UNIT 21 RESOURCE MANAGEMENT: WATER

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21.0 INTRODUCTION

Water resources occupy an extremely important position in the environmental discourse both in history and in the contemporary period. It is such a paradox that the total availability of water on planet earth is so much that water had for long time been considered an inexhaustible natural resource, yet water scarcities are today staring the human civilization so starkly in its face that none would even imagine the bounty of nature with regard to water as a reality ever. World oceans cover about three fourth of earth's surface. The total amount of water on earth is about 1400 million cubic kilometre (m.cu.km.). However the proportion of fresh water in this expanse is very small. About 2.7 per cent of the total water available on the earth is fresh water of which about 75.2 percent lies frozen in Polar Regions and another 22.6 per cent is available as ground water. The rest is available in lakes, rivers, atmosphere, moisture, soil and vegetation. What is therefore effectively available for consumption by the living beings and for other uses is a small proportion of the quantity available in rivers, lakes and as ground water. According to World Health Organization (WHO), only 0.0075 per cent of all water is readily available for human consumption. And, yet we are unable to manage our water resources with any degree of rationality leave alone wisdom.

Freshwater is not only precious and scarce but also a finite resource, which is unevenly distributed. In Africa 40 per cent of the population is still without access to water, which is 20 per cent in Asia and 15 per cent in Latin America and the Caribbean region. The World Development Report, 1992 points out that the global renewable water resource can be roughly estimated at 41,000 cubic kilometers. India sustains about 17 per cent of world population with only 4.6 per cent of the total average runoff i.e. 1900 cu.km. Its availability in nature, though is highly uneven both spatially and temporally. India is one of the wettest countries of the world with an annual average rainfall of 117 cm over the plains— about one and a half times the annual average over the land areas of the globe taken together. This position is graphically illustrated by the following chart:

India's Water Profile (in Cu.Km.)

Annual Precipitation Volume (Including snowfall)		4000
Average Annual Potential flow in Rivers		1869
Per Capita Water Availability (1997)		1967
Estimated Utilizable Water Resources		1122
(a) Surface Water Resources	690 Cu.Km.	
(b) Ground Water Resources	432 Cu.Km.	

Source: Ministry of Water Resources, Government of India.

Given this position we propose to discuss the theme of water resource and its utilisation and management in this unit. It will use and incorporate information from the post-colonial period also to illustrate the current situation with regard to water resources in India.

21.1 SITUATING WATER RESOURCES: COLONIAL PERIOD

The evidence for the use of water resources by the earliest settled societies is sufficient to merit an analytical attention. We have examined a part of this evidence in Block 4 and composed descriptive information. We have seen that the practice of irrigation since the establishment of settled agriculture during the Indus Valley Civilization was an established feature. As agricultural development was the pillar of the economy, all large powerful empires paid special attention to development of irrigation systems. Early in history, during the Mauryan period, a big reservoir called Sudarshana was created at the foot of mount Girnar in Saurashtra for supporting irrigation in the semi-arid conditions of the place. In the south, perennial irrigation may have begun with the construction of the Grand Anicut by the Cholas as early as second century AD to utilise the water of the Kaveri River for agricultural purpose. Wherever the topography and terrain permitted, it became a practice in the region to impound the surface drainage water in tanks or reservoirs by raising dams/embankments across the flow channel.

The references relating to the use of water resources in the medieval period are as plentiful as for the earlier period. Rapid advances took place in the construction of inundation canals. Water was blocked by constructing bunds across streams. The Tughlaqs encouraged the digging of canals and Firuz Shah Tughlaq is considered to be the greatest canal builder before the nineteenth century. In south India too the situation was the same. Irrigation is said to have been one of the major reasons for the growth and expansion of the Vijayanagar Empire in the fifteenth century. The Mughals had known the importance of water as they promoted irrigation facilities by providing loans to farmers to install irrigational devices. Water is said to have played such an important role in the life of a city that Delhi was abandoned and rehabilitated seven times in search of abundant water resources. Shahjahanabad, the Mughal Capital was located along the riverbank keeping the factor of easily accessible water resources in view. It may be noted that, but for exceptional cases, most of the canal irrigation prior to the arrival of the British was of the diversionary nature. In the early nineteenth century, however, the colonial rule initiated a 'sharp break' in the technique by introducing perennial canal irrigation in several parts of the South Asian subcontinent.

The colonial interface with water resources began with the development of irrigation works — the renovation, improvement and extension of existing network. Soon afterwards was started what is known as the 'era of modern irrigation'. For the first time, permanent head works in the form of barrages and weirs were thrown across riverbeds and their waters diverted through intricate and extensive canal systems. These barrages and weirs were equipped with a series of shutters to regulate flows by impounding water during lean season and diverting it into canals and, on the reverse, the former could be flipped open to release waters during periods of the river's peak discharges. In effect, by flattening the river's variable flow regime at certain points along its course, irrigation was sought to be transformed from a seasonal to a perennial possibility. The ensuing period saw the construction of several large canal irrigation schemes like the Bari Doab Canal (1859), Godavari (1852), Ganges (1854), the Krishna (1855), the Sirhind (1889) climaxing with the grandest irrigation project of the colonial period – the Triple Canal Project (1916).

The recurrence of drought and famines during the second half of the nineteenth century also necessitated the development of irrigation works as a protection against the failure of crops. As irrigation works in low rainfall tracts were not considered likely to meet the productivity test, they had to be financed from current revenues. Significant protective works constructed during the period included the Betwa Canal, the Nira Left Bank Canal, the Gokak Canal, the Khaswad Tank and the Rushikulya Canal. The colonial irrigation policies were significantly influenced and reiterated by the famine and irrigation commissions. The First Famine Commission (1880) emphasized the need for direct state initiative in the development of irrigational works while the First Irrigation Commission (1901) recommended the renovation of several existing defunct or dilapidated irrigation works while proposing new schemes. It drew up a 20-year plan envisaging a huge public expenditure to irrigate 2.6 million hectares of fields. Some storage works in the South, tank irrigation projects in Central and South India, and tube-well irrigation schemes in western Uttar Pradesh were also implemented.

The 1930s saw the implementation of a new hydraulic principle in India. Known as the Multi-Purpose River valley Development (MPRVD), the new model of water resource development was sculpted on the lines of the Tennessee Valley Association (TVA) in the post-depression United States. The new technique envisaged focusing upon the entire river basin instead of merely the channel. The intention was to train the river through a sequence of interconnected dams, reservoirs, and diversions from its catchment all the way to its estuary by 'harnessing' its waters simultaneously for navigation, irrigation, flood control, and power generation. Between 1943 and 1946, the colonial government approved plans to build MPRVD schemes on the Damodar, Mahanadi, and Kosi rivers, besides setting up the Central Water, Irrigation and Navigation Commission (CWINC) as a professional water bureaucracy for formulating and implementing other MPRVD schemes.

MPRVD schemes continued to remain the dominant strategy of water resource management in independent India. Multi-Purpose river projects looked the best solution as India engaged in planned economic activities to achieve self-reliance, foster economic development and improve the standard of living of its people. Some important projects were initiated such as the Damodar Valley Project. Completed in 1963 across the Sutlej River, Bhakra-Nangal Project was the joint venture of Punjab, Haryana and Rajasthan governments; built across the river Rihand (a tributary of Son River), the largest multi-purpose project of Uttar Pardesh, Rihand Dam Project was completed in 1966 with a cost of 375 million rupees; the Hirakud Project involved construction of three dams across Mahanadi at Hirakud, Tikarpara and Naraj; The Chambal Project was a joint venture of the Rajasthan and Madhya Pradesh state governments; the Kosi Project was the result of a joint agreement between the governments of Bihar (India) and Nepal in 1954. Its main objective was to construct a barrage near Hanuman Nagar in Nepal along both banks of the river; the Tungabhadra Project was a joint undertaking of the governments of Karnataka and Andhra Pradesh; the Nagarjuna Sagar project was another of the same type. The harness of water resources on a large scale had become the priority of the state policy.

21.2 THE CONTESTED DOMAIN: STATE, ENVIRONMENT AND WATER RESOURCES

The themes of water, community, state and environment form an integral part of the contemporary discourse on environment and are rooted in the current politics of development. As David Mosse says at least two major political and policy positions currently shape questions around water resources and their development in India. Both narratives invoke polarized notions of state and the community and both emphasise and find justification in the existence of long-term, successful, indigenous community managed irrigation systems, conceptualised as a counterpart to resource management by the state. The first is the critique of the modernising development strategies of the centralised state and the dominance of western technical perspectives on the irrigation and water resources over those of the indigenous community; a critique sharply focused in recent years by the controversy over large dams, the Sardar Sarovar in particular, but which in India derives from the visions of Gandhi and his followers. The second is a reformist policy arguing for devolution of irrigation management responsibilities from the state to the community of users, which forms a part of the international consensus on public sector reform underpinned by ideologies of privatisation, free-state, and a reduced role for the development state.

The relationship between state and resource management has often been explained in terms of a linear grand or mega narrative. The dominant thrust of such overarching explanation known as a 'standard environmental narrative' or 'new-traditionalist' discourse puts all the blame on the state. According to such narratives, the pre-colonial India is seen as a period of 'harmonious' and sustainable resource management. Colonialism is seen as the 'breaking-point' and it is argued that the intervention of the state, particularly the colonial state and the attendant revenue and proprietary rights regime, played havoc with common resources leading to the demise of village traditions of sustainable resource use. The process was accelerated by the post-colonial forms of government. The dichotomies of community/state, pre-colonial/colonial, tradition/modernity, and indigenous/foreign are extremely polarized in the traditional narratives.

In their search for a grand causal theory, the environmental protagonists of water resources extend the 'standard environmental narrative' to highlight what they consider as the breaking point in traditional water management systems. Modeled on the lines of Mahatma Gandhi's environmentalism, the classic argument comes from the authors of *Dying Wisdom* (Anil Agarwal and Sunita Narain, *Dying Wisdom: Rise, Fall and Potential of India's Traditional Water Harvesting Systems*, New Delhi, 1997). Accordingly Indian water harvesting systems are represented as rooted in a pre-colonial 'organic village economy' wherein the autonomous 'village republics' were the primary locus of management of natural resources and economic and political affairs. With the rise of the state control over common water resources, there was an 'erosion of the autonomous functioning of village management systems'. Colonial rule converted village common property into state property, denied customary rights and weakened traditional village authority transforming managed commons into degraded free access resources; it placed the decentralised village water systems under the control of centralised bureaucracies which prioritised modern engineering knowledge, large-scale irrigation and the expansion of commercial agriculture neglecting indigenous skills. On the other hand, punitive colonial revenue regimes impoverished the peasantry and undermined the local financial base of water harvesting systems. This dismal state of India's traditional water harvesting systems only worsened with the 'arrogance of the post-Independence Indian political leadership and the irrigation bureaucracy' which preferred Nehru's vision of independent India with large dams as temples to Gandhi's vision of independent India founded upon its village heritage. It also calls for the revival of community control and traditional water harvesting systems. There is therefore a need for serious investment in research and development of traditional water harvesting systems through integrated and participatory renovation of tanks and the deforestation of catchments, drawing on indigenous knowledge of water-land relationships and involving all sections of community.

The relationships between the state and the community were more complex and problematic than has been made out to be in traditional accounts. David Mosse points out in his study of statecraft, ecology and collective action in South India that the impact of colonial governance on the water commons defies a simple representation and has more to do with changing systems of state than the erosion of village tradition. Indeed, traditional village water management system proves extremely elusive, and identification of the moment of their collapse is an impossible task involving a seemingly endless journey back in the time. Thus the decisive moment of a loss can be variously located in:

i) the present government's neglect of indigenous knowledge and traditions;

ii) the 1960s-70s green revolution expansion of capitalist agriculture and ground water irrigation;

iii) changes brought about in the 1950s following Independence (for example, the abolition of Zamindari estate and establishment of structures of local government);

iv) the colonial commercialisation of dry land agriculture in the late 19th and 20th centuries ;

v) the centralisation of the colonial government and the building of technocratic irrigation bureaucracy from the 1850s ;

vi) the consolidation of British power, its revenue systems and property law by the 1840s;

vii) the dismantling of the south Indian old regimes around 1800;

viii) the wars of the immediate pre-colonial period of the 1790s;

ix) the neglect of decentralised systems under the Mughal rule during the 18th century;

x) the disruption generated by the rise of the Vijayanagar empire in south India after 1350; and

xi) the collapse of the Chola empire and its system of locality and village government.

21.3 SURFACE WATER AND GROUND WATER

The annual precipitation including snowfall, which is the main source of the water in the country is estimated to be of the order of 4000 cu.km. According to the National water Policy, 2002 (**Appendix 1**) as per the latest estimate (1993), out of a total precipitation (including snowfall) of around 4000 billion cu.m in the country, the availability from surface water and worthy-of-replenishment ground water is put at 1869 billion cu.m based on basin wise estimates of Central Water Commission. Due to various constraints of topography and uneven distribution of resource over space and time, it has been estimated that of 1869 cu.km., only about 1122 cu.km. can be put to beneficial use. From this nearly 690 cu. km. shall be due to surface water resources. The availability of water is highly uneven in time and space. Precipitation is confined only to monsoon months every year varying from 100 mm in Rajasthan to over 10000 mm at Cherrapunji in Meghalaya. Rivers and underground water aquifers often cut across state boundaries. Based on 199l Census, the per capita availability of water works out to **220 cu.m.**

There are two main sources of water resources: surface water and ground water. Rivers are main source of surface water; the following chart makes clear the potential of surface water:

Basin-wise Surface Water Potential of India ***(Cubic Km/Year)***

Sl. No	Name of the River Basin	Average annual potential in river
1.	Indus (up to Border)	73.31
2.	a) Ganga	525.02
	b) Brahmaputra Barak & Others	585.60
3.	Godavari	110.54
4.	Krishna	78.12
5.	Cauvery	21.36
6.	Pennar	6.32
7.	East Flowing Rivers Between Mahanadi & Pennar	22.52
8.	East Flowing Rivers Between Pennar and Kanyakumari	16.46
9.	Mahanadi	66.88
10.	Brahmani & Baitarni	28.48
11.	Subernarekha	12.37
12.	Sabarmati	3.81
13.	Mahi	11.02
14.	West Flowing Rivers of Kutch, Sabarmati including Luni	15.10
15.	Narmada	45.64
16.	Tapi	14.88
17.	West Flowing Rivers from Tapi to Tadri	87.41
18.	West Flowing Rivers from Tadri to Kanyakumari	113.53
19.	Area of Inland drainage in Rajasthan desert	NEGLIGIBLE
20.	Minor River Basins Drainage into Bangladesh & Burma	31.00
	Total	1869.35

Source: Ministry of Water Resources, Government of India.

Inland water resources of the country can be classified as rivers and canals; reservoirs; tanks and ponds; jheels, oxbow lakes, derelict water; and brackish water. K L Rao points out that the total quantity of water annually carried by the rivers of the country is about 16,45,000 million cu.m.

Of the rivers and canals, Uttar Pradesh occupies the first place with the total length of 31.2 thousand km, followed by Jammu & Kashmir and Madhya Pradesh. The next in the order of geographical coverage of inland water bodies are the tanks and ponds occupying 2.9 m.ha. and then come the reservoirs covering 2.1 m.ha. Most of the area under tanks and ponds lies in southern states of Andhra Pradesh, Karnataka and Tamil Nadu. Along with West Bengal, Rajasthan and Uttar Pradesh, these states account for 62 per cent of total area under tanks and ponds in the country. As far as reservoirs are concerned, major states like Andhra Pradesh, Gujarat, Karnataka, Madhya Pradesh, Maharashtra, Orissa, Rajasthan and Uttar Pradesh account for a larger portion of area under reservoirs. More than 77 per cent of area under jheels, oxbow lakes and derelict water lies in the states of Orissa, Uttar Pradesh and Assam. Orissa ranks first in relation to the availability of brackish water followed by Gujarat, Kerala and West Bengal.

The importance of groundwater as a source for meeting drinking, industrial and irrigation requirements for an ever-increasing population cannot be denied. It caters to around 50 per cent of the total irrigation in the country. India has a vast area for ground water resources. Around 22 per cent of India's rainfall percolates under the ground. Of this total, about 430 billion cu.m reaches up to the upper surface of the soil. Nearly 384 billion cu.m reaches the pervious strata, which can be obtained by digging wells. According to a rough estimate the total ground water reserve at a depth of 300 m is 3700 m ham. This is almost 10 times the annual rainfall. The Central Ground Water Board (CGWB) estimates the annual exploitable potential at 42.3 m ham of which les than ¼ is presently being exploited. In terms of exploitation of ground water potential Punjab comes on the top (93.85 per cent), followed by Haryana (83.88 per cent), Tamil Nadu (60.44 per cent), Rajasthan (50.63 per cent), Gujarat (41.45 per cent), Uttar Pradesh (37.67 per cent), Maharashtra (30.39 per cent), West Bengal (24.18 per cent), and Andhra Pradesh (23.63 per cent). States like Assam, Bihar, Madhya Pradesh, and Orissa have not been able to utilize even one-fifth of their total ground water potential.

Basin-wise Ground Water Potential of Country ***(Cubic Km/Year)***

Sl. No.	Name of Basin	Total Replenishable Ground Water Resources
1.	Brahmai with Baitarni	4.05
2.	Brahmaputra	26.55
3.	Cambai Composite	7.19
4.	Cauvery	12.30
5.	Ganga	170.99
6.	Godavari	40.65
7.	Indus	26.49
8.	Krishna	26.41
9.	Kutch & Saurashtra Composite	11.23
10.	Madras and South Tamil Nadu	18.22
11.	Mahanadi	16.46
12.	Meghna	8.52
13.	Narmada	10.83
14.	Northeast Composite	18.84
15.	Pennar	4.93
16.	Subarnrekha	1.82
17.	Tapi	8.27
18.	Western Ghat	17.69
	Total	431.42

Source: Ministry of Water Resources, Government of India.

Although the ground water is a resource that can be replenished annually, its availability is non-uniform in space and time. A wide range of factors; climatic conditions, relief (topography), geological structure and local hydrological conditions control the ground water occurrence and movement. No precise techniques are available for assessment of recharge and discharge therefore the methods employed for ground water resource estimation are all indirect. Ground water being a dynamic and replenishable resource is generally estimated based on the component of annual recharge, which could be developed by means of suitable ground water structures. An understanding of the behaviour and characteristics of the water bearing rock formation known as aquifer is crucial for the quantification of ground water resources. An aquifer has two main functions — (i) to transit water (conduit function) and (ii) to store it (storage function). The ground water resources in unconfined aquifers can be classified as static and dynamic. The static resources can be defined as the amount of ground water available in the permeable portion of the aquifer below the zone of water level fluctuation. The dynamic resources can be defined as the amount of ground water available in the zone of water level fluctuation. The replenishable ground water resource is essentially a dynamic resource, which is replenished annually or periodically by precipitation, irrigation return flow, canal seepage, tank seepage, influent seepage, etc. The methodologies adopted for computing ground water resources, are generally based on the hydrological budget techniques. The hydrologic equation for ground water regime is a specialised form of water balance equation that requires quantification of the items of inflow to and outflow from a ground water reservoir, as well as of changes in storage there in.

The main problems associated with the unscientific and unregulated development of groundwater are the over-exploitation of the resource leading to a fall in water levels causing failure of wells/tube wells; or deepening of the structure resulting in higher cost of pumping, seepage from sewer systems, industrial and urban waste disposal sites etc., and landward movement of sea water/fresh water interface in the coastal aquifers. Excessive withdrawal of water from the coastal aquifers has resulted in the landward movement of sea water/fresh water interface in some areas of Tamil Nadu and Saurashtra region.

For an effective water security system, it is imperative to take steps for augmentation of ground water storage through artificial recharge concurrent with the measures for development of the resource. The CWGB has carried out a number of artificial recharge and ground water conservation studies to develop the methodologies and technologies and to assess the economic viability of these measures. These studies conducted in Gujarat, Maharashtra and Tamil Nadu have established the feasibility of various recharge measures such as spreading, recharge through injection wells and induced recharge from surface water bodies and conservation of sub-surface flows through construction of sub-surface dykes. Percolation tanks have been found to be particularly effective in checking the surface runoff during the monsoons and conserving the same water recharging the underlying aquifers. Pilot projects have been carried out by CWGB in Karnataka, Maharashtra, Delhi and Chandigarh in this regard. Efforts have also been made to intercept and recharge the rooftop runoff during the rainy season by encouraging the installation of simple water harvesting systems.

There is however a need for suitable legislation to control and regulate various aspects related to the utilisation and development of ground water. The Ministry of Water Resources, Government of India has prepared a model bill in this regard. Known as the **Model Bill to Regulate and Control the Development and Management of Ground Water (2005**), its provisions include the establishment of a ground water authority, powers to notify areas to regulate and control the development and management of ground water, grant of permits, registration of users, penalties for offences, efforts at promoting rain water harvesting etc. **(Appendix 2).**

21.4 WATER-RESOURCES: SPATIAL AND TEMPORAL VARIATIONS

- Rajasthan, which accounts for almost 8 per cent of India's population, is endowed with only 1 per cent of the country's water resource.

- The annual average runoff per capita in the country varies between 18147 cu.m in the Brahmaputra basin and 631 cu.m. in the west-flowing rivers of Kutch and Saurashtra to 411 cu.m. in the east flowing rivers from Pennar to Kanyakumari in the south.

- About 80 to 90 per cent of the annual rainfall occurs during the four monsoon months (June to September) every year. For six to eight months of the year, the rainfall is either scanty or nil over most parts of the country.

- Rainfall in India shows unequal geographical distribution and the frequent departures from the normal. It generally exceeds 1000 mm in areas to the East of Longitude 78 degree E to 2500 mm along almost the entire West Coast and Western Ghats and over most of Assam and sub-Himalayan West Bengal. On the west of the line joining Porbandar and Delhi and thence to Ferozpur, the rainfall diminishes rapidly from 500 mm to less than 150 mm in the extreme west. The peninsular region has large areas of rainfall less than 600 mm with pockets of even 500 mm.

- Of the major rivers, the Ganga – Brahmaputra - Meghana system is the biggest system with a catchment area measuring nearly 110 m.ha, which is more than 43 per cent of the catchment area of all the major rivers in the country. The other major rivers with catchment area more than 10 m.ha are Indus (32.1 m.ha.), Godavari (31.3 m.ha.), Krishna, (25.9 m.ha.) and Mahanadi (14.2 m.ha).

- As against the national per capita annual availability of water of 2208 cu. m., the average availability in Brahmaputra and Barak is as high as 16589 cu m. while it is as low as 360 cu.m. in the Sabarmati basin.

- The total area of inland water resources is unevenly distributed over the country with five states namely Orissa, Andhra Pradesh, Gujarat, Karnataka and West Bengal accounting for more than half of the country's inland water bodies.

21.5 CURRENT ISSUES

The water resource management in India is today faced with some important issues. We must address them in order to understand the underlying conceptual operatives and also to find a way out from the impending impasse that threatens to make water resources the most contested and bitterly disputed matter. A list of such issues may be formed as below:

- Inter-State Water Disputes
- Inter-Linking Rivers: The National Water Grid
- Big Dams versus Small Dams
- Flood Control versus Flood Management
- Water Pollution

21.5.1 Inter-State Water Disputes

Most of the major rivers in India are inter-state in character; having catchments/ water sheds in two or more states. Often, water disputes arise amongst the basin states with regard to the use, distribution or control of the waters in respect of many inter-state rivers or river valleys or in the interpretation and implementation of the terms of any agreement relating to the use, distribution or control of such waters or in the levy of any water rate in contravention of various prohibitions. During the British period, inter-state disputes were settled by the central government. Upon adopting a constitution the Republic of India made irrigation a state subject. The state governments could now exercise control over planning, development, regulation, and distribution of water flowing through their territories. Over a period of time certain legislations have been enacted which enable the central government to intervene in matters of inter-state dispute. According to the Water Dispute Act, 1956, the central government can constitute a tribunal for the settlement of an inter-state water dispute when a request is received from a state government. The River Board Act, 1956 authorizes the central government to constitute river boards in consultation with the state governments for regulation and development of inter-state rivers. The Government of India formed rules on 30 June, 1959 to settle inter-state water disputes. By the Inter-state Water Dispute Act, 1968, the central government has been given the responsibility of regulation and development of inter-state rivers to the extent to which such regulation and development under the control of the Union is declared by the Parliament by law to be expedient in the public interest. Above all, under Article 262 of the Constitution, the Parliament is empowered to provide for the adjudication or control of the water of any inter-state river. The following chart gives a preliminary idea of the inter-state river water disputes:

River in Question	States Involved
Kaveri	Karnataka, Kerala and Tamil Nadu
Krishna	Maharashtra, Karnataka and Tamil Nadu
Tungabhadra	Andhra Pradesh and Karnataka
Godavari	Maharashtra, Andhra Pradesh, Madhya Pradesh, Karnataka and Orissa
Narmada	Gujarat, Madhya Pradesh, Maharashtra and Rajasthan
Mahi	Gujarat, Rajasthan and Madhya Pradesh

Ravi and Beas	Punjab, Haryana, Rajasthan, Delhi, Jammu and Kashmir
Yamuna	Uttar Pradesh, Haryana, Himachal Pradesh, Punjab, Rajasthan, Madhya Pradesh and Delhi
Karmanasa	Uttar Pradesh and Bihar
Barak	Assam and Manipur
Mandvi	Goa and Karnataka
Mahadeyi	Maharashtra, Goa and Karnataka
Bhavani	Tamil Nadu and Kerala
Indravati	Orissa and Chhattisgarh

The central government has set up five Inter-State Water Disputes Tribunals so far, namely: Godavari Water Disputes Tribunal (April, 1969); Krishna Water Disputes Tribunal (April, 1969); Narmada Water Disputes Tribunal (October, 1969); Ravi and Beas Waters Tribunal (April, 1986); and Cauvery Water Disputes Tribunal (June, 1990). While the first three tribunals have already given their final awards, the remaining two tribunals are still adjudicating the issues referred to them. Most of the inter-state water disputes have been settled on the basis of equitable apportionment, which is the universally accepted principle. In addition, India also has some disputes with neighbouring countries like Nepal, Bangladesh, China over sharing of river waters.

21.5.2 Inter-Linking Rivers: The National Water Grid

It was in the middle of the nineteenth century that schemes for linking the rivers of entire Indian sub-continent were first planned. Since then almost a century passed before a similar idea was proposed again. In 1960s, K.L.Rao the Union Minister of State for Power and Irrigation spoke about the Ganga-Cauvery Link Canal. Later in the seventies, he developed the plans for a national water grid, which would transfer the surplus waters of the Ganges and Brahmaputra to the parched regions of central and southern states. The main Ganga-Cauvery link was to be composed of a canal 2640 km long. In the meantime Captain Dastur had proposed a similar idea. Popularly known as the 'Garland Canal', the project envisaged a 4200 km long 300 m wide Himalayan Canal aligned along the southern slopes of the mountain range and another 9300 km Central and Southern Garland Canal. Both these canals were to be linked at Delhi and Patna. In 1982, the Government of India formed the National Water Development Agency (NWDA) to identify river links for a national grid, to prepare feasibility studies and to execute detailed project reports. NWDA has in the last two decades identified a possible 30 river links, which would connect every major river in the Indian mainland and has prepared feasibility reports on six of these. It estimates that the cost of the entire project would be 5.6 lakh crores and would take 30 years to execute. The issue came alive again in 2002 when, following a directive from the Supreme Court, the Government of India set up a task force to prepare and outline an action plan for implementing a project to link the rivers of India and the Prime Minister declared that the task would be taken up on a war footing. Critics have pointed out many issues that crop up with this grand plan:

- It is said that the plan tantamounts to altering nature and redrawing the geography of the country.

- Questions have also been raised on the technical feasibilities of the plan. The concept of transferring water from surplus source basins hinges on the availability of surplus in source basins. It has been pointed out that surplus water in source basins might not always be true in India. According to the internationally accepted definitions, eight of the twenty basins of India are water-scarce today and by 2025 (when the water grid is expected to be fully functional) thirteen river basins will be below the water-scarcity level. It is also argued that all the basins will qualify as water stressed, with the exception of Brahmaputra-Barak system.

- Where would the funds for the plan come from? The estimated cost of 112 million is more than India's outstanding external debt and the Task Force (on Inter-Linking) has not indicated how and from where the funds would come. All over the world, inter-basin transfers have proved to be the most expensive option to develop water next only to sea-water desalinisation. Raising the funds would be a big constraint and the cost overruns would make the project prohibitively costly.

- The environmental cost of the inter-basin transfer is another factor to be taken into account. It has been argued by hydrologists and ecologists that as opposed to being merely moving masses of water out to be regulated and dammed, rivers are fluvial regimes with complex geomorphologic, chemical and biological processes in motion. They are made up of a wide variety of aquatic and riparian species. Rivers with highly altered and regulated flows lose their ability to support natural processes. Experience from the U.S. (California), Israel, and former Soviet Union indicates high environmental costs of inter-basin transfer.

- Water transfers can be made only with the consent of the states concerned. The NWDA assessment that surpluses are available in the Mahanadi and the Godavari is not shared by Orissa and Andhra Pradesh. Apart from the techno-economic feasibility, on which the Ganga-Cauvery link idea was abandoned earlier, the diversion of Ganga water would have international implications. In view of some water issues with our neighbouring countries, Bangladesh and Nepal, it is not likely that they would take this very kindly. The following chart illustrates some of the promises and pitfalls of the planned inter-basin transfer:

Promises	Pitfalls
Transfer 173 billion cubic meters of water to water-stressed regions.	More inter-state water disputes; diplomatic row with Bangladesh and Nepal.
Building 11,000 km of canal network.	Increased incidence of water-logging and submergence of 19292 ha of forests.
Generate 34,000 MW of power.	Raising funds a constraint; cost overrun to make the project prohibitively costly.
Boost GDP growth by 4 percent.	4.5 lakh people to be displaced

Source: The Hindu Survey of Environment, 2003.

It has been suggested that the feasibility of inter-basin transfers should be examined for contiguous basins, on a case-by-case basis unlike the current National Water Grid project which is an “all-or-nothing” linking of major river systems. People-centered sustainable local solutions have been posed as the more viable alternatives. Community efforts at harvesting rainwater and recharging the aquifers have been a major success in Alwar. Its success has revived the Arvari River which had not flown in the last forty years. Similar district and watershed-level experiences from Maharashtra, Madhya Pradesh and Andhra Pradesh hint at the potential possibilities of community based and participatory water management.

21.5.3 Big Dams versus Small Dams

India has around 4300 dams of which 2256 were built in a peak period between 1971 and 1990. Around three-quarters of the completed dams are situated in three western agricultural states. The large dams in India are constructed and owned by state governments. However droughts in recent years have raised some very vital questions regarding big dams. The supporters of large dam projects argue that:

- dams confer many benefits and without them, the growing needs of food, water and energy cannot be met and any harm they may cause can be anticipated and remedied;
- some of the adverse consequences attributed to the dams really arise from certain ‘political economy’ factors prevalent in the country; and
- small dams, local watershed development, and water harvesting etc. are no substitute for large dams- they are complimentary measures that can meet only a small part of the overall requirements.

On the other hand, those who question the acceptability of such claims contend:

- benefits, supposedly coming from many dams are overstated and the cost understated;

- impact and consequences are rarely assessed in advance and cannot be fully foreseen, much less remedied; many adverse effects are irremediable;
- needs of the future can be met without recourse to large dams, through smaller structures and demand side management.

The central question is whether the price of environmental damage and social disruption of indigenous and other communities is worth the ostensible benefits of providing water and power. The debate has become increasingly heated and has assumed the shape of a broader conflict between top-down, technocratic, and interventionist approaches to development and bottom-up, participatory and locally appropriate alternatives. The debate in India has been exemplified by a number of protest movements against big dams, the most well known being the Narmada Bachao Andolan. The nature of the conflict is even reflected in Government of India's rejection of the report on the World Commission on Dams (WCD) on the grounds that it was incompatible with country's development priorities. While acknowledging the fact that the dams have made a big contribution to human development, the WCD report indicated that the same had been accompanied in many cases by unacceptable social and environmental costs. In the last few years there has been an intense debate in India over alternative modes of storage (like tanks, small and medium sized dams) and in-situ capture through integrated watershed development and rainwater harvesting. The process has received a boost by numerous case studies of successful revitalisation of traditional collective water management systems and local level participatory management systems involving community mobilisation.

21.5.4 Flood Control versus Flood Management

Even after adding 16,199 kms of new embankments during 1954-1993 and spending crores of rupees on flood detention reservoirs, the area liable to floods in India has actually shown an increase. From roughly 19 million hectares in 1953, the flood prone area increased to 40 million-60 million hectares based on the different estimates. The trend has therefore been upwards. The expenditure on flood control has also been on the rise in the post-independence period from Rs. 13.21 crores in the First Plan to a high of 1691.68 crores in the Eighth Plan. India in fact remains the most flood-affected country in the world after Bangladesh. The massive infrastructure of storage reservoirs, pumping stations and more than 1000 kms of canals planned for linking the rivers might further hinder the already impaired drainage in most basins thereby exacerbating the flood situation. The simple question that follows relates to 50 years of embankments and large dam centered approach that has perhaps increased India's vulnerability to the floods. Environmentalists have pointed to a paradigm shift in the approach to the floods worldwide– from flood control to flood management and its application in the Indian context. . It has been argued that recovering the experiences of flood utilisation would be an important component for forging a more viable response to the flood situation in the long run.

21.5.5 Water Pollution

According to Centre for Science and Environment, Delhi, 25 large towns and cities along Ganges discharge close to 1340 million litres per day of sewage mostly untreated waste including traces of heavy metals in the river. Agricultural runoff, mainly fertilizers and pesticides, also find their way through the drains and tributaries. Similarly from the time Yamuna enters Delhi at Wazirabad it is loaded with close to 1700 million litres per day of untreated sewage. In the south, the Noyyal tributary, which flows into the Kaveri River, has over 800 dyeing and bleaching units pouring soda ash, caustic soda, sulphuric acid, hydrochloric acid, sodium peroxide and other chemicals into the river. Even ground water is severely affected by pollution. Over-pumping in some coastal areas has let in sea-water; in others, contaminants such as fluorides and arsenic have been released from rock–strata; and in yet others, agricultural chemicals and industrial wastes have seeped into aquifers. There are some estimates, which indicate that pollution also reduces the volume of available water. According to one such estimate, there is a 6 to 7 per cent decrease in available ground water due to sewage, wastewater and garbage.

21.6 SUMMARY

India is facing an acute water crisis with soaring costs to public health due to pollution and water-borne diseases. The crisis is also due to the lack of access to safe water supply to millions of people as a result of inadequate water management and environmental degradation. The country's huge and growing population is putting a severe strain on all of the country's natural resources. While the total population has risen to one billion people, its supply of water continues to be increasingly contaminated by pesticides, heavy metals and natural pollutants. Every drop of water is locked into the global hydrological cycle. Human actions modify the hydrological cycle and often seriously pollute available freshwater. Climate change is also affecting the hydrological cycle significantly thereby affecting freshwater production and its distribution. Population growth, urbanization and increasing demand from competing uses for drinking, agriculture, industry and energy- the pressures on this finite resource are mounting every day.

India has made progress in the supply of safe water to its people, but gross disparity in coverage exists across the country. Official figures show that around 90 per cent of India's population has access to drinking water. But people who work at improving the water supply say only just over half the country can count on its water being safe and constantly available. The deprivation of these two fundamental human needs impacts every facet of their existence: their health, dignity, environment, livelihoods and indeed the sustainable development of their societies

and consequently their nations. The shortage of water and its growing pollution has acquired the proportion of a crisis especially for the 'poorest of the poor'. And yet there is a false sense of complacency that not only is water an infinite resource but that it also has to be available at no cost resulting in waste, inefficient usage and pollution. Water users barely pay for even the operating costs. There is absolutely no contribution to capital outlays, which are met by domestic governments and external assistance by way of aid or loans. Irrigated farming is generally heavily subsidized placing a severe burden on the budgets of local authorities. Per capita average annual availability of freshwater in the country has reduced from 5,177 cubic metres in 1951 to 1,869 cubic metres in 2001 and would fall further to 1,341 cubic metres in 2025. In a recent study of 27 Asian cities with populations of over 1,000,000, the World Bank says that two Indian cities — New Delhi in the north and Chennai in the south - are the worst performing centers in terms of hours of water availability per day. Mumbai, a western Indian city, is the second worst performer and Calcutta, the fourth. Experts say Delhi could even run out of water within 25 years if strict conservation measures are not brought in soon. Environmental analysts assert that there are at least 100,000 Indian villages facing severe water shortages. If the present consumption patterns continue, two out of every three persons will be living under 'water stressed' conditions by the year 2025. Drastic measures are needed to redeem the situation.

21.7 EXERCISES

1) Write an essay on the importance of water as a natural resource.

2) Bring out the changes in water management methods from pre-colonial to colonial period.

3) Write short notes on the following:

   i) Inter-State Water Disputes

   ii) Interlinking of Rivers

   iii) Big dams versus small dams

21.8 SUGGESTED READING

David Mosse, *The Rule of Water: Statecraft, Ecology and Collective Action in South India,* New Delhi, 2003

Chhatrapati Singh, *Water Law in India,* New Delhi, 1992