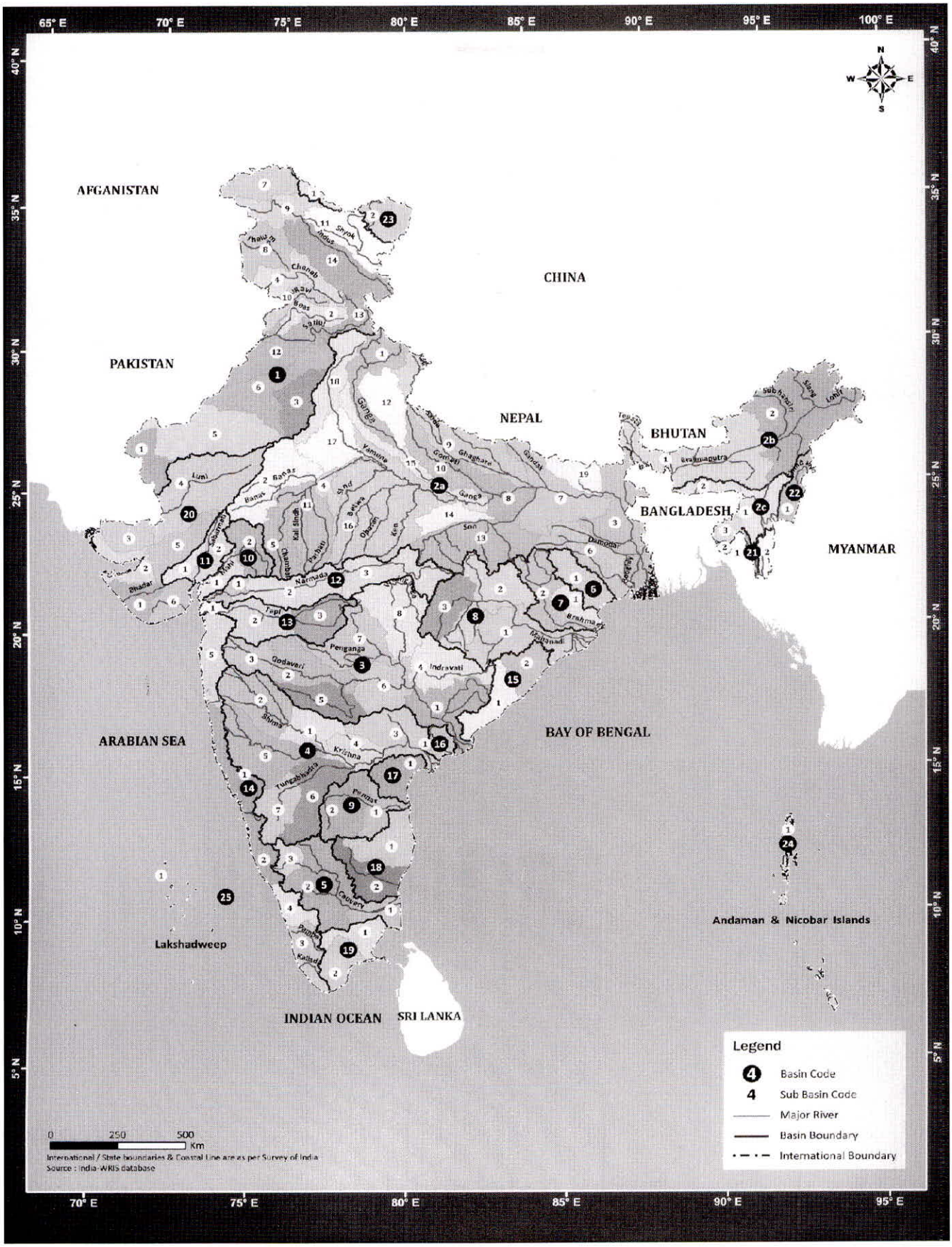
Activity

When a river flows into two or more countries it is classified under International River. Can you name such examples from India? Ask the participants

India's National Water Policy recommends that resource planning in the case of water has to be done for a hydrological unit such as a basin or sub-basin. This means that all developmental projects in a basin should be formulated within the framework of an overall plan for a basin/sub-basin. The National Water Policy further lays down that there should be an integrated and multidisciplinary approach to the planning, formulation, clearance and implementation of projects, including catchment and management, environmental and ecological aspects, rehabilitation of affected people and command area development. Such an integrated, multidisciplinary and basin-wise approach to river basin planning and management requires the establishment of an appropriate organization at the river basin level for ensuring optimum, all round and balanced development of the water resources of a river basin.

RIVER BASIN ORGANIZATIONS

River Basin Organizations (RBO) are main planning, co-ordination and management organization for the basin, combining of various disciplines related to water resources development, drawing expertise from these disciplines in order to



(Source: River Basin Atlas, CWC, MoWR)

S. No	Basin Code	Basin Name	Area (Sq.km)
1	1	Indus (Up to border) Basin	453931.87
2	2a	Ganga Basin	808334.44
3	2b	Brahmaputra Basin	186421.6
4	2c	Barak and others Basin	45622.41
5	3	Godavari Basin	302063.93
6	4	Krishna Basin	254743.31
7	5	Cauvery Basin	85624.44
8	6	Subernarekha Basin	25792.16
9	7	Brahmani and Baitarni Basin	51893.68
10	8	Mahanadi Basin	139659.15
11	9	Pennar Basin	54243.43
12	10	Mahi Basin	38336.8
13	11	Sabarmati Basin	30678.59
14	12	Narmada Basin	92670.51
15	13	Tapi Basin	63922.91
16	14	West flowing rivers South of Tapi Basin	111643.87
17	15	East flowing rivers between Mahanadi and Godavari Basin	46243.06
18	16	East flowing rivers between Godavari and Krishna Basin	10345.16
19	17	East flowing rivers between Krishna and Pennar Basin	23335.82
20	18	East flowing rivers between Pennar and Cauvery Basin	63646.21
21	19	East flowing rivers South of Cauvery Basin	38646.11
22	20	West flowing rivers of Kutch and Saurashtra including Luni Basin	184441.06
23	21	Minor rivers draining into Bangladesh Basin	5453.23
24	22	Minor rivers draining into Myanmar Basin	24731.08
25	23	Area of North Ladakh not draining into Indus Basin	29238.78
26	24	Drainage Area of Andaman and Nicobar Islands Basin	6918.2
27	25	Drainage Area of Lakshadweep Islands Basin	462.59

(Source: River Basin Atlas, CWC, MoWR)

achieve optimal and integrated development of the water resources of the basin. Storage apportionment, regulation and control at various points in the river basin, publishing statistics or other information relating to various aspects of the regulation and development of the inter-state rivers and investigations, surveys etc. as found necessary are undertaken by the RBOs.

The government, as early as 1956, had enacted the River Boards Act, recognizing the necessity of some organization for the control and regulation of interstate river basins. The Act authorizes the Union Government to establish River Boards, on a request received on this behalf from a State Government or otherwise, for advising the government bodies interested in relation to such matters concerning the regulation or development of an interstate river or river valley or any specified part thereof and for performing such other functions as may be specified in the notification.

EXISTING RBOs

1. Damodar Valley Corporation
2. Bhakra-Beas Management Board
3. Tungabhadra Board
4. Ganga Flood Control Commission
5. Betwa River Board
6. Bansagar Control Board
7. Brahmaputra Board
8. Narmada Control Authority
9. Sardar Sarovar Construction Advisory Committee
10. Upper Yamuna River Board

RIVER INTERLINKING

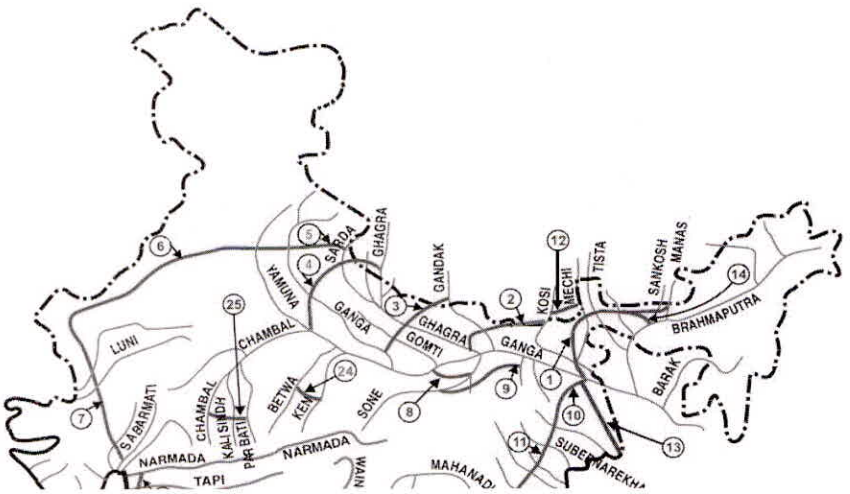
The indian rivers interlinking is a proposed large-scale civil engineering project that aims to join the majority of India's rivers by canals and so it can reduce persistent water shortages in parts of India.

The proposed interlink plan consists of two components, a northern Himalayan River Development component and a southern Peninsular River Development component.

HIMALAYAN DEVELOPMENT

The northern component consists of a series of dams constructed on the Ganga and Brahmaputra rivers in India, Nepal and Bhutan for the purposes of storage. Canals are proposed to be built to transfer surplus water from the eastern tributaries of the Ganga to the west. The Brahmaputra and its tributaries to be linked with the Ganga and the Ganga with the Mahanadi River.

PROPOSED COMPONENTS



1. Kosi - Mechi link
2. Kosi - Ghaghara link
3. Gandak - Ganga link
4. Ghaghara - Yamuna link
5. Sarda - Yamuna link
6. Yamuna - Rajasthan link
7. Rajasthan - Sabarmati link
8. Chunar - Sone Barrage link
9. Sone dam - Southern tributaries of Ganga link
10. Manas - Sankosh - Tista - Ganga link
11. Jogighopa - Tista - Farakka link
12. Farakka - Sunderbans link
13. Ganga - Damodar - Subernarekha link
14. Subernarekha - Mahanadi link

PENINSULAR DEVELOPMENT

The main part of the project is to send water from the eastern part of India to the south and west. The southern development project proposed to consist of four main components.

First, the Mahanadi, Godavari. Krishna and Kaveri rivers would all be connected by canals. Extra water storage dams would be constructed along the path of these rivers. The purpose of this would be to transfer surplus water from the Mahanadi and Godavari rivers to the southern part of India.

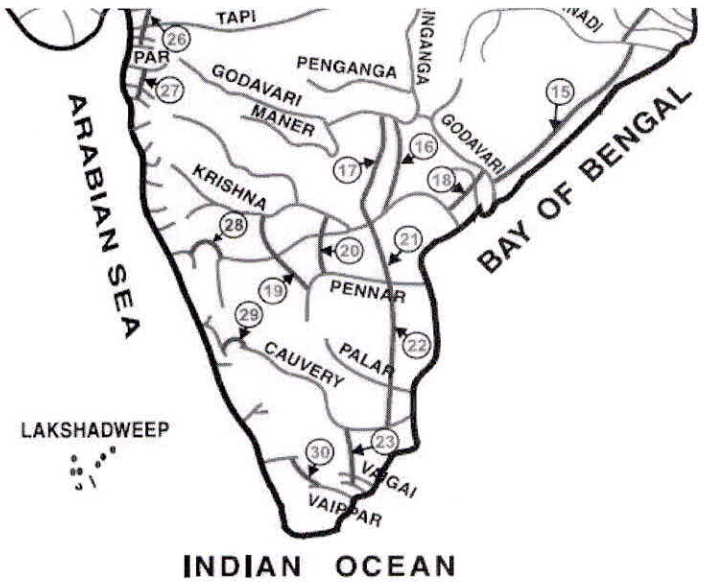
Second, those rivers that flow west to the north of Mumbai and the south of Tapi to

be linked. Due to the irregular fluctuations in water levels in the region, as much storage capacity would be built. The water would be used by the urban areas of Bombay and also to provide irrigation to the coastal regions of Maharashtra.

Third the Ken and Chambal rivers would be linked in order to provide better water facilities for Madhya Pradesh and Uttar Pradesh.

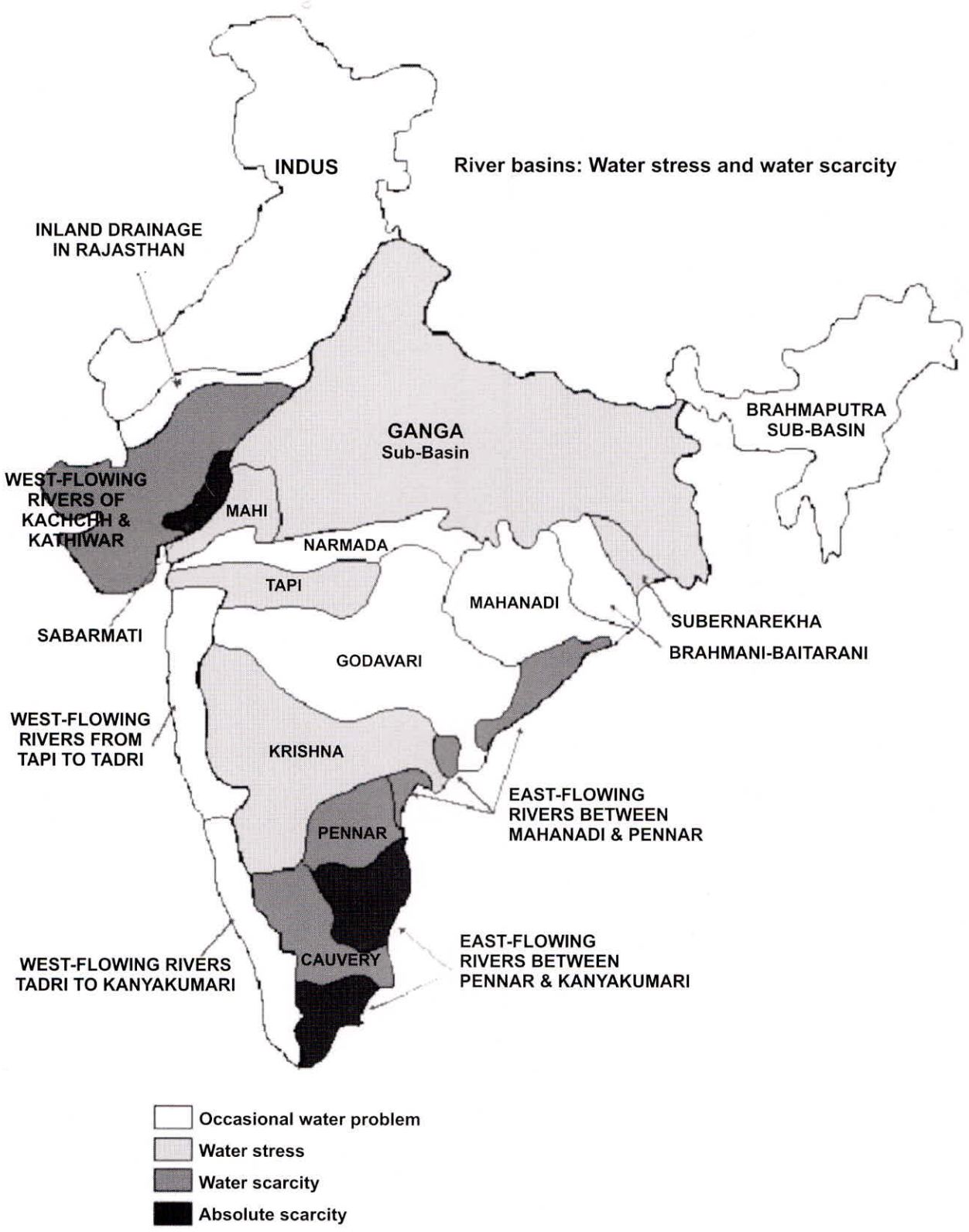
Finally a number of west-flowing rivers along the Western Ghats simply discharge into the Arabian Sea. As many of these as possible would be diverted for irrigation purposes.

PROPOSED COMPONENTS



1. Mahanadi - Godavari Link
2. Inchampalli - Nagarjunasagar Link
3. Inchampalli - Pulichintala Link
4. Polavaram - Vijayawada Link
5. Almatti - Pennar Link
6. Srisailam - Pennar Link
7. Nagarjunasagar - Somasila Link
8. Somasila - Grand Anicut Link
9. Kattalai - Vaigai - Gundar Link
10. Ken - Betwa Link
11. Parbati - Kalisindh - Chambal Link
12. Par - Tapi - Narmada Link
13. Damanganga - Pinjal Link
14. Bedti - Varada Link
15. Netravati - Hemavati Link
16. Pamba - Anchankovil - Vaippar Link

WATER SCARCITY



[Source: www.quora.com/India]

More than two billion people worldwide live in regions facing water scarcity and in India this is a particularly acute crisis. Millions of Indians currently lack access to clean drinking water, and the situation is getting worse. India's demand for water is rising at an alarming rate. India currently possesses the world's second largest population, which is expected to overtake China's by 2050 when it reaches a staggering 1.6 billion, putting increasing strain on water resources as the number of people grows.

A rapidly growing economy and a large agricultural sector stretch the India's supply of water even more tenuous.. Meanwhile, India's supply of water is rapidly dwindling due primarily to mismanagement of water resources, although over-pumping and pollution are also significant contributors. Climate change is expected to exacerbate the problem by causing erratic and unpredictable conditions, which could drastically decrease the supply of water coming from rainfall and glaciers

As demand for potable water starts to outstrip supply by increasing amounts in coming years, India would face increasing problems, such as food shortages, intrastate, and international conflict.

Did You KNOW

263 river basins are shared by two or more nations worldwide.

Per Capita Availability of Water

Year	Population (In Millions)	Per Capita Water Availability (In m^3)
1051	361	5177
2001	1027	1820
2025	1394	1341
2050	1640	1140

[Source: Strategic Plan for Ministry of Water Resources (February, 2011)]

CAUSES OF WATER SCARCITY

Over-extraction has its most straightforward manifestation in the level of aquifers, underground reserves charged by the passage of water through soil and rocks. If withdrawals exceed the natural rate of recharge, the level of an aquifer will fall, eventually drying up altogether.

Human intervention degrades the natural supply of freshwater and occurs in three principal ways.

Firstly, there are approximately 3,200 dams constructed in India, with many more under construction. Dams alter the natural flow of a river, often improving water and energy security for some, at the expense of others including environmental and societal concerns.

Before starting this topic, know the views of participants on 'Unsustainable extraction of freshwater and other human interferences with the water cycle are the immediate causes of water scarcity within a river basin'.

Activity

Can building of smaller dams be a solution to this problem? How? Discuss with the participants.

Secondly, soil moisture is lost in land degradation caused by poor farming practices and deforestation.

Activity

What can be the examples of healthy farming practices? Ask the participants and discuss.

And *thirdly*, the surface waters are polluted by run-off of chemicals used in farming and by untreated industrial and household wastewater in cities. This is an acute problem in less developed countries where environmental and sanitation regulations remain inadequate.

SOURCE

Activity

Trainer will discuss with the participants -

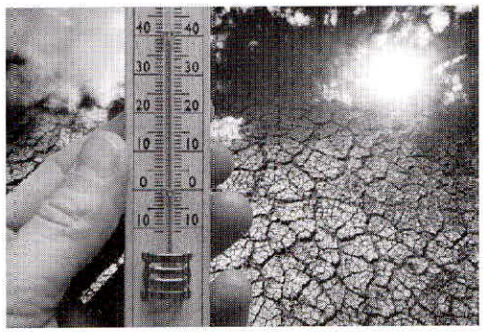
Surface water and groundwater are the sources of India's water supply. Other sources, such as desalination, are negligible because they are not cost effective.

Do you think the above problem invites our attention towards water conservation? How?

India receives an average of 4,000 billion cubic meters of rainfall every year. Unfortunately, only 48% of rainfall ends up in India's rivers. Due to lack of storage and crumbling infrastructure, only 18% can be utilized. Rainfall is confined to the monsoon season, June through September, when India gets, on average, 75% of its total annual precipitation. Once again, due to India's storage crunch the government is unable to store surplus water for the dry season. Such uneven seasonal distribution of rainfall has not provoked the development of better capturing and storing infrastructure, making water scarcity an unnecessary yet critical problem.

Monsoon Rainfall

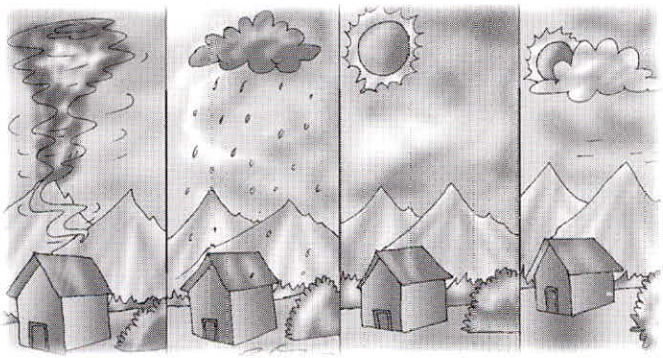
Groundwater is increasingly being pumped from lower and lower levels and much faster than rainfall is able to replenish it. The



Global Warming

average groundwater recharge rate of India's river basins is 260m^3/day. In addition, the human, agricultural, and industrial waste that pollute India's rivers seep into the ground, thus contaminating the groundwater. Groundwater crisis is not the result of natural factors; it has been caused by human activities. During the past two decades, the water level in several parts of the country has decreased rapidly due to an increase in extraction. The number of wells drilled for irrigation of both food and cash crops have rapidly and indiscriminately increased.

CLIMATE CHANGE



Different Climates in India

Climate change also has an effect on rainfall patterns, but, how it will affect them is still uncertain. However, scientists agree that climate change will ultimately make rainfall more erratic and cause unpredictable weather. Many believe that the increased average water temperate in oceans, will increase the probability and intensity of monsoons during the summer. As one of the world's biggest emitters of greenhouse gases, India contributes significantly to global warming, but is not required under the Kyoto Protocol to reduce its emissions because it is a developing country. This is yet another regrettable example of how India sacrifices its environment and its future supply of resources for economic growth.

Activity

Trainer will discuss with the participants -

Climate change is exacerbating the depleting supply of water. As the climate warms, glaciers in the Himalayas and the Tibetan Plateau have been melting.

Can you name two such glaciers in the Himalayas and the Tibetan Plateau?
Hint: The rivers Ganga and Yamuna originate with these glaciers.

MANAGEMENT

The tragedy of India's water scarcity is that the crisis could have been largely avoided with better water management practices. There has been a distinct lack of

Given that India does not regulate water usage, it should come as no surprise that there is also little regulation on pollution and even less enforcement of what regulations do exist.

attention to water legislation, water conservation, efficiency in water use, water recycling, and infrastructure. Historically, water has been viewed as an inexhaustible resource that did not need to be handled as a scarce commodity or provided as a basic human right.

POLLUTION

Melting Glaciers

Every river in India is polluted to some degree. The water quality in underground wells violates the desired levels of dissolved oxygen and coliform, the presence of which is one measure of filth, in addition to having high concentrations of toxic metals, fluoride, and nitrates. India's rivers also have high fluoride content, beyond the permissible limit of 1.5 ppm, which affects 66 million people. The polluted water then seeps into the groundwater and contaminates agricultural products when used for irrigation. Over 21% of transmissible diseases in India are related to unsafe water. Millions of the poorest are affected by preventable diseases caused by inadequate water supply and sanitation.

LEGAL INSTRUMENTS ON RIVERS IN INDIA

India has been endowed with abundant water resources, through numerous small and large rivers. Of the total geographical area of the country, approximately 95 percent of the area is under international or inter-state river basins. The water resources development of these rivers takes place within the legal framework of the interstate rivers. Sufficient familiarity with the legal framework both in its generalities and specifics are therefore, an essential pre requisite for planning, operation and management of water resources of these rivers.

The main legal instruments in referred in this context can be classified as:-

1. The constitutional provisions relevant to inter-state rivers.
2. Treaties or agreements between India and other countries in regard to development of international rivers/basins.
3. The laws enacted by the Parliament in connection with the development, use or regulation of inter-state rivers.
4. The awards and the proceedings of inter-state water disputes tribunals set up by the central government.

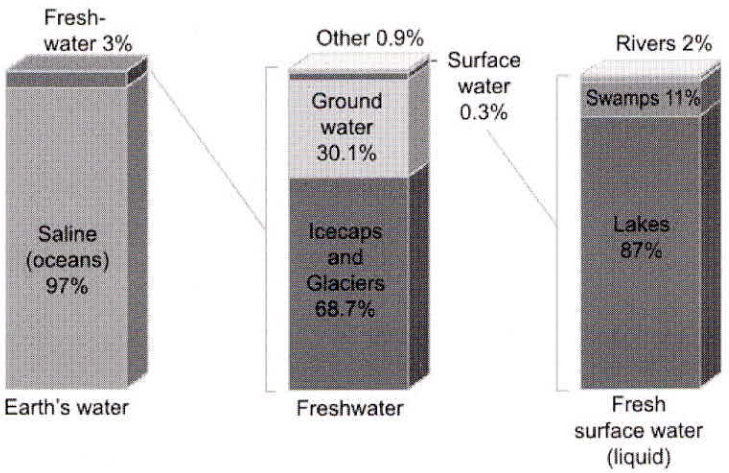
5. Notification, resolutions, orders etc. issued by the central government in pursuance of the laws or tribunal awards settings up agencies, machineries or procedures to deal with inter-state rivers from time to time.
6. The various agreement, contracts etc. reached by the state government amongst or between themselves, in regard to inter- state rivers. This includes the various agreements amongst or between the princely states and Indian provinces. Similarly, minutes of important Inter-state meetings about the inter-state water problems, signed by the concerned parties, which reflect, agreed decisions.
7. Notifications, resolution, orders etc. passed by central government, in pursuance of the inter-state agreements setting up agencies machineries or procedures etc. to deal with inter-state rivers.

WATER AVAILABILITY

Water is abundant on Earth and covers 71% of its surface area; however water is not distributed equally throughout the planet. Some areas have an overabundance of water like the waterways & marshy wetlands of the Amazon Basin and some other have extreme aridity like the great Sahara Dessert. The collective mass of water found on, under, and over the surface of a planet is called the Hydrosphere.

Did You KNOW

On an average, India receives annual precipitation (including snowfall) of about 4000 km^3. Out of this total available water resource, only 1123 km^3 is utilizable (690 km^3 from surface water resources and 433 km^3 from ground water resources).



[Source: India-WRIS Wiki, 2013]

Distribution of Earth's Water

Water Availability Facts for India

Area of the country as % of world Area	2.4%
Population as % of world population	*17.1%*
Water as % of world water	*4%*
Rank in per capita availability	*132*
Rank in water quality	*122*
Average annual rainfall	*1160 mm (world average 1110 mm)*
Range of distribution	*150-11690 mm*
Range rainy days	*5-150 days, Mostly during 15 days in 100 hrs*
Range PET	*1500-3500 mm*
Per capital water availability (2010)	*1588 m^3*

[Source: India-WRIS Wiki, 2013]

WATER AVAILABILITY IN SURFACE WATER

- The rivers depend on precipitation for water.
- The rainfall being the major component of precipitation is highly seasonal as most of the rain is concentrated during the monsoon season which lasts about 4-5 months (June to September/October).
- There are huge geographical variations in the rainfall across the country i.e. western parts of Rajasthan get merely 100 mm of rain during the year, while Cherrapunji in Meghalaya gets yearly rainfall of 11,000 mm.
- Hence, the annual average surface water that is available in the river basins varies a lot.

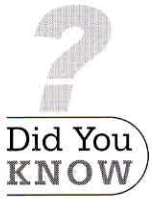
Activity

Trainer asks each participant to find out how much rainfall his place receives in a year.

WATER AVAILABILITY IN GROUND WATER

- Unlike the availability of surface water, which is highly seasonal, groundwater is a steady source of water throughout the year
- Stage of ground water development for the country as a whole is 58%.
- Stage of ground water development is high (~100% or more) in the states of Delhi, Haryana, Punjab and Rajasthan and UT of Daman & Diu and Pondicherry; 70% and above in Gujarat, Karnataka, Tamil Nadu and Uttar Prades, in rest of the states / UT's the stage of ground water development is below 70%.

- In the Ganga river basin, the share of groundwater in the total water storage is about 64 percent. In basins like Krishna, Mahanadi, Subernarekha, and Narmada the share is 35 per cent or less.



Nearly 92 percent of the groundwater resource is used for irrigation while the remaining is used for domestic and industrial use.

Activity

Steady availability of groundwater makes it a popular source of irrigation. Find out what are the different sources of irrigation in your area.

WATER USES AND DEMAND

In India, agriculture consumes the largest quantity of water. The industrial, energy, residential and other segments account for the rest of water consumption. By 2050 demand is expected to double and consequently exceed the 1.4 trillion cubic meters of supply.

Projected Water Demand in India

Year (BCM)	2025
Irrigation	910
Drinking Water	73
Industry	23
Energy	15
Other	72

[Source : Water & Related Statistics (December 2010), Central Water Commission]

DOMESTIC

Due to the amenities of typical urban life, such as flush toilets and washing machines, people living in cities tend to lead more water intensive lives. The urban population has doubled over the past 30 years, now representing 30% of India's total population and is expected to reach 50% of the total population by 2025.

Population growth is going to accelerate the water crisis in India, especially as more and more people move into the cities and become part of the middle class. Because the rivers are too polluted to drink and the government is unable to consistently deliver fresh water to the cities, many urban dwellers are turning to groundwater, which is greatly contributing to the depletion of underground aquifers. Rural citizens face a similar crisis.

Did You KNOW

India's 1.1 billion people need access to clean drinking water. The demand for drinking water is divided between the urban and rural populations, and comprises about 4-6% of total water demand.

Most people who live in rural areas demand less water for day-to-day living than people living in cities, and the majority of their water demand comes from agricultural needs.

Activity

What is the daily need of water for domestic purpose in rural and urban areas? Discuss.

AGRICULTURE

Farming System

Despite the recent rapid growth in the services and industrial production, agriculture is still an integral part of India's economy and society. Between 1947 and 1967 India underwent the Green Revolution, which concentrated on expanding farm yields by double-cropping existing farmland and using seeds with improved genetics. The result was a huge increase in agricultural production, making India one of the world's biggest exporters of grain.

The availability of canal water led farmers to adopt highly profitable, but extremely water intensive crops, such as Sugarcane. In addition, India achieved its goal of obtaining food security. The rural economy sustains two-thirds of India's 1.1 billion citizens. Unfortunately, this huge surge in agriculture, required significant water resources for irrigation and accelerated the onset of present water shortages.

India's agricultural sector currently uses about 75-80% of total water resources. Irrigated agriculture has been fundamental to economic growth, but unfortunately caused groundwater depletion. As water scarcity becomes a bigger and bigger problem, rural and farming areas will most likely be hit the hardest. Thus far, food security has been one of the highest priorities for politicians, and the large farming lobby has grown accustomed to cheap electricity, which permits extremely fast pumping of groundwater, which is something they are unwilling to give up for the sake of water conservation.

Did You KNOW

Groundwater was considered safe for all use. However, many anthropogenic activities and over exploitation has resulted in groundwater pollution in many states of India.

INDUSTRIAL

Water is both an important input for many different manufacturing and industrial sectors and used as a coolant for machines, such as textile machines. Cheap water that can be rapidly pumped from underground aquifers has been a major factor in the success of India's economic growth.

Industrial Discharge

Despite the many benefits from a thriving economy, industrial waste is largely responsible for the high levels of pollutants found in India's rivers and groundwater. Many corporations end up polluting the very water they later need as an input. According to the Ministry of Water Resources, industrial water use in India stands at about 50 billion cubic meters or nearly 6 percent of total freshwater abstraction. This demand is expected to increase dramatically in the next decade.

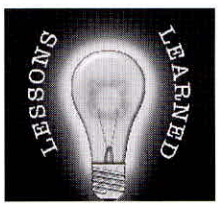
Activity

What are the examples of water intensive crops? What can be better alternatives to them? Collect the samples and visit a field to discuss the two alternatives.

Activity

The trainer asks the participants to suggest measures to bring down industrial demand for freshwater and ways to check the freshwater pollution caused by the industries and gives them two days time to complete the task.

LESSONS LEARNED



- We learnt what river basins are: A river basin is the portion of land drained by a river and its tributaries. They are a crucial source of fresh water for industrial and agricultural use in our country.
- Depending upon basin-area size, Indian rivers have been divided into three categories: Major River Basins (12), Medium Basins (46) and Minor Basins.
- Indus, Ganga and Brahmaputra are major river basins of India

- Water is abundant on earth and covers 71% of its surface area; however water is not distributed equally throughout the planet, creating many problems of availability.
- Unsustainable extraction of fresh water and other human interference with the water cycle is the immediate causes of water scarcity across the length and width of India.
- India's agricultural sector currently uses approximately 75-80% of total water resources, which can be and must be brought down in order to conserve water resources.

NOTES

The trainer can note down important notes below and discuss them towards the end of the training programme.

NOTES