WATER SCENARIO 2025

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Water is needed in all aspects of life. Difficult to purify, expensive to transport and impossible to substitute, water is an indispensable element of life. Renewable fresh water is an increasingly scarce commodity and the amount of fresh water actually available to people is finite. The general objective is to make certain, that adequate supplies of water of good quality are maintained, for the entire population of this planet, while preserving the hydrologic, biological, and chemical functions of the ecosystems, adapting human activities within the capacity limits of nature and combating vectors of water related diseases. Without sufficient water, economic development becomes virtually impossible and conflict over scarce resources virtually inevitable. Regional and local water shortages have always existed because of the inequalities of the hydrological cycle, but a global view also indicates that the entire hydrologic cycle is nearing the limits of use and therefore, even the water surplus countries will very soon start experiencing water shortages.

United Nation Organization has given top priority to the problem of water scarcity and sanitation. This is because:

- The subsurface water table level is shrinking in all the continents of the world.
- Agricultural lands are becoming saline.
- Increasing pollution of surface and sub-surface waters.
- Nearly 45 crores of people in 29 countries are staying in water-deficit regions.
- More than 100 crores of people are not getting safe drinking water.
- Nearly half of the world's population is lacking water purification plants.
- In the Third World countries nearly 50 % of its diseases are due to the use of contaminated water.
- Nearly 70 % of the fresh water is used for irrigating the agricultural fields which has raised water conflict between the urban and rural areas.

If all this continues, then very soon i.e. by 2032, nearly half of the world's population will be facing water shortage problem. It is predicted that in the 21st century there will be water wars.

Water being unevenly distributed over the land, influences inter-state and international relations and so is the cause of hydro politics. The earth's growing population with its multifaceted activities demanding fresh water is now putting this vital resource under increasing pressure. The United Nations estimates that by 2025, nearly 1/ 3rd of the World's population, will suffer from chronic water shortage, if current rate of consumption continues.

Human concerns regarding water can be divided into two categories: *quantitative* and *qualitative*. **Quantitative** refers to issues such as whether we will have enough water to meet our needs and what will be the impacts of diverting the water from one point of cycle to another. **Qualitative** refers to issues, such as whether the water will be of sufficient purity so as not to harm human or environmental health.

Water and conflict

Resource scarcity can exacerbate preexisting tensions or invite new ones, and water is no exception. Renewable fresh water is an increasingly scarce commodity and the amount of fresh water actually available to people is finite. As population grows, the average amount of renewable fresh water available to each person declines. Thus water stress and outright scarcity are all but inevitable. Tensions over water resources permeate in every region of the world, ranging form urban and agricultural water uses in the Western U.S. to outright warfare in the Middle-East. With over 200 river and lake basins bordered by two or more countries and aquifers crossing International borders, the potential for increased regional tensions over shared resources, as population increases, is substantial particularly in arid and semi-arid regions, where water is already a scarce resource. Within a decade water could overshadow oil as a precious resource commodity at the center of conflict and peacemaking.

Freshwater ecosystems are disappearing as rivers sand coastlands are developed around the world. Dams block the return of Salmon fish to spawning areas; toxic pollution and acid precipitation kill fish; leaching of fertilizers promotes algal blooms (eutrophication) in surface waters; heavy metals drained by industries in water accumulate in fish and shell-fish that enter into the higher food-chain.

Throughout the World urban areas lose staggering amounts of water through leaks and breaks in water supply systems, and much of this water will have to be saved through targeted efficiency and conservation efforts. With 90% of future population growth expected to occur in urban areas the demand for fresh water for domestic and industrial use and waste treatment will soar worldwide.

Agriculture is the single largest user of water with 70 % followed by industry and energy withdrawing 23 % of water, while household use is just 8 %. However these patterns vary greatly from country to country depending upon the levels of development, climate and population size.

In many of the developing countries river pollution from untreated sewage has crossed the limits of the recommended safe limits for drinking and bathing, for example; in India, cremated corpses and millions of tons of sewage is all found in the holy waters of the Ganges. This gives rise to spread of infectious diseases through water related diseases. Such diseases form single largest killers of infants in the third world countries.

Gross mismanagement in preserving rainwater is much to blame for the present water crisis in the country of India. There are enormous amounts of recoverable water that go wastes every year. Although many parts of India receive up to 38 inches of rainfall annually, only 10 % to 20 % of it is actually captured. This is because we lack in well-established practices and water development projects.

Besides, much of the water is lost through leakages due to poor maintenance of thousands of tanks, wells, pipes and their fittings, and water reservoirs. Hence, while formulating any strategies for the country, the first priority has to be assigned to the issue of raising of water resources and its management.

Established in 1998, the World Commission on Water for the 21st century was given the responsibility for developing a long-term vision for water for that century. The U.N.O. is proposing to organize an international conference on water resources in the year 2005.

To face this problem and avoid water conflicts and water wars the timely steps are incorporated with the concepts of River-Basin Partnership, Hydro-solidarity. For the development of this concept the International Organizations such as Global Water Partnership, World Water Council and World Water Forum are working actively. Hence **22nd March is celebrated as 'Global Water Day'**.\

To be used sustainably, water cannot be withdrawn from reservoirs and other sources faster than it is replenished through the natural hydrologic cycle. Water must be drawn at a rate that permits water-table level to remain stable over time. The essence of ‘Sustainable Development’ is that natural resources must be used in ways that will not limit their availability to future generations.

References

Richard T. Wright and Bernard J Nebel: “Environmental Science” Toward a Sustainable Future; Eight edition (2002), Prentice Hall of India Private Limited New Delhi-100 001.

Michael L. McKinney and Robert M.Schoch: “Environmental Science: Systems and Solutions (1996), West Publishing Company, U.S.A.

World Bank: World Bank Report, 1992: New york.

Population Action International, Washington D.C.

Newspaper: Times of India.

HISTORY OF IRRIGATION IN INDIA

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Water is one of the most important natural resources, which is pivotal for the existence of the mankind. One cannot imagine the life on any planet in the universe in the absence of water. Of course, there are some other factors too which determine the existence of life, but water is one of the most important of them. Infact, water is the life line of the mankind. If there is no water, the human beings and other species simply cannot prevail. As far as human beings are concerned they can sustain without food at least for some days – but cannot sustain without water for many days. Water consumption is must for a person to remain alive. It was in this sense, it is stated above that water is the lifeline of the mankind .

Water is needed for the human beings not just for the drinking purpose, it is also needed for the agricultural purpose. Water is used as one of the most important agricultural input for the production of food grains and variety of crops. As it is so, it becomes very interesting to study the historical evolution of the water management, particularly for the agricultural purposes by the way of irrigation, during the ancient, medieval and the modern period of the Indian history .

Water management especially for the purpose of Irrigation during Ancient India.

Till the beginning of the 20th century, it was believed that the ancient Indian history begins with the Vedic Civilization. But with the discovery of Indus Valley civilization in 1921-22 by the two Indian archaeologists viz. Rai Bahadur Dayaram Sahani and R.D. Bannerji [1], it became clear that Vedic civilization was preceded by the Indus Valley civilization. One of the hallmark features of the Indus Valley civilization is that, it was the urban civilization. Archaeologists have discovered various cities from the different sites of the Indus Valley civilization, to mention a few – Mohenjodaro, Harappa, Kalibangan, Lothal etc.

Water plays very vital role in the development of any city or urban centre. As one knows, with the growth of the city, the number of dwelling houses increases, the number of various businesses goes up, it results in to the migration of people from the rural areas to the urban areas for seeking jobs and earning fortunes .As a result of it the population of that area increases immensely. The increased number of people require lot of fresh water, basically for the drinking or consumption purpose. As, the Indus Valley civilization was the urban civilization it's demand for water would have been definitely high. In order to fulfill the demand for the water the Indus Valley Civilization might had some system to bring the water in to the different cities. One building called as – The Great Bath has been discovered from one of the Indus Valley cities viz. Mohenjodaro.[2] There are various theories about the real motive of this building .Some experts say that it would have been used as the public building by the people for the some sort of ritual bathing. One can even compare the 'Great Bath' with the modern swimming pools. Some other scholars say that it could have served as the temple of river goddess. Whichever of these theories is correct, the very existence of the Great Bath throws a light on the fact that, water was very important and sacred for the Indus Valley people. Some scholars point out that, as the big cities like Harappa and Mohenjodaro (these cities lie in present Pakistan) flourished during the ancient period in a relatively dry areas there could have existed the extensive irrigation systems during those times.[3]

Scholars like A.L. Basham are skeptical about the possibility of irrigation during the Indus Valley Civilization.[4] But, the cultivation of variety of grains and crops like – wheat, barley, peas, seasamum, etc. by the Indus Valley people shows that, they might had the idea and knowledge of irrigating their fields with the help of Indus water .

During the early and the later Vedic period – one can see the development of the irrigation facilities. It is said that once *Rishi* Narad asked the Emperor Yudhisthira (about 3150 B.C.) about the condition and prosperity of the farmers and about the availability of waters in the dam for the distribution in different parts of the kingdom.[5] This type of enquiry throws the light on the importance of the equitable distribution of water in the kingdom for the irrigation purposes. It also shows that some sort of break through was definitely made in the field of irrigation by the time of 3150 B. C.

During later years the process of urbanization and formation of states started in India. Accordingly, many Mahajanapadas – sixteen as listed in the Buddhist texts[6] and the urban centers or cities like *Taxila, Hastinapur, Rajgriha*, etc. came in to existence by the 6th century B.C. As the people living in urban areas don't produce the food grains consumed by them on their own, definitely they would have been produced by the farmers living in the adjacent rural areas during those times also . In other words, if the food grains required by the rural and urban masses were produced by the rural farmers only, in that case they could have produced it in surplus, so that they could sustain and fulfill the needs of both the sets of population i.e. urban and the rural. And for producing the surplus food grains irrigation was a precondition.[7] Many ancient Indian ruling dynasties knew the importance of water management and irrigation for various purposes. For instance, the Nandas of Magadha, predecessors of the great Mauryas had built the noteworthy canal in Kalinga.[8]

It is said that during the time of Chandragupta Maurya, the founder of Mauryan dynasty, there were many parks in the suburbs which used to have pavilions and people used to spend their time in leisure in these parks. One of the unique features of those gardens and parks was that it contained artificial lakes and pools, often with fountains, and with steps leading down to them for bathing.[9] It shows the fantastic development regarding the use of water for amusement parks so that the people in urban areas can enjoy their spare time in those parks. During the time of Chandragupta Maurya the District Officers were appointed in order to ensure that every one gets the " fair share of the canal water.[10] It proves the fact that there used to be the canals during those tines in order to provide the irrigation facility to the people .

The later ruling dynasties of ancient India like Shakas, Cholas, Pallavas, Bhoj and Pandyas also gave due attention to the issue of water management and the irrigation. For instance, the dam on the Sudarshana lake - constructed during the Mauryan period was repaired by the Shaka ruler – Rudradaman.[11]

As far as the Pallavas were concerned, they could be considered as one of the master excavators of several wells, tanks and the canals . Some of these tanks are being used even today. Under the Pallavas irrigation was strictly controlled by the government . Even if any private individual or party wanted to dig a tank in order to irrigate the fiel, it was mandatory for such parties or individuals to obtain the permission from the state. There used to be the 'Tank Committees' probably they overlooked the irrigation works and the facilities. The excessive consumption of water was taxed by the authorities.

One of the other prominent ancient Indian dynasties ruling in the south was the Cholas. They had built the Grand Anicut in the first century A.D. on the river Cauvery in South India. The purpose behind building the Grand Anicut was to enable the irrigation of the fertile Tanjore delta lands with the help of Cauvery water.[12]

In the western India, one of the most famous reservoirs was built at Girnar, unfortunately the great embankment over 100 feet thick at the base no more exists. King Bhoja Paramara of Dhara had built one of the lakes at Bhojpur near Bhopal for the purpose of irrigation, this too does not exist at present.[13]

Irrigation and Water Management during the Medieval period.

Land Revenue was one of the most important sources of the revenue during Delhi Sultanate period. Hence, in order to facilitate the higher agricultural production on the part of the farmers irrigation facilities were provided by the Sultans belonging to different dynasties. Land Revenue was collected in kind, hence , higher the agricultural production more would be the revenue collection to the state, that is why the care was taken to provide irrigation facilities to the farmers. During the Sultanate period wells would have been the major source of artificial irrigation in various areas.

Certain references have been found which show that Sultan Muhammad Tughlaq (1325 – 1351 A.D.) belonging to the Tughlaq dynasty used to extend loans to peasants for digging wells so that they could make use of the water of those wells to increase their cultivation and the agricultural production. Even the throwing dams (*Bands*) were built upon the streams to block the water for the purpose of irrigation during those days.[14]

During the 14th century A.D. the canals were also constructed by the Sultans in order to provide the irrigation facilities to the farmers. The first Sultan of Delhi who dug the canal for promoting agriculture was Ghiyasuddin Tughlaq (1220 – 1225). He was the father of Sultan Muhammad Tughlaq.

The credit for creating / builiding the biggest network of canals before the 19th century goes to Sultan Firuz Tughlaq (1351- 1386). He constructed the canals on various rivers in north viz. Yamuna, Sutlej Ghaggar, Kali, etc. These canals brought in lot of irrigation water to the farmers.

During this period both big as well as small canals were constructed . The beauty of the system was that some of the canals in the Multan region were dug and maintained by the local people.[15] It could have directly taught the people the importance and proper use of the scarce resource like water.

During the Mughal period too the irrigation was paid attention by the different Mughal Emperors . Emperor Akbar (1556- 1605) renovated the Yamuna canal in 1568 originally built by the Sultan of Delhi – Firoz Shah Tughlaq.[16] It shows that Akbar knew the need and importance of such canals for the irrigation purposes. Even, during the Mughal period land revenue remained one of the important sources of revenue.Perhaps, this is one of the reasons behind the renovation of the above stated canal.

Mughals being the great lovers of gardens, the purpose of the canals built by them was twin – firstly, it's water was used to irrigate the fields in different regions in the Mughal empire. Secondly, it was also used to maintain the various gardens erected by the Mughals. For instance, one of the branches of the Western Yamuna canal repaired by Akbar was taken to Delhi to supply water to the fountains and gardens in the Red Fort. Shah Jahan, the grand son of Akbar who later became the Mughal Emperor and built the world famous Taj Mahal at Agra, also had erected one canal from the river Ravi through the Shalimar Gardens at Lahore.[17] Definitely, purpose of building it would have been to make use of the canal water for maintaining the garden.

The farmers availed both the natural as well as artificial means of irrigation during the medieval period. Wherever required, wells, tanks, reservoirs and canals were constructed for the irrigation purpose. "Drawing water for irrigation by means of leather buckets and the Persian - wheel and lifting water by means of *dhenkli* – (a system worked on the lever principle) and baling were commonly employed".[18]

Irrigation under British Rule

The process of the establishment of British rule in India began in the real sense of the term from the year 1757. In 1757, the battle of Plassey was fought and the province of Bengal went under the control of the British East India Company subsequently. The British rule was strengthened and the take over of India nearly completed by the third Anglo- Maratha war of 1818.After this war majority of the parts of India went under the British rule.

During the British rule too, quite excellent work was done in the field of irrigation. Various irrigation projects were developed in India by the British throughout 19th century and during the first half of the 20th century. One of the major problems faced by India during the 19th century was the problem of famine. Farmers used to suffer a lot due to the frequent occurrence of the famines in various parts of India. Hence, in order to deal with this problem irrigation projects were developed by the Britishers.

Some of the British administrators took keen interest in the development of irrigation. One of such administrators was Sir Bartle Frere , the Governor of Bombay Presidency from 1862 to 1867.[19] He felt that the Bombay Presidency required the irrigation works as the rivers in this area had abundant and certain supply of water for quite a good number of months in a year. The work of one of the masonry dams on river Mutha near Poona could be initiated due to Sir Bartle Frere.[20]

Some of the major irrigation projects undertaken by the British during the 19th century were as follows:

1) Upper Anicut – built on the Cauvery river
2) Godavari Anicut – built on the Godavari river . This project proved to be a boon to deal with the famine problem in the Godavari district of Andhra Pradesh .
3) An anicut across the river Krishna and a canal system.
4) Upper Ganga canal .
5) Sirhind canal.
6) Lower Chenab canal.
7) Lower Ganga canal.
8) Agra canal .
9) Periyar system of canals in Tamil Nadu .
10) Mutha canals in Maharashtra .

Britishers continued to undertake the irrigation canal projects even during the 20th century. British government constituted the Irrigation Commission in the 20th century. Following projects initiated or completed during the 20th century:

1) Tribeni canal project (Bihar)
2) Pravara canals (Maharashtra)
3) Godavari canals (Maharashtra)
4) Nira Right Bank canals (Maharashtra)
5) Sarda canal projects (U.P.)
6) Weinganga canals (M.P.)
7) Mahanadi canals
8) Krishanasagar project (Karnataka)
9) Nizamsagar project (A.P.)
10) Mettur project (Tamil Nadu)

All the above mentioned projects helped to laid the strong foundation of the irrigation canal system throughout the century.

There were some drawbacks of the canals built during the British period .It widened the gap between the rich farmers and the poor farmers because the poor farmers could not pay the rates of the canal water hence, many a times the richer farmers got the water and they became more prosperous. These farmers cultivated the cash crops like sugar and cotton which ultimately resulted in the decline of poor man's food like millets and pulses. These canals also on some times caused swamps and excessive salinity [21] which could have affected the agricultural land.

Irrigation in the Independent India.

India won it's political independence from the British yoke in 1947. Now, the responsibility of making the further development and improvement of the precious water resource and irrigation lied on the shoulders of the government of independent India. The government of India had got the legacy of developing irrigation projects from the ancient period. Hence, it carried out the responsibility successfully.

Under Pandit Jawaharlal Nehru , the first prime minister of independent India , the focus of the government was to achieve the social and economic development of the country. In order to achieve the economic development it was necessary to pay equal attention towards the primary and secondary sectors of the economy i.e. the agriculture and the industries. As nearly 80% of the Indian population was involved in the agriculture, it was the prime responsibility of the government to give relief to the farmers by making available the irrigation facilities. For achieving all these goals the government of India decided to follow the model of the Five-year plans. The government of independent India considered the multi purpose river valley projects and other dams and canals as necessary and essential for meeting India's critical requirements of irrigation for agriculture, electricity for industries and flood control, in fact Pandit Jawaharlal Nehru considered the dams as the temples of modern India.[22]

The successive Five-year plans gave sufficient preference for increasing the irrigation facilities. The following figures of the amount spent on the irrigation promotion in different Five Years plans is enough to realize the importance given by the government to the development of irrigation.

Five Year Plan	Amount Spent[23]
First plan (1951 – 56)	Rs. 300 crores
Second plan (1956 – 61)	Rs . 380 crores
Third plan (1961 – 66)	Rs. 572 crores
Fourth plan (1969 – 74)	Rs. 1470 crores

In 1950 nearly 20 million ha. area was under irrigation and by 1974 as much as 43 million ha. area was under irrigation , it means that the area under irrigation increased by 23 million ha. from 1950 to 1974 .[24]

Over the years since the independence various major and medium irrigation projects were developed in India . Some of them are as following : [25]

1) Bargi Project (M.P.)
2) Beas (Joint venture of Haryana,Punjab and Rajasthan) It consists of Beas-Sutlej Link and Beas Dam At Pong .
3) Bhadra (Karnataka)
4) Bhakra Nangal (Joint project of Haryana , Punjab and Rajasthan .It is India's biggest multi purpose river valley project.
5) Bhima (Maharashtra)
6) Chambal (Joint project of M.P. and Rajasthan)
7) Damodar valley project (West Bengal and Bihar)
8) Farakka (West Bengal)

9) Gandak (Joint project of Bihar and U.P.)

10) Hasdeo Bango Project (M.P.)

11) Hirakud (Orissa)

12) Jayakwadi (Maharashtra)

13) Kakrapara (Gujarat)

14) Kangsabati (West Bengal)

15) Karjan (Gujarat)

16) Kosi (Bihar)

17) Krishna Project (Maharashtra)

18) Kukadi Project (Maharashtra)

19) Left Bank Ghagra Canal (U.P.)

20) Madhya Ganga Canal (U.P.)

21) Mahanadi Delta Scheme (Orissa)

22) Mahanadi Reservoir Project (M.P.)

23) Mahi (Gujarat)

24) Malaprabha (Karnataka)

25) Mayurakshi (West Bengal)

26) Nagarjunasagar (A.P.)

27) Panam (Gujarat)

28) Parambikulam Aliyar (Joint venture of Tamil Nadu and Kerala)

29) Pochampad (A.P.)

30) Rajasthan Canal (Rajasthan) . Now it is known as Indira Gandhi Canal .

31) Ramganga (U.P.)

32) Sabarmati (Gujarat)

33) Sarda Sahayak (U.P.)

34) Sone High Level Canal (Bihar)

35) Tawa (Madhya Pradesh)

36) Tehri Dam (U.P.)

37) Thein Dam (Punjab)

38) Tungabhadra (Joint project of A.P. and Karnataka)

39) Ukai (Gujarat)

40) Upper Krishna (Karnataka)

41) Upper Penganga (Maharashtra)

Nowadays the focus has shifted from just irrigation and availability of water to the management of the scarce resource like water. Day by day the population of India is increasing, at the turn of the 20th century India has crossed the mark of 1 billion. India is the second largest populated country after China It is said that if the population of India increases at the present rate it may even surpass China's population and India may become the largest populated country in the world replacing China. This increased population has brought the new challenges. Hence, it has become the need of the hour to pay due attention to the proper use and management of the country's water resources. Different parts of India are affected by the severe drought every year posing the great hardships to the rural masses in particular. In India there are various agencies which initiate the policies and takes decisions on the issue of water some of them are as following:[26]

1) The Ministry of Water Resources Management .It lays down the policies and programmes for the development and regulation of the country's water resources.

2) National Water Resource Council works to lay down the national water policy and to review it periodically, to recommend acceptance of water plans, to advise on the modalities of resolving inter-state water issues, to make recommendations that would foster speedy and environmentally sound economic development.

3) Central Water Commission initiates and assists the state schemes for the purpose of flood management, irrigation, navigation and waterpower generation.

4) Central Ground Water Board monitors the national water table behaviour . It also provides the technical know how for the construction of rainwater harvesting structures free of cost.

More recently, the plan of interlinking the major rivers of the country has come forward in order to help and give relief to the people in the areas of scanty rainfall.

(Endnotes)

1 D'souza ,E. J . , *Ancient India (Up to 1000 A.D.)*,PP – 34 - 35

2 Ibid , P – 53.

3 Rao , K.L., *India's Water Wealth– Its Assessment Uses And Projections*, p – 126.

4 Basham , A.L., *The Wonder That Was India*, P- 18. "It is not certain that irrigation was known , although this is possible."

5 Rao , K.L. , op. cit. , P – 126.

6 D'souza , E. J., op. cit. , p – 88.

7 Thapar , Romila , *The Penguin History of Early India From Origins To AD 1300*, PP – 142 – 143.

8 Ibid , P – 246.

9 Basham , A.L. , op. cit., P – 202.

10 Rao , K.L. , op. cit., P – 126.

11 Nayar V.S. , Ramanna, Mridula, Srinivasan Padma, *Ancient India Up To 1000 A.D.*, P – 125.

12 Rao , K.L., op. cit., P – 126.

13 Basham , A.L., op. cit., PP – 192 193.

14 Raychaudhuri Tapan , Habib Irfan , *The Cambridge Economic History Of India vol. – I : C. 1200 – 1750*, P – 49.

15 Ibid , P – 49.

16 Rao , K.L. , op. cit., P – 127.

17 Ibid , P – 127.

18 Ed.- Chopra , P.N. , *The Gazetteer Of India - Indian Union , Vol. - II, History and Culture,* P – 383.

19 Ed. – Chaudhari , K.K. , *Maharashtra State Gazetteers – Greater Bombay District , Vol. – I*, P – 598.

[20] Ranade , Rekha , *Sir Bartle Frere And His Times(A Study Of His Bombay Years – 1862 – 1867)*, P – 177. "This lakewas named after Captian Fite. The dam was nearly a hundred feet high at the deepest point and supplied water to the town of Poona , and the cantonments and about 86000 acres of land."

[21] Sarkar Sumit, *Modern India*, P – 36.

[22] Dutt Ruddar , Sundharam K.P.M. , *Indian Economy*, P – 526.

[23] Kundra , D.N. , *A Combined Text Book of History And Civics , Book 3 , According to the N.C.E.R.T. syllabus*, P – 197.

[24] Rao , K.L. , op. cit., P – 129.

[25] *Manorama Year Book*- 2003, PP – 568 – 570.

[26] *Civil Services Chronicle*, November 2004 issue , "Water Resources Management" , P – 35.

WATER RESOURCE OF INDIA

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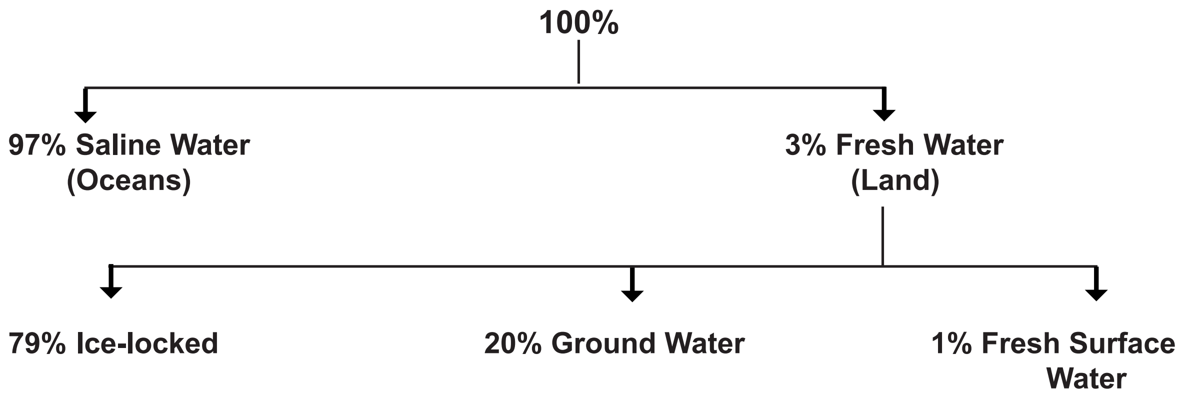
Introduction

Water is one of the fundamental resources and indispensable element of life on the earth, as rightly stated by GOETHE that 'everything originated in the water and everything is sustained by water'.

The earth appears as a water planet from the space, yet water is a scarce resource, because, of the planets total water, accessible fresh water accounts for less than 1% as explained below :

Global Distribution of Water



Fresh water that is continually renewed through the Global water cycle is a finite natural resource in each country. The precipitation on the earth is also highly unevenly distributed as it is governed by natural factors that are favourable to some areas resulting in water surplus regions and unfavorable in other, causing water-deficit regions in the world. Following table illustrates the concept.

Table No. 1 Distribution of World's Water and Percentage Share of Population to total World's Population of few selected countries.

Sr.No	Country	% of Water	% share of population to total world population
1	Brazil	17	2.46
2	Russia	11	2.12
3	Canada	7	0.45
4	China	7	18.52
5	Indonesia	6	3.09
6	U.S.A.	6	3.99
7	Bangla Desh	6	1.86
8	**INDIA**	**5**	**14.91**
9	Others	35	52.6

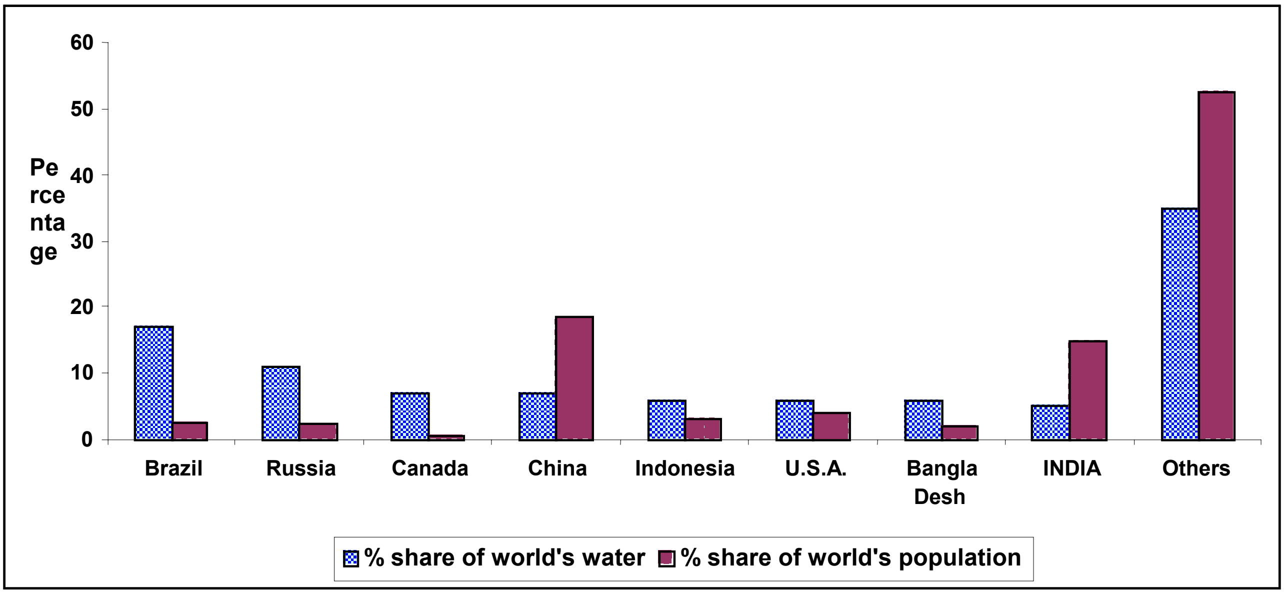


Figure No-1

From the above Figure No-1, it is thus noted that India shares only 5 % of the total world's water and supports approximately 15 % of the total World's population. China & India and other countries together constitute 86 % of World's population but receive only 47 % of water, whereas 14 % of the world's population receives 53 % of water.

This scarce potable water has long been over-exploited, polluted and fought over. The earth's growing population along with its multifaceted activities demanding fresh water, is now putting this vital resource under increasing pressure. Since the 1992 International Conference on Water and the Environment in Dublin, there has been a great deal of intensive and serious thought about the limited water availability and possibilities of exploiting and managing the earth's fresh water resources. According to World Bank estimates, by the year 2025, one person in three will live in conditions of water shortage. Water is becoming as increasingly scarce and extremely valuable resource; without which sustainable development is impossible. The guaranteed sustainable supply of water, the quality of which is also good enough to meet the requirements of people, is an enormous challenge to the governments of many countries, especially the developing world.

Water being unevenly distributed over the land, influences inter-state and international relations and so is the cause of 'Hydro politics'. Already its footprints are noticed with conflicts increasing at local, regional, national and international levels. The United Nations estimates that, by 2025 nearly one third of the world's population will suffer from severe water shortage if current rates of consumption continues. The United Nations therefore declared 2003 as the International Year of Fresh water.

A recent World Water Development Report ranked India 133rd among 180 countries in terms of water availability and 120th among 122 countries in terms of water quality. Water tankers supplying drinking water in many parts of the country by rail and road is a common sight. Women in villages suffer most as they have to walk more than 2 kms to fetch drinking water needs. Millions of households in urban areas wake up in the pre-dawn to fill water as the municipal supply is only for few minutes/hour in a day.

Water situation in the country is indeed critical as noticed with water riots and acrimonious conflicts over water becoming the norm. Skirmishes among stated over sharing of water are becoming too common, for example; for decades the two states from south India namely, Tamilnadu and Karnataka have been bitterly squabbling over sharing of the waters. Rapid population growth, industrial expansion and migration of people from rural to urban areas, especially to the metro cities of the country, are threatening India's water resources. The supply of water for human use is related with its quantity and quality. All human activities impair the natural quality of water which beyond a certain degree or pollution becomes unusable. This results in the reduction of supply of usable water. Reports of acute water shortage of drinking water are pouring in from different parts of the country. According to World Watch Institute, Washington, India will be a highly water-stressed country from 2020 onwards. Hence there is a need to evolve simple solutions that can be replicated on a large scale. Therefore identifying the water potentials of the country is utmost essential.

Rainfall and Potential of Flow

The climatic condition influences to a great extent the water resource availability in the country, as it ranges from continental to maritime, resulting in extreme aridity in some areas to torrential rains in the other areas of the country. Rainfall in India is dependent upon the influence of south-west monsoon between June to September and north-east monsoon during October to November. The annual average rainfall over India based on the daily collected data by Indian Meteorological Department from more than 3000 rainfall-recording stations for a period of 50 years (1901-1950) is computed as 105 centimeters. It is largest anywhere in the world for a country of a comparable size. A good part of it is lost through the process of evaporation and plant transpiration, leaving only a half of it on the land for us to use. However distribution of rainfall in India shows great variations with unequal seasonal and geographical distributions and its frequent departure from the normal. Because of this spatial and temporal variation in precipitation, the potential usable water supply is very small. The entire western coast and Western Ghats, most of the Assam and the Sub-Himalayan West Bengal receive more than 250 cm. rainfall, but it decreases rapidly from 50 cm. in Delhi to less than 15 cm. in Rajasthan to the extreme west. Peninsular India receives less than 60 cm. to 50 cm of rains. The resources potential of the country, which occurs as natural run off in the rivers, is about 1869 km3 as per the latest estimates of Central Water Commission Ministry of Water Resource Govt. of India, considering both surface and ground water as one system.

Ganga-Brahmaputra-Meghana system is the major contributor to total resources potential of the country with 60 % of its share to total water resources potential of the rivers. Of total potential surface water resources, 40 % of utilizable surface water resources are in the Ganga-Brahmaputra-Meghana system. In majority of river basins, present utilization is significantly high and is in the range of 50 % to 95 % of utilizable surface resources(Fig.2).

However, in the rivers, such as Narmada and Mahanadi percentage of utilization is quite low.

The distribution of water resources potential in the country shows that as against the national per capita annual availability of water of 19054 m3, the average availability in Brahmaputra and Barak is as high as 16589 m3, while it is as low as 360 m3 in Sabarmati basin. Brahmaputra and Barak basin with 7.3 % of geographical area and 4.2 % of population of the country has 31 % of the annual water resources. Per capita annual availability for rest of the country excluding Brahmaputra and Barak basin works out to about 1583 m3. Water shortage is a regionally, locally and seasonally specific problem.

India's Annual Renewable Fresh Water availability per person.

Year	Water per person in cubic meter.
1955	5277
1990	2464
2000	1970
2025	1496

India's Annual Renewable Fresh Water availability per Person

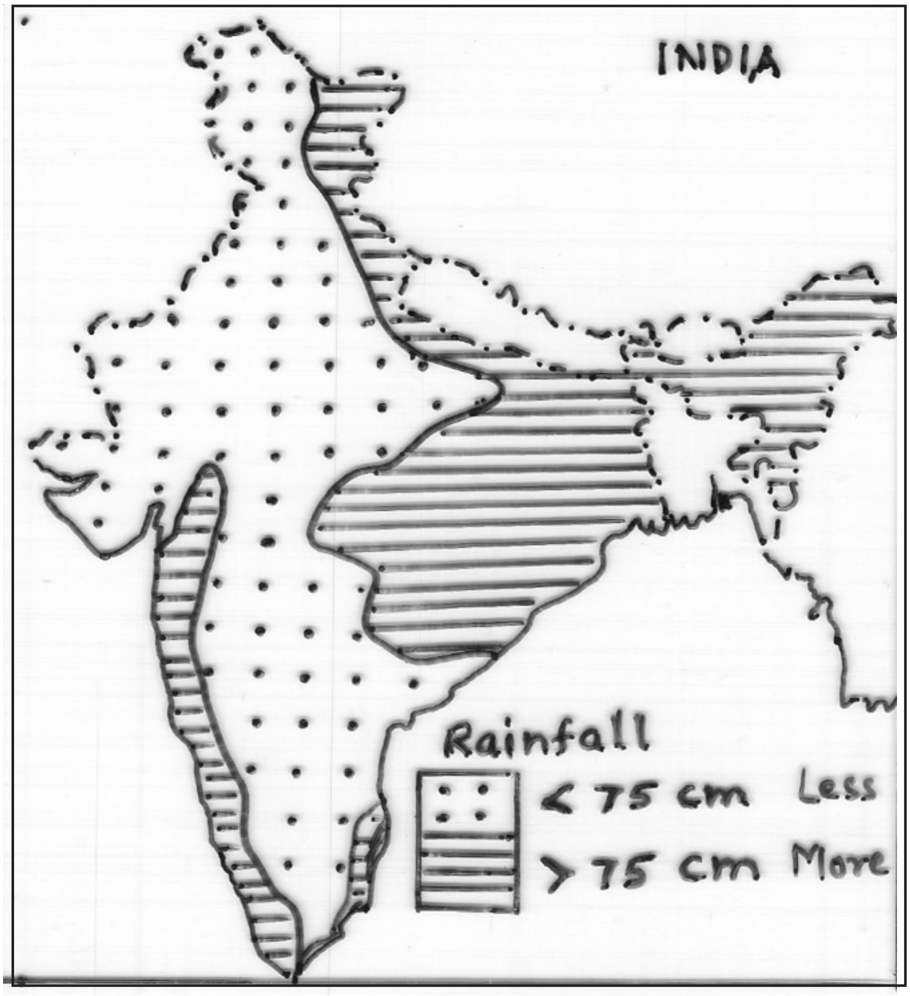


Figure No. 2

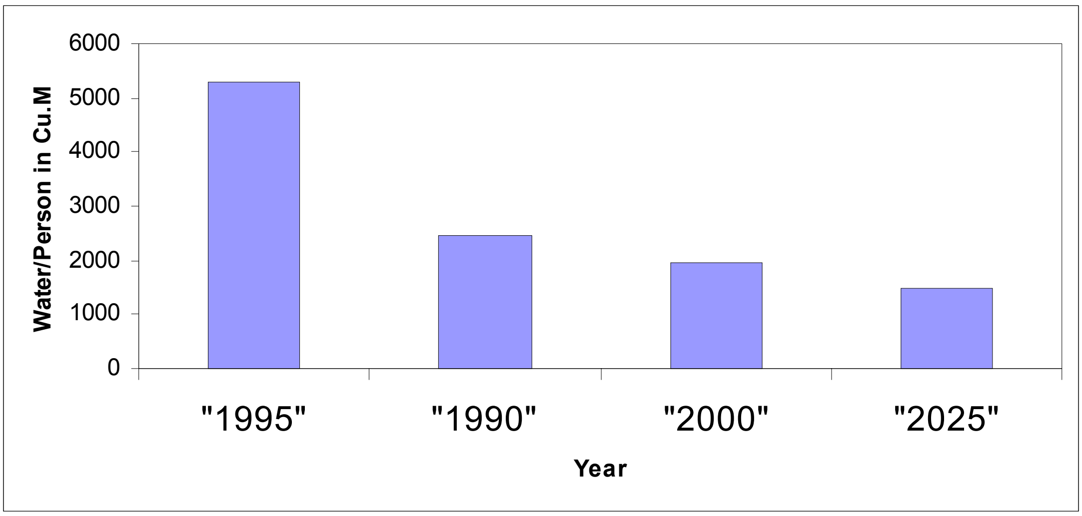


Figure No. 3

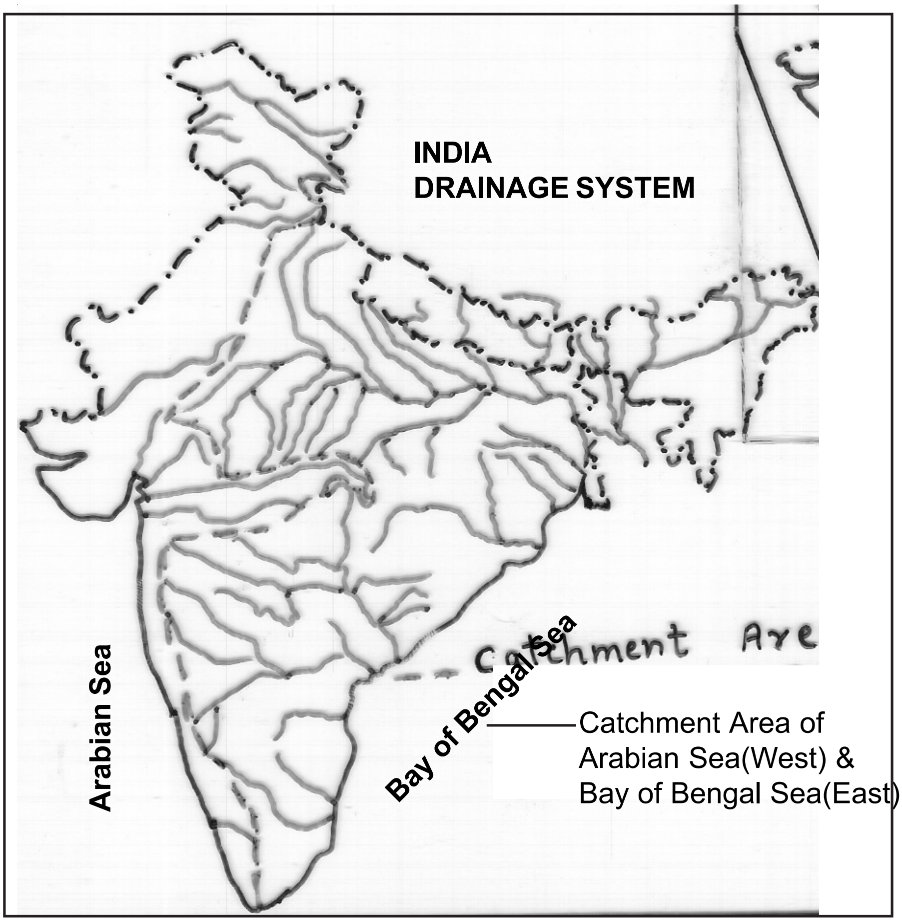
Surface and subsurface percentage of Runoff in India.

Table No. 3

Runoff Arabian	Sea	Bay of Bengal Sea
Surface	19.6	80.4
Sub-surface	20.0	80.0

Catchment Area of River Basins

There are fourteen major river basins in the country which occupy 83 % of the total drainage basins, contribute 85 % of the total surface flow and house 80 % of the country's population. These are Brahmaputra, Ganga, Indus, Godavari, Krishna, Mahanadi, Narmada, Cauvery, Brahmini, Tapi, Mahi, Subernrekha, Pennar and Sabarmati. A glance at the river basins map of India reveals some interesting features. The Brahmaputra, Ganga, Indus basins along with that of Godavari cover more than half of the country Fig. 4.



Catchment Area of River Basin
Arabian Sea(West) &
Bay of Bengal Sea(East)

Figure No. 4

Classification of Rivers

All the major river basins are not perennial. Only four of the fourteen major basin posses areas of high rainfall, i.e. Brahmaputra, Ganga, Mahanadi and Brahmini are perennial having a annual average discharge of a minimum of 0.47 million cubic meter per km2. Six basins i.e. Krishna, Indus, Godavari, Narmada, Tapi and Subernrekha area in the medium rainfall zone and have annual average discharge of a minimum of 0.26 million cubic meter per km2, and the remaining four i.e. Cauvery, Mahi, Sabarmati and Pennar occupy the area of low rainfall and have annual average discharge between 0.06 to 0.24 million cubic meter per km2. Thus many of the major rivers basins also goes dry during summer leaving no available water for dilution of waste water discharged I them. State wise perennial riverine length is given in Table No. 4 fig. 5

Sr.No.	**State**	**Riverine Length in Km.**
1	Madhya Pradesh	6090
2	Uttar Pradesh	5618
3	Maharashtra	4612
4	Andhra Pradesh	4017
5	Karnataka	2868
6	Bihar	2525
7	Jammu Kashmir	2290
8	Orissa	2250
9	Assam	2042
10	Tamil Nadu	2028
11	Kerela	1407
12	West Bengal	1163
13	Gujarat	1155
14	Himachal Pradesh	1094
15	Punjab	1071
16	Rajasthan	841
17	Manipur	758
18	Sikkim	753
19	Arunachal P.	706
20	Meghalaya	556
21	Nagaland	502
22	Haryana	348
23	Mizoram	234
24	Goa	65
25	Delhi	48

India: State-wise Riverine Length in Kilometer.

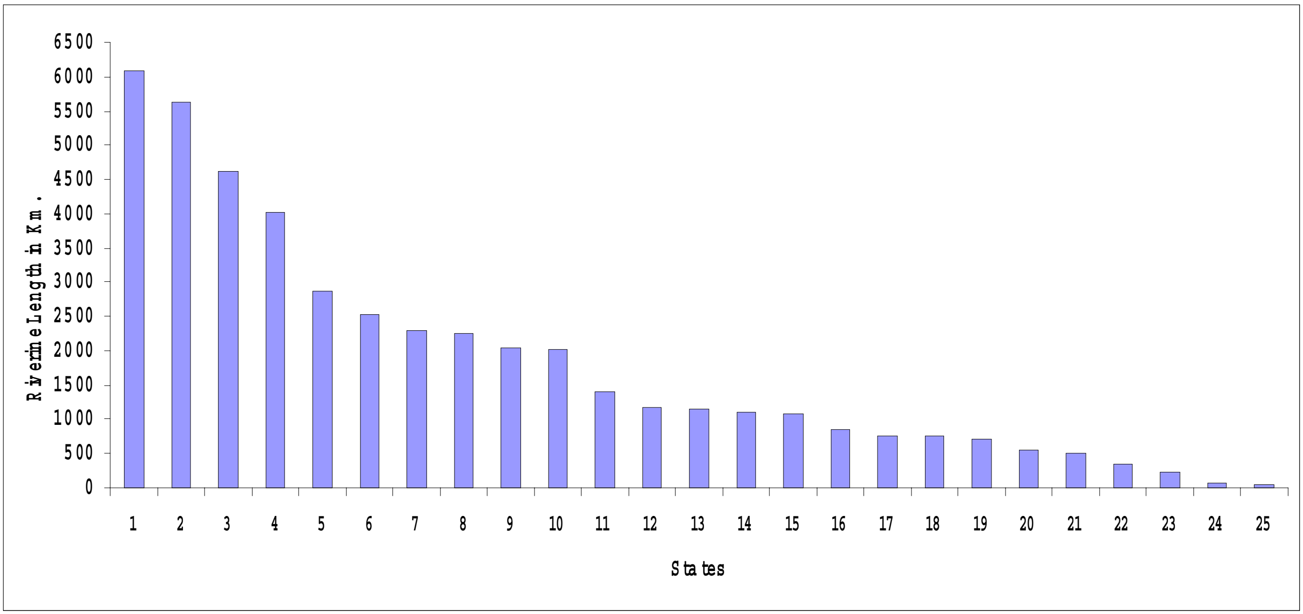


Figure No. 5

The water resources of the country as natural runoff in rivers (surface & sub-surface water) is about 1869 km3 as per the latest estimates of Central Water Commission Ministry of Water Resources, Government of India.

The Northern Rivers are always subjected to floods during monsoons and during early summers due to melting of snow in Himalayas. This water therefore needs to be carried to the drought stricken areas of Central and South India. All this water needs to be collected and stored so that it can be used during 'dry spell'. The National Water Grid Policy such as interlinking of rivers for eg.Ganga-cauvery link, Brahmaputra-Ganga link, a link canal from Narmada to Rajasthan and other links needs due consideration for sustaining development in the country Fig. 6.

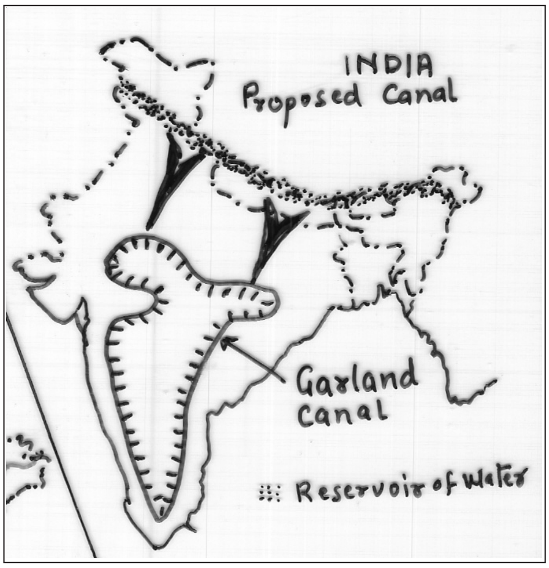


Figure No. 6

Ground Water Potential : Total replenishable ground water potential of the country has been estimated by Ministry of Water Resources as 431 cu.km. Per year. After making provision for drinking, industrial and other purposes (other than irrigation), which is about 16 % of the total potential, the potential available for irrigation is 360 km3 per year. Thus substantial portion i.e. about 68 % of ground water is still remaining untapped.

Analysis of basin wise potential of ground water by the Ministry of Water Resources indicated that the Ganga Basin has the maximum potential which is 171 km3 i.e. 40 % of total potential in the country. The potential of Uttar Pradesh is in about 84 km3/year and Goa with the lowest of 0.22 km3/year.

Development of ground water in Punjab in percentage is highest where about 94 % of the resources appear to have been tapped Haryana with 84 %; Tamil Nadu with 60 % Water Resource; and Rajasthan with 51 %. Percentages of development in the states of J&K, Assam, Goa and Orissa are very low.

Water resources regions : can be planned on the basis of river basins, which are the natural unit. A river basin has a defined watershed boundary and also has relationship with ground water resources in most of the cases. The development of a balanced plan for water resources utilization requires full knowledge of the quantity, quality and distribution of water resources utilization and also the changing patterns of land use in the entire water shed and its influence of the river flows.

India has been divided into six river basins for the purpose of assessment of the available water resources as given below in table no.5

Sr. No.	River Basin	Origin & itsTributatries	States covered	Average Annual Rainfall (cm)	Catchment Area (million hectares)
1	Indus	Mansarower lake in Tibet. Jhelum, Chenab,Ravi, Beas & Sutlej	J&K, Punjab, H.P., Haryana.	56	35.4
2	Ganga	Dev Prayag. Ramganga, Jamuna, Tons, Gomti, Ghaghra, Son, Gandak, Buohi	U.P., Bihar, MadhyaP., Rajasthan, West Bengal	111	100
3	Brahmaputra	Tibet	Assam, Nagaland, Meghalaya & Bhutan.	120	51
4	East Coast	Mahanadi, Brahmani, Baitarni, Subernarekha, Godavari, Krishna & Cauvery.	M.P. Mah, Andhra.P.Tamil Nadu.	109	120
5	West Coast	Many small rivers	Guj, Mah., Karnataka, Kerela.	122	49
6	Rajputana region	Imperennial	Rajasthan	29	17

Ganga-Brahmaputra Meghana system is the major contributor (60 % to total water resources potential of the country. The rest of the river systems are with less potential.

Population and Water Stress: Malin Falkenmark, a Swedish hydrologist, pioneered the concept of a "Water Stress Index", based on an approximate level of water required per capita to maintain an adequate quality of life. According to her 100 litres of water per day per capita is a minimum requirement to maintain good health. Based upon it Falkenmark suggests specific thresholds of water stress and water scarcity.

Water Scarcity Index

Annual per capita availability in cubic meters	Condition
1700	Occasional shortage
1000 – 1667	Water stress
< 1000	Chronic shortage
< 500	Absolute water shortage.

The 1000 cubic meter benchmark has been accepted as a general indicator of water scarcity by World Bank and other analysts. Water engineers and planners consider a country to have reached a point of water scarcity when it has fewer than 1000 cubic meter of renewable fresh water availability annually per person in the country. Cauvery, Pennar, Sabarmati, East Flowing rivers and west Flowing rivers are some of the basins that fall into this category. Since renewable fresh water resources are essentially constant in each nation per capita availability falls as population increases pushing some countries over time into water stress and water scarcity. Falkenmarks higher stress benchmark of about 1700 cubic meter per capita per year is a "Warning Light' to nations whose populations continue to grow.

Regional Water Scarcity in India: Water shortage is a regionally, locally and seasonally specific problem. Based on per capita renewable water availability, India has enough water to meet its people needs. But despite an estimated 2,462 cu.m. Per person per year, many of its nearly 900 million people suffer from severe water shortages in part as a result of uneven availability of water.

India's vulnerability of regional water scarcity is well illustrated by the case of Rajasthan with per capita water use in 1990 at 562 cu.m., a level of absolute scarcity. The state houses about 8 % of India's population but claims only 1 % of the country's water resources in the form of ground water, limited rainfall and a restricted share of water that straddle state boundaries. With increasing population in the coming decades acute shortages are imminent.

Even the regions receiving high rainfall in India often face drought because landscapes have been denuded, soil is compacted and most of the rainfall run's off before sinking into subsurface leading to flooding for 3 to 4 months and then dry for the rest of the year, for eg. Cheerapunji of Meghalaya with rapidly growing population, clearing of forests for agricultural and housing, water shortages and desertification will likely worsen the situation Fig 7.

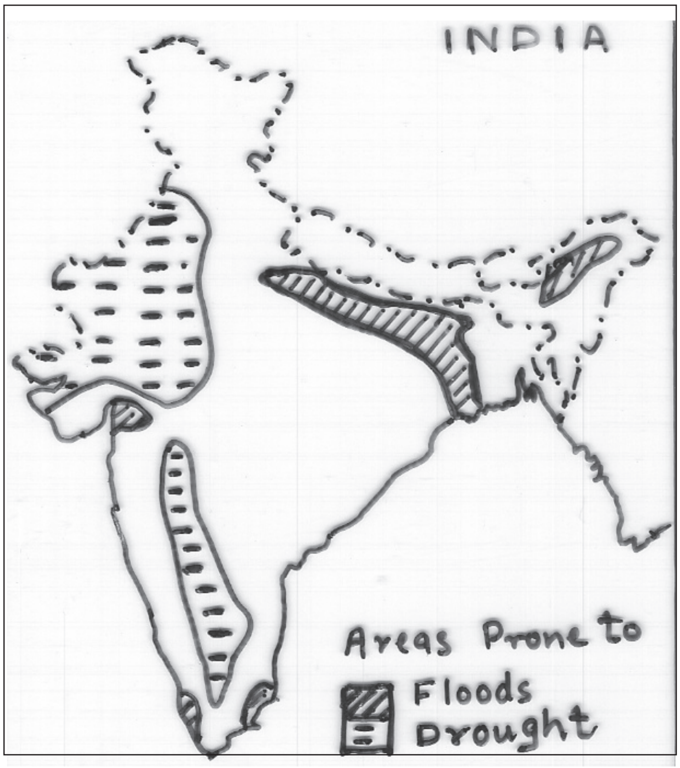


Figure No. 7

Hence combating floods, checking growth rate of the population, providing other survival measures, restoring the forests and preserving forests lands would go a long way in preserving water resources.

Conclusion:

Water Scarcity in India is largely man-made. It is the result of a short-sighted pricing policy for public water supply that encourages wasteful use of water and makes it difficult to raise resources for upkeep and expansion of the system. Reduced recharge mechanisms, unregulated exploitation of ground water due to highly subsidized electricity supply for pumping water, illegal tapping of water by slum-dwellers and illegal dwellings in the urban areas, theft of water from the major water supply pipelines by rural communities, as they are deprived of their own water resources, and enormous wastage of water at different points all along the pipeline is very common. Besides loss of water from runoff, conventional methods of water use are all responsible for water scarcity in India.

The water crisis could spiral out of control if it is not handled in time. The challenge is to develop and apply water saving technology and management methods and through capacity building, enable communities to aadopt new approaches for both rain fed and irrigated agriculture.

It is crucial to stop successive runoff by increasing the infiltration or by transferring it to regions of drought. It can be achieved only by massive afforestation, planning and implementing inter-basin transfer and sustainable development without harming the natural surroundings. It therefore calls for concerted efforts to make people aware of the magnitude of Water crisis and to settle the water disputes on fair and equitable sharing within the admissible limits. Thus India has to manage its water resources sensibly, optimally and equitably. It therefore calls for everything humanly possible to be done to guarantee sustainable use of fresh water.

References:

Geography Text Book Std. IX (1983): Maharashtra State Board of Secondary and Higher Secondary Education,Pune 411 010.

Institute of Development Studies, (1990): "Priorities of Research in Water Management for Water-Scarce Regions", Jaipur. Jaipur Printers Pvt. Ltd.

M.S.Reddy., (1992): Country paper prepared by India for International Conference on Water and Environment, Dublin, January 1992.

Population Action International, 1120, 19th street, N.W. Suite 550.

Washington D.C.20036.

Radhakrishna Rao., (1989): "Water Scarcity Haunt's Worlds Wettest Place", Ambio, 18.

World Bank: World Development Report 1992, Newyork, Oxford University Press.

Science Reporter : Water Woes Environmental Special; June 2004

WATER MANAGEMENT

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Rapid population growth, Industrial expansion due to liberalization policy and five year plans, increasing urbanization trend and migration of rural folk to urban places, are threatening India's water resources. According to the World Watch Institute, Washington, India will be a highly water stressed country from 2020 onwards. Caught between growing demand for fresh water on one hand and limited and increasingly polluted water supplies on the other, India faces difficult situation. Rising demands for water, for irrigated agriculture, increasing domestic consumption in Urban Areas, Commerce and industry are forcing stiff competition over the allocation of scarce water resources, among both rural and urban areas and their uses. It is still not too late a yet for the country to press ahead with solutions to the impending water crisis. Appropriate policies and strategies should be formulated and acted upon immediately.

Luna Leopold suggests a new philosophy for water management based on geologic and climatic factors as well as on the traditional economic, social and political factors. Surface and sub-surface waters are both subject to natural flux with time. Wet Years and dry years that can be expected must be handled efficiently with specific strategies to minimize the hardships. In wet years there is plenty of surface water and the near surface groundwater resources are replenished. During wet years we should also adopt artificial recharge of excess of surface water into subsurface water areas that are too deep. This water management plan recognizes that excesses and deficiencies in water are natural and can be planned for.

Although it is not possible to increase the earth's water supply, it is possible to manage the water resources effectively, so as to reduce the impact and spread of water resources problems.

There are three approaches to water resource management:

1. Increase the usable supply.
2. Recycle and reuse waste water.
3. Decrease the necessary loss and waste.

At the Central level, the Union Ministry of Water Resources is responsible for development, conservation and management of water as a national resource. It therefore includes general policy on water resources development and provides technical assistance t the states on irrigation, multipurpose dams, flood control measures, water logging measures, sea-erosion problems, dam safety and hydraulic structures for navigation and hydropower. It also oversees the regulation and development of inter-state rivers.

The National Water Policy has assigned the highest priority for drinking water supply needs followed by irrigation, hydropower, navigation, industrial and other uses. A basic necessity of industrial development is adequate availability of water.

The Second Irrigation commission in their report of 1972 recommended a provision of 50 billion cubic meters for industrial purpose as a whole in the country. However, a recent assessment indicates that the requirement for industrial use will rise to 1220 b.cu.m. by 2025 A.D.

The need for water management arises from the following facts:

- Growing demand for fresh water.
- Limited fresh water availability.
- Increasingly pollution of fresh water.

- Increasingly polluted water supply.
- Wasteful use of fresh water.
- Lack of concern towards conservation of water resources.
- Lack of initiatives for rain-water harvesting at micro levels.
- Lack of stringent legislative measures towards illegal tapping of water resources; pollution; recovery and treatment.

All this calls for formulation of appropriate water management policy that needs to focus on the following aspects:

- Identifying water potentials of India
- Controlling the growth rate of population by comprehensive measures.
- Avoiding wasteful use and pollution of water with legal controls.
- Providing potable water supplies to our people.
- Adopting strategies to conserve water resources.
- Massive Afforestation Programmes.
- Promoting Rain-Water Harvesting Programmes at micro-levels.
- Transfer of surplus water to deficit areas i.e. planning and implementing inter-basin transfer without harming the natural surroundings.
- Desalination of sea water.
- Managing of limited water resources with social justice.
- Reclamation of sewage and waste water.
- Development of ground water sources and surface storages.
- Predicting of wet and dry years of precipitation.
- Reclamation and preservation of wet lands.
- Rejuvenation of polluted sources of water.
- Efficient water use with appropriate technology and rational use of water.
- Recycling of industrial waste water.
- Rationing of water.
- Installation of water meters with different slab rates.
- Stringent legislative measures.
- Water Awareness Campaign through water literacy movement, documentary films, street plays, advertisements and educational curriculum at all levels.
- Special water awareness drive for women as they are most affected ones.
- Appreciation awards and incentives to those who help in the implementation of any of the above measures as per their capacity.

Renewable water resources that exist within national borders need to be managed by policy makers and planners.

Interlinking of rivers is another aspect for efficient management of water resources. The disparities in the different river basins of India call for water transfers from the 'surplus basins' to the 'deficit basins'. The proposal of the Ganga-Cauvery link for diverting the waters from the northern plains to the peninsular south of water scarce region involves huge capital investment and therefore needs an in-depth study with reference to its Environmental Impact Assessment, Cost-Benefit analysis, Qualitative assessment of non-quantifiable aspects, region investment appraisals need to be undertaken. Diverting Narmada's water, from relatively high rainfall region in Madhya Pradesh, to the areas most troubled by drought and salinity of Gujarat is another proposal. The cost is only 10 % of the subsidies provided by the Central and State governments during floods and droughts. Such Networking of diverting water from 'surplus water region to water deficit region' will control the devastating floods and the recurrent droughts of the regions. This water will be gainfully used to produce about 450 million tones of food grains needed by 2050 A.D.

Tennessee Valley Authority is a quasi-government organization in U.S.A., which manages water sharing for seven states. It was started as flood control programme and is a model worth emulating for linking up Indian rivers. Another ray of hope is Mekong, the largest international river of Asia.

A combination of strategies at international, national and local levels is required to meet the water requirements. Besides strategies for improved efficiencies and conservation of water use are increasingly an important component of any country's water management plans. A 'Blue Revolution' in water supply and sanitation is needed as much today as the 'Green Revolution' in food production was needed to feet the billions of people.

The most effective long term strategies for dealing with water scarcity include conservation and more efficient water use. Some of the towns in Kansas and Nebraska have set up a trade where the farmers provide the town with fresh water and the towns provide the farmers with treated waste water for irrigating their croplands.

Israeli farmers use drip irrigation techniques for crop production and have achieved 95 % efficiency with doubling of their food production without increasing water use. Japan and Singapore have been using reclaimed wastewater to flush toilets in commercial and residential buildings for years.

Urban population growth coupled with increasing contamination of existing water supplies threatens to make the provision of safe drinking water and sanitation in urban areas a critical issue for the next several decades.

At the Earth Summit the governments if the World agreed that water resources must be managed sustainably with full recognition of their limits. We nom longer can 'find more water', but must shift our attention to the management of the renewable water resources that exists within national borders.

Strategies for improved efficiencies and conservation of water use are an important component in country's water management plans.

Water recycling, improved efficiencies in water use and reallocation of water rights offer substantial potential for stretching water supplies.

References

Daniel Botkin and Edward Keller: "Environmental Science- Earth as a Living Planet" John Wiley and Sons, Inc.
Dash M.C. and Mishra P.C. : "Man and Environment", Macmillan India Limited. 2001.
Science Reporter: Water Woes, Environmental Special; June 2004.
P.G.Shinde and others: "Environmental Studies" (2004), Sheth Publishers, Mumbai.

WATER-SHED DEVELOPMENT: AN EMERGING AREA OF VOLUNTARY WORK IN INDIA

Dr. Ashok V. Jain and Dr. D. V. Pawar

1. The present paper deal with the significance of water resource, management, illustrated by a case study of a voluntary organization engaged in this area.

2. Water is the most significant and scarce natural resource in the agrarian economy of the developing countries. This mauves the utilization, conservation and management of water resources a vital issue.

Water resources management implies the efficient management of available water resources so as to ensure optimum utilization. It aims at harnessing the water resources for irrigation for stepping up to farm production. Water resources management has different aspects like water management in flood-prone areas, surface water management and ground water management. For this purpose, the technique of watershed management is advocated and practiced in India during the last three decades.

Anna Hazare undertook the pioneer experiment in watershed development in Ralegan Siddhi village in 1972. The success of this experiment was universally acknowledged. This encouraged the voluntary organizations in different parts of India to make watershed development as one of their principal activities.

Vilasrao Salunkhe launched Paani Panchayat, a successful experiment in watershed management in the drought prone areas of Purander Taluka in Pune districts in 1974.

Salunkhe formed Gram Gaurav Prathisthan and persuaded the residents of Naigaon to donate 40 acres of land belonging to the village temple. Salunkhe started a modest project in water conservation. He built a percolation tank and dug a well, fitted with a 7.5 H.P. pump. Later, he laid a 300-meter pipeline and planted trees. The Salunkhe experiment worked wonders. Within three years, the grain yield went up from a meager 10 quintal to 200 quintals. Encouraged with this success, Salunkhe started a movement with the co-operation of local farmers, named as Paani Panchayat, to decide on equitable distribution of water and collective farming.

3. Thus we may conclude that

1. Paani Panchayat and similar other activities of the voluntary organisation are community based programmes.
2. The beneficiaries are involved in the implementation of the programme.
3. The water-shed development, when undertaken by the community, is cost efficient in comparison to the similar activity undertaken by the government.
4. It is an effective way of honest association and rural development.

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WATER RESOURCES DEVELOPMENT IN INDIA

Prof. H.M. Desarda

As we enter the new century and millennium the foremost problem that besieges and bewilders India is: Water. Of course the droughts and floods have been a part of our agricultural history and geography. However, the kind of water stress and scarcity, we are facing during past few decades, both in its extent and dimension is distinctly different from what we have been historically used to. Intriguingly, there are flash floods in arid regions like Rajasthan and water scarcity in Cherapunji during summer.

Regrettably, we keep on ignoring and deferring the most issues unless it reaches a calamitous point and becomes socially volatile and politically explosive, and hints headlines in the media. Willynilly, the powers that respond to the desperate situation but after the crisis management scarcely think of the enduring solution. The plan to provide potable water, famine eradication and flood control is a classic example of the yawning gap between policy statements and actual performance.

'As of now, nearly one hundred million people in nine states are bearing the brunt of the water-stress of varying order. For nearly 50 million people in vast tracts of the drought-prone Rajasthan and Gujrat the water scarcity is most acute and the people are forced to migrate with their livestock.

Frankly speaking, it is a matter of national shame that we could not provide even potable water for all our people after 50 years of the national independence and all that goes by the name of planning and development. Let us not forget that water is not yet another commodity, it is life!

Indisputably, our ability to quench thirst and banish hunger should be the litmus test of Swaraj, or true independence for the masses. The Constitution of India enjoins this obligation on the rulers. Alas, the successive governments have singularly failed in this task. Notwithstanding all the euphoria of globalisation and hype of hi-tech, today the harsh reality is : The bottom half of India is, by and large, thirsty, hungry, illiterate, under-nourished and shelterless. Indeed, such a scenario of persistent water scarcity in some regions and for a vast section of the vulnerable population is bound to make the people very restive and rise in revolt.

The Genesis

If we look at the sporadic and spontaneous instances of the social strife and political conflicts during past few years in the face of paucity of drinking water as well as the dominant agricultural, industrial and urban groups trying to grab as much water as they can, the water-wars of varying intensity appear imminent. Already what is on anvil may manifest into major civil war. The cleavage and contradiction between the greed of the ruling elite and the need of majority of the people is accentuating day by day.

Well, it is hightime all thinking people should clearly understand the basic causes and terrible consequences of the water-stress we are facing today. The causality of the current crisis and recurrence of the malady needy to be grasped in totality. Appearances and realities as well as the identification of the exact problems and the solutions perceived should be placed in proper perspective. In other words there is need for a holistic understanding of the whole gamut of water issues.

The usual governmental approach of pumping in more and more money is no solution. After all, how can you buy water which is non-existent with the currency notes on the spur of the moment of acute scarcity? In short, "more of the same" is no answer. Careful scrutiny would show that the inadequacy of the funds is not the chief cause of non-completion of the water-use projects. By all reckoning the allocation made both for the drinking water supply schemes as well as water conservation and water harvesting through employment-linked watershed development programme is quite sizeable. During past few years annually Rs. 8,000 to 10,000 crore are allocated to the various rural employment programmes. Besides, there is lot of money pumped (siphoned!) through the National Drinking Water Mission as well as water supply schemes in each state. Even then if the situation is horrific the real reasons are indifference, negligence and corruption.

The Greed-Mania

On the contrary, on account of the lure of the kick-backs, capital-intensive high cost, long distance water conveyance projects are deliberately chosen by the policy-makers, bureaucrats and technocrats who are in league with the lobby of construction contractors. Innumerable examples across the length and breadth of the country and particularly in the water-scare regions have demonstrated the viability and desirability of adopting the lowcost local input based rainwater harvesting and conservation techniques. The crucial element in this is the community participation, which brings to bear time-tested approach of caring and sharing.

All in all, such an acute scarcity of bare minimum drinking water is symptom of deeper malaise. This amply proves that the water-conservation measure like recharging of aquifer, replenishment of ground water is utterly neglected. Moreover, the available water is put to erronecus use, whether it is water guzzing cash crops like sugarcane, tobacco etc. or the water-intensive industrial processes. Let us not forget that tremendous amount of fresh water is squandered by the water-wasting lifestyles of the urban well-to do populace and also the chemical, sugar, paper, liquor and other industries, even in the water-short regions. Above all, what happens in the name of development is destroying the life-support system-land, water, forest, fisheries and all those natural and environmental resources on which the toiling people depend for their survival and livelihood.

For the sake of conceptual clarity let us remember that drought and particularly the long dry spell, scanty rainfall, its periodic and erratic pattern is a part of climatic and hydrological cycle. Though there is a long term secular trend in the precipitation it is marked by an element of urcertainty and surprises and the raingods can and do play a truant. Notwithstanding all this the meteorological drought need not necessarily lead to agricultural and hydrological drought. Most notably, drought need not cause a famine.

Here we must understand the distinct hallmark of the water as natural element and eco-entity : it is a renewable resource. But the renewability is crucially dependent on the other ecological entitles like soil, vegetation and climate. Given the characteristics of the monsoon, the spatial and temporal mismatch in the water availability is inevitable. Indeed, the human ingenuity lies in harnessing the water which is potentially available.

The crux of the water planning is : catch as much water as you can when it is on land. After all, you cannot have more water than that is there in each hydrosphere. But when it is in ocean and sky you can do little to directly tap it. Cloud ceding and desalination, albeit technically possible, are not the practical viable answers.

Resource Illiteracy

Rather, you do not have to resort to such extremes. In fact, what we get from the precipitation and snowmelt is quite adequate to meet all our needs in almost every place. Therefore, what is most critical is holistic understanding of the hydrological cycle and correlation of the three vital water R's the rainfall, runoff and recharge.

The experience suggests effective water availability if function of these three R's. Happily, even in low rainfall and and semi-arid regions we can harvest water which can surface to meet the basic needs of the people. Through the ages people have been doing it. Even today, large number of traditional rainwater harvesting systems are in vogue across the length and breadth of the country. The roof water harvesting is quite common in the Western Rajasthan, Kutch, Saurashtra and the north-east India. Now it is successfully tried in Bangalore, Chennai, Devas and few other places. It is a matter of resource-literacy about which our policy-makers are most illiterate. Besides, their real intentions are dubious and the approach is most arrogant-we know all!

The sum and substance of all the micro-watershed and other water conservation experiments in Alwar, Mandvi, Sukhomajri, Ralegan, Siddhi and hundreds of such projects in different agroclimatic regions of the country vouchsafe the efficacy of the local rainwater harvesting in drought proofing. In-situ rainwater harvesting, storage in soil-profile, aquifer recharging through earthen, and biological bunding in each mirco-watershed is the cheapest, quickest and ecologically safest method of storing water. In each basin, sub-basin, mega and micro-watershed on the principal of ridge to valley we should conserve, harvest and harness the water. This pre empts or at least largely reduces the need for surface storages. Surely, then we need much fewer and smaller surface storages as against the large dams we think are necessary today.

Though politicians right from the Prime-Minister to the Chief-Minister and MPs/MLAs from time to time reiterate the need for rainwater harvesting they do not have time and interest to get down to the actual task. Moreover, as it is labour intensive and community-centered process, most politicians do not have much interest in it. Obviously, you cannot cook-up the budget estimate limitlessly in this local material and labour components! Also, it calls for actual presence and involvement at the village level. As we know, majority of the modern-day breed of politicians who are based in state capitals and Delhi hardly have a genuine interest in solving the problem. The question of soiling their own hands and bearing the heat and dust for carrying out such work on ground is too much to expect these modern princes. All that they are interested in is working through the contractors, who can take care of financing their next election!

Bane of Gigantism

That's why after spending literally one lakh crore rupees on the drought-prone areas programme (DPAP), drinking water schemes, watershed works and the rural employment programmes focused on the soil and water conservation, the situation is so very dismal. The extreme water famine, like the one some parts of India are passing through, exposes the hollowness of the governmental claims in respect of the provision of basic necessity like water. Significantly it exposes the bluff of the economics and politics of the gigantism.

Diabolically, most policians keep on harping on the need of the big dams like the Sardar Sarovar to solve the problem of drinking water in far-flung and remote areas through the long distance pipelines. Unequivocally, this is the band of the present system which relies (and thrives) on the mega-engineering structures for providing water and energy. The techno-engineering approach is dictated by the greed of the agricultural and industrial elite and the urban middle class whose sectional interest is well-served through the public exchequer by building the grid of water and power. It is the part of growth model which we have borrowed from the West. The experience amply proves that it is neither equitable and nor is it sustainable. Hence, there is urgent need for a paradigm shift. Luckily, we have indigenous and traditional model which is based on what Gandhiji called providing needs of all. The stupid lifestyle we are aping is the root-cause of ecological destruction which has created this hopeless situation where women-folk have to traverse several kilometers each day just to fetch pot of water; which we urbans mindlessly flush each time we use toilet! If we are really serious about averting the water-wars we have no other option but to adopt socio-resources with which we are well-endowed. The average annual precipitation of 1100 milimeter that India gets is adequate enough to meet all our basic needs. Infact, through the micro-watershed development even areas with 300 to 400 mm rainfall can have enough water to meet all the basic needs, is demonstrated by the examples cited above. Of course, this calls for adopting alternative approach-ecological and ethical-which gives go-by the water-squandering mode of production and the consumer lifestyles.

'Let us not lose the sight of vital fact : That India, as a country is well-endowed with the water-resources. What we get from the precipitation and snowmelt is quite sizable and sufficient to meet all our basic needs, in all places and at all times. Indeed, it is very pathetic that we have turned this water-rich country in to watershort nation. Certainly, it is not the niggardliness of the nature but the greed and short-sightedness of the ruling elite which has created such a sordid state on the water front. If we do not initiate the corrective steps, the water-wars of the worst-kind are knocing at our doors.

Above all, we should remember that through the ages highly ingenious systems and methods of the water harnessing, harvesting and husbanding the water-resources in conjunction with the land and biomass resources were developed. They were community-based and collectively managed. The hallmark of these systems was : caring, sharing and conserving. True, many of them have been allowed to go into disuse on account of neglect and the lack of maintenance and particularly resource-squandering growth patterns we are adopting in the name of growth and modernisation. Therefore, the need of the hour is : A holistic approach. This calls for a comprehensive understanding of the water as life-resource. Hence, a movement for Jal Saksharta, water-literacy and the water culture-the Jal Sanskriti alone can pave way to the sustainable development of the water-resources. This is the pre-condition to solve the water problem with social and regional equity, and longterm sustainability.

WELL IRRIGATION IN THANE DISTRICT

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Introduction

The state of Maharashtra lies in the north western part of the Deccan peninsula and comprises 30.8 million hectares. It is one of the most developed, progressive and industrialized states of India, being third in population as well as area. With a command of the Arabian Sea through its port of Mumbai, Maharashtra has a remarkable physical homogeneity, enforced by its underlying geology. The Sahyadri Range is the physical backbone of Maharashtra. Rising on an average to an elevation of 1000m. it falls in steep cliffs, to the Konkan on the west. Eastwards, the hill country falls in steps through a transitional area known as Mawal to the plateau level. The Konkan, lying between the Arabian Sea and the Sahyadri Range, is a narrow coastal lowland, barely 50 km. wide. Though mostly below 200 m., it is far from being a plain country. Highly dissected and broken, Konkan alternates between narrow, steep-sided valleys and low laterite plateaus.

Except around Mumbai, and along the eastern limits, the State of Maharashtra presents a monotonously uniform, flat-topped skyline. The state's area, barring the extreme eastern Vidarbha region, parts of Kolhapur and Sindhudurg, is practically co-terminus with the Deccan Traps. The state enjoys a tropical monsoon climate; the hot scorching summer from March onwards yields to the rainy monsoon in early June. The rich green cover of the monsoon season persists during the mild winter that follows through an unpleasant October transition, but turns into a dusty, barren brown as summer sets in again. The seasonal rains from the western sea-clouds are very heavy and the rainfall is over 400 cm., on the Sahyadrian crests. The Konkan on the windward side is also endowed with heavy rainfall, declining northwards. East of the Sahyadri, the rainfall diminishes.

There are around 400 rivers in Maharashtra and their total length is approximately 20000km. The entire state can be divided into five river basins – Krishna, Godavari, Tapi, Narmada and narrow belt of west flowing rivers of Konkan. The data below depicts that in the narrow Konkan belt, water availability is comparatively better.
For better planning these five basins are further divided into 25 sub-basins.

Basin wise average annual availability of water (mm3)

Major Basins	Average annual availability of water (mm3)
Godavari	50880
Tapi	9118
Narmada	580
Krishna	34032
Konkan Rivers	69210
STATE	**163820**

The soils of Maharashtra are residual, derived from the underlying basalts. In the semi-dry plateau, the moisture-retentive regur (black-cotton soil) is clayey, rich in iron, but poor in nitrogen and organic matter. Where re-deposited along the river valleys, soils are deeper and heavier, better suited for rabi crops. Farther away, with a better mixture of lime, soils form the ideal kharif zone. The higher plateau areas have soils, which contain more gravel. In the rainy Konkan, and the Sahyadri Range, the same basalts give rise to the brick-red laterites productive under a forest-cover, but readily stripped into a sterile 'varkas' when the vegetation is removed. By and large, soils of Maharashtra are shallow and somewhat poor. Forests, comprising only 17% of the state area, cover the eastern region and the Sahyadri Range, while open scrub jungle dots the plateaus. Water is the most precious natural resource of the state, greatly in demand, and most unevenly distributed. A large number of villages lack drinking water, especially during the summer months, even in the wet Konkan. Perched water tables in the basalt aquifers have contributed to increased well irrigation. The granitic-gneissic terrain in the eastern hilly area of Vidarbha accounts for all tank irrigation. Tube-wells in the Tapi-Purna alluvium and shallow wells in the coastal sands are the other main sources of water.

Objectives

The main objective of this paper is to determine the extent of irrigation facilities available with reference to well irrigation in Thane district of Maharashtra. A spatio-temporal analysis has been done taking into consideration area under irrigation, cultivable, cultivated and unirrigated areas.

Methodology and Database

Secondary data from sources like District Census Handbooks, reports of various organizations/ institutions e.g. Irrigation Department have been used. For cartographic analysis maps have been prepared with the help of mapping software (MapInfo Professional version 5.5).

Status of Irrigation

Agriculture is the main economic activity (census figures for 2001), where the total number of workers in the state is given as 42.10 million, of which 55.41% are cultivators and agricultural labourers. Agriculture and allied activities play an important role in the state's economy. However the share of agriculture and animal husbandry in the gross state domestic product has remained comparatively low, around 13%. The Agriculture Department has divided the state into 9 different agro-climatic zones depending on the climate, topography, vegetal cover, soil and cropping pattern.

Out of a total area of 308000 km2, 65% is under cultivation; 23% of the cultivated area is under irrigation of which more than 50% is based on groundwater, utilizing dug wells and bore wells. During the kharif season, 89.3% of the land is used for crop production, while during rabi season, less then 50% of the land is used. Utilisation of water in the kharif season depends on the amount and distribution of rains. 54% of the area is not operated during rabi season, probably due to inadequate irrigation facilities.

Maharashtra is a leading state with reference to ground water based irrigation development and water supply. The overall stage of ground water development is above 30% despite being a predominantly hard rock with difficult hydro-geological conditions (82% of the area is occupied by Deccan trap basalt).

With growing urbanisation and industrialization, the non-irrigation use of water has also increased – 64% of total non-irrigation water use is for domestic purpose, and 36% for industrial and other uses. The water used for irrigation from 1997-98 to 2003-04 was in the range of 69% to 82% of the total water used. The percentage distribution of area irrigated by source of irrigation is given in the table below.

Percentage distribution of area irrigated by source of irrigation

Source of Irrigation	Kharif	Rabi
Canal	16.9	15.2
Tank	0.7	0.4
Tube well	14.4	10.4
Well	61.5	66.8
Others	6.5	7.2
Total	100.0	100.0

Source: Economic Survey of Maharashtra, 2003-04

In both the kharif and rabi seasons, the major source of irrigation is found to be well, followed by canal. The bore-wells have diameter of 150 m and depth of 60 to 100 m. Wells that yield 500 liters per hour are considered successful and may be fitted with hand pumps. Those that yield 3000 liters or more per hour are fitted with power pumps.

Drilling of bore-wells for irrigation is easier today and hence popular. Attractive financial incentives and greater depths to which they can penetrate are other factors that encourage their drilling as compared to open dug wells. With the exception of Konkan and Nagpur divisions, all others show larger area under well irrigation as compared to surface irrigation. Percentage of net area irrigated to net area sown and percentage of total area irrigated to total cropped area are similar for the state as a whole with higher values for Pune, Nagpur and Kolhapur, and much lower values for Amravati and Konkan.

Table 1a: In the state of Maharashtra there is not much difference in the number of privately owned tube wells and those that are owned by the government. Among the other wells that are used solely for irrigation, private ones far outnumber those owned by the government. The lined wells (with masonry work) are far greater than the unlined ones (non-masonry). Also the number of wells running on electricity is much higher than those using oil engines. Pune Division has the highest number of surface wells and tube wells, while Konkan has the least. It is pertinent to note that there are a large number of wells, which are not in use.

In Konkan Division, government owned tube-wells are far greater in number than those privately owned (Table 1b). Thane has the largest number of tube-wells and also a greater area under well irrigation. As far as ordinary wells are concerned, privately owned wells clearly outnumber the government-owned ones. Tube-wells are fewer in number.

Table 2 (1991): As per the 1991 Census, out of 1697 villages in the district of Thane, about 100 villages have any kind of irrigation facility. Wells are the main source of irrigation. This includes those that use electricity and those that do not. 82.53% of the irrigated area uses water from non-electrified wells. Only one village in Murbad uses river for irrigating 20 hectares of land. The data shows "net area sown with crops and orchards (area sown more than once in the same year has been counted only once). Culturable areas or wastelands include all lands available for cultivation, whether not taken up for cultivation or taken up for cultivation once but not cultivated during the preceding five years or more in succession. The land may be either fallow, or covered with shrubs and jungles, under thatching grasses, bamboo, bushes, groves for fuel etc., grazing lands and village common and grazing grounds within forest areas" (District Census Handbook, 1991). Thus irrigated area, unirrigated area and culturable wastelands together constitute cultivable land. 48.9% of the area is cultivable. Shahapur has a comparatively low proportion of cultivable land. Cultivated area constitutes 43.28% of the total area and 88.57% of all cultivable area of rural Thane. Only 0.79% of the cultivated area is irrigated.

Table 3: This table compares the data over a decade (1981-1991). Urbanisation has been on the rise and a number of villages have been usurped as towns grew. In some cases villages have been divided to form new villages. Re-organisation of villages has result in drastic changes in rural areas of talukas. The decline in rural area gets translated into a decline in cultivable and cultivated areas. A marginal increase in irrigated area is seen in Shahapur and a moderate increase is seen in Palghar and Murbad. In all three there is an increase in the total area and area irrigated by wells. Vasai shows an increase in cultivable area and unirrigated area but a decline in irrigated area. It is interesting to note that here

- river and tank cease to be sources of irrigation,
- the area irrigated by ordinary wells has risen
- the area irrigated by wells running on electricity has declined sharply.
- the decline in area under culturable waste is comparable to the decline in total area.

The talukas that show drastic changes in the areas under any of the categories mentioned include Jawhar, Vada and Shahapur. It appears that culturable waste has been brought under the plough, as yet without irrigation facilities.

Irrigated area is an index of achievement for utilisation of potential created.

Changes that have taken place over two decades (1971 to 1991) have been mapped for certain variables – cultivable land i.e. irrigated, unirrigated and culturable waste land taken together; and cultivated land i.e. irrigated and unirrigated areas added together. The maps reveal some interesting facts. However three points need to be borne in mind:

- The maps show relative, not absolute, values i.e. their proportion in selected areas.
- It appears that private wells irrigating small farms/areas have been excluded. These are frequently seen during field surveys and are used primarily for domestic purposes and to a limited extent for irrigation.
- The talukas at the periphery of Brihanmumbai have experienced large-scale urbanisation and hence a drastic reduction in their rural areas.

1. There appears to be both an increase and a decrease in the proportion of cultivable area relative to the total area. A moderate increase is seen in the northernmost taluka Talasari while a much higher increase is seen from Dahanu south-eastwards. The decrease is nominal in Palghar, but much higher in Jawhar. It is essential to re-iterate that this is *not absolute area* but with reference to total area of the taluka, which itself may have undergone change.
2. As far as the cultivated area is concerned, the proportion seems to have declined in Talasari, Murbad and Shahapur, while all other talukas record an increase. The increase is substantial in Vada.

   It appears that tracts of culturable waste have been taken up for uses other than cultivation.

Problems related to irrigation:

- Over exploitation of groundwater resource has led to failure of both irrigation and community water supply wells, as aquifers in hard rocks have limited quantity of stored water. The situation may get accentuated by low and variable rainfall.
- Irrigation and drinking water wells are in competition for same limited resource and increasing abstraction has led to the removal of utilizable proportion of water before the onset of summer, resulting in progressive depletion of water table.

TABLE 1a										
WELL IRRIGATION IN MAHARASHTRA										
Division	TUBE WELLS			No. of other wells used for irrigation purpose only						
	Govt.	Private	Total	Govt.		Private		Total		Grand Total
				Masonry	Non Masonry	Masonry	Non Masonry	Masonry	Non Masonry	
Konkana[1]? [1 Ulhasnagar ? "WELL IRRIG	2719	549	3268	1104	110	26230	17267	27334	17377	44711
Pune	8311	15957	24268	1581	2070	186000	113105	187581	115175	302756
Kolhapur	1243	1408	2648	1962	1464	34811	57151	66773	58615	125388
Aurangabad	2048	2042	4090	1634	74	128830	18212	130464	18286	148750
Latur	5648	6535	12183	5143	4279	62450	55531	67593	59810	127403
Amravati	4148	463	4611	4182	1146	153386	30279	157568	31425	188993
Nagpur	8807	3457	12264	4641	929	85855	30704	90496	31633	122129
MAHARASHTR	**35149**	**36143**	**71292**	**27555**	**12191**	**863531**	**373536**	**891086**	**385726**	**1276813**

WELL IRRIGATION THANE (1991) Area in ha						
Taluka	**Source**	**No. of villages**	**Total Area**	**Irrigated Area**	**Unirrigated Area**	**Culturable Waste**
Thane			**2873.38**	**0**	**1723.67**	**174.07**
Vasai	Well (Electrified)	3		97		
	Well	8		550		
	Total	**11**	**48914.41**	**647**	**21997.73**	**3075.59**
Palghar	Well	**11**	**117828.6**	**1348.26**	**33826.37**	**17109.91**
Dahanu	Well (Electrified)	27		209.01		
	Well	3		33		
	Total	**30**	**125021.1**	**242.01**	**41341.44**	**18159.38**
Talasari	Well (Electrified)	6		60.18		
	Well	18		208.39		
	Total	**24**	**26683.08**	**268.57**	**15721.62**	**60.61**
Jawhar	Well	**7**	**85903.94**	**19.41**	**45935.84**	**1359.42**
Mokhada			**67181.2**		**34336.05**	**4147.1**
Vada			**80128.26**		**33942.61**	**2364.09**
Bhiwandi			**159330.9**		**30145.79**	**1739.54**
Shahapur	Well	14	159330.86	152	58962.58	1739.54
Murbad	Well	15		269		
	Well (Electrified)	1		160		
	River	1		20		
	Total	**17**	**91994.84**	**449**	**50912.57**	**194.04**
Kalyan			**20357.89**		**11682.82**	**632.89**
Ulhasnagar			**23149.09**		**12266.12**	**2086.7**
TOTAL			**914765**	**3126.25**	**392795.21**	**511.3.34**

TABLE 3					
Difference in Areas in ha (1981-1991)					
Taluka	Total Area	Cultivable area	Irrigated Area	Unirrigated Area	Culturable Waste
Thane	-28540.48	-7661.61	-728	-3903.96	-3029.73
Vasai	-1031.59	7524.32	-739	9263.73	-1000.41
Palghar	9990.09	-571.41	182.26	45.13	-798.8
Dahanu	-4468.38	-6496.14	-73.8	-3947.67	-2474.67
Talasari	295.61	328.86	0	301.02	27.68
Jawhar	-2185.81	8118.48	-201.59	28960.92	-20640.85
Mokhada	-4367.61	-4991.81	0	2483.53	-7475.34
Vada	2584.26	5254.71	0	22181.61	-16926.9
Bhiwandi	-1556.02	4768.14	-40	6581.09	-1772.95
Shahapur	10768.31	6562.09	28	11817.95	-5283.86
Murbad	2317.84	9761.61	417	9586.57	-241.96
Kalyan	-16851.93	-7958.56	0	-7736.56	-222
Ulhasnagar	-9413.96	1835.03	-1509.08	3747.9	-403.79

- There are problems of leakage from shallow aquifers to deeper ones and increased abstraction from deeper aquifers thus affecting the stability of water table.
- Overexploitation is responsible for acute conditions in rural areas, where tankers are often employed.
- Unsustainability of resources, quality and pollution problems have arisen due to the above.

Conclusion

The soils of the state are by and large shallow and poor. Scarcity of water is experienced during summer even in the wet Konkan. Perched water tables in the basalt aquifers have contributed to increased well irrigation. It appears that wells are gradually getting electrified and they are bringing more and more areas under irrigation. Other sources of irrigation are increasingly losing their significance. Drilling of bore-wells for rural water supply has accelerated over the last few decades leading to the lowering of the ground water level in many parts of the state. Surface irrigation and rain water harvesting using various traditional methods need to be encouraged.

There should be incentives for changing cropping patterns to low water intensity crops, for improving efficiency in irrigation technology, management and recharge, for provision of reliable power supply, for the use of non-conventional energy source for ground water pumping and water conservation.

There is a need to understand competitive and multiple uses of water and regulate its demand. What is desired is a shift from development to management in an integrated manner along with community involvement. Water supply to drinking and industry has priority over irrigation as per the state’s water policy. Increase in demand for these purposes results in less water available for irrigation.

Equitable and acceptable legal enforcement of provisions of Ground Water Act with community participation in ensuring implementation of the Act is essential. This can be taken up locally through extensive training and orientation programs

It is necessary to reorient institutions to provide strong linkages with each other, and develop a comprehensive and user-friendly database.

Environmental issues of sustainability, overexploitation, declining water quality and pollution should become an integral part of ground water assessment, evaluation and planning leading to effective monitoring and implementation of remedial measures.

References

Irrigation Status Report: Maharashtra State-India (2003-2004).

Economic Survey of Maharashtra 2003-04.

Pathak, M.D., Gadkari, A. D. & Ghate, S. D. (1999): Groundwater development in Maharashtra State, India 25th WEDC Conference, Addis Ababa, Ethiopia.

Maharashtra Census office: District Census Handbook – Thane (1971) Part A & Part B, Mumbai.

Maharashtra Census office: District Census Handbook – Thane (1991), Series 14, Part XII – A & B, Mumbai.

WATER MANAGEMENT PROBLEM CAUSED BY CONSTRUCTION OF A KHARLAND BUND ACROSS A CREEK – A CASE STUDY OF PURNAGAD

Dr. V. S. Phadke

The Problem

Saline water has always created some problems to farmers working in marginal areas located in the realm transitional to land and sea. The problems arise because of alternate covering and uncovering of such lands by tidal waters. The changes in the level of sea water are both periodic and non-periodic. While non-periodic changes are slow and gradual, and therefore imperceptible to human eye, periodic changes are rapid and hence more perceptible. Furthermore, such changes in the level, being influenced by the movement of astronomical bodies like the sun and the moon, show variations from day to day, sometimes showing a high level high tide associated with low level low tide (Spring tide), and at other times characterised by low level high tide and high level low tide (Neap tide). Kharlands, which are inundated by sea water only for a few days in a fortnight, are a creation of such periodic changes in the level of sea water due to tidal regime (Vaidyanathan and Phadke, 2002).

The problem of drinking water in the kharlands is well known (Govt. of Maharashtra, 1976; 1982; Phadke, 1982) and is the result of salinity incursion in the underground water of such lands. Driniking water is often brought from external sources and is often short in supply especially during the height of summer when it is required the most. Periodic ingress of sea water over cultivable lands leads to accumulation of salts on evaporation. The lands are, therefore, cultivable only during the rainy season when the salts are washed away due to heavy rains. Even during this season the output is affected due to tidal ingress. Historically, the communities and the government agencies have, therefore, taken a series of measures to protect these lands.

The practice of protecting such lands by building earthen bunds to bring them under cultivation is in vogue for over eight to nine hundred years. While during the historical period the feudal governments helped communities to build such bunds, after Independence the state governments have entered in a big way by constituting agencies like the Kharland Development Board. Kharland bunds have been constructed to overcome the problem of saline water intruding low-lying cultivated areas on both the sides of the creeks. In the initial stages, such bunds were built along the banks allowing tidal water to flow in and recede freely up and down the creek. These days, however, the bunds are raised across the mouth of a creek restricting the flow of saline water to only downstream side of the bund. There are gates, with lids on the downstream side of the bund, which automatically close at the time of flood tide barring the entry of saline water. However, during low tide the pressure of tidal water is absent and the lids open to allow fresh water from the upstream side of the bund to flow down freely as the gates open out that side due to pressure exerted by flowing fresh water. This arrangement has no doubt protected agricultural fields from salinity but has also given rise to some new problems. The objective of the present paper is to understand some such problems faced by the residents, examine their causal factors and consider some measures to overcome them, if possible.

The Context

The present author was exposed to such problems during the discussion he had with local residents/ farmers at the time of a visit to one such area. Villagers claim that after construction of the bund the underground watertable has gone down. This is stated on the basis of the fact that their fresh water wells, which used to yield water throughout the year, go dry for 2-3 months during the later part of dry season. Some report that their fresh water wells become saline for the last 2-3 months in summer. This, in their opinion, is due to poor maintenace that does not serve the original purpose of constructing the bund; salt water enters though fractured lids and fresh water on the upstream side of the bund is contaminated. This enters the wells during height of the dry season. An extension of enquiry to upstream parts of the command area indicated that the famers there do not face such a problem. Yet another group reported that there is a problem of flooding of their fields by fresh water during the rainy season. Looking at the diversity in the nature of the problem, the author decided to probe in a little more detail and undertook a case study of one such bund constructed across a branch of Purnagad creek to apprise himself of the problems created by it.

Sources of Data and Method of Analysis

Maps of the area were procured and the command area of the bund delineated. This was done by fusing the information available from the topographical maps as well as that supplied by the Kharland Development wing of the Irrigation Department of the Government of Maharashtra located at Ratnagiri. As no data were available with any of the agencies in secondary form, it was decided to overcome this deficiency by generating the same through primary survey utilising the contacts already established. Field observations were also made to supplement the data so collected. Discussions with the local elite also helped to understand the width, depth and diversity of the problem. In general, ethnographic design was preferred in data collection as people were found to be reluctant to give the answers in writing (Atkinson, 1979; Goetz and LeCompte, 1984). The data were analysed case by case keeping in mind the differential and area specific nature of the problem. Relevant information was mapped to understand the space relations.

Results of Analysis

The investigation yielded four different facets of the problem which were location specific. They are detailed as follows:

1. There are farmers located just on the shelving, upstream side of the bund who complain about drying of their wells during summer. A representative study of one such well revealed that it used to provide fresh water for all the twelve months of the year. Detailed questioning, however, brought home the point that the amount of water consumed was barely sufficient. Only one household was using this water because of its shortage and others were not generally allowed to use it because of its scarcity. The same household has now dug another well and is no more dependent on this well to draw its water supply. This should have augmented the water supply of this well but that has not happened because the well was opened to the other people and the restrictions on its use have gone. But the fact that non-availbitiy of water for 2-3 months during summer began to be felt immediately after construction of kharland bund forcing this household to go in for a new well indicates that there is some truth in the claim that it is the result of the construction of such a bund.

While making an attempt to decipher the cause, it is revealed by the farmers of the area that when water was freely moving up and down the creek, it used to withold free flow of fresh water. This daily movement ensured less run-off and more percolation of fresh water into the ground. More recharge finally provided water for a longer period. Further enquiry, however, pointed out that this is only a partial truth and that local water channels in the nearby area, which used to supply water throughout the year, also go dry during summer. Thus, other factors such as deforestation also play a crucial role in reducing the underground storange of fresh water.

2. A little more upstream the story was slightly different. The farmer there had only one small unlined well located very close to shore. It used to provide plenty of fresh water throughout the year. The entire village of Purnagad used to rely on this well for nearly 5-6 months in a year. The consumption of water was, however, limted. Water used to be drawn with the help of a small bucket attached to a rope. Distance was also an important factor in restricting the use. But it was also used to water mango plantations whenever needed and so also for certain other operations like spraying of insecticides on nearby mango orchards. The well was located at the foot of a local hill and drew water from a catchment area of the

entire hill slope; it. satisfied the genuine needs of the community. The owner coming from another village did not feel it necessary to install even a persian wheel to draw up water and this prevented overuse.

The present gneration of the farmers is more enterprising and ambitious. Two farmers from this generation sought to lift up water through a height of nearly 80 m to convert the till recently unproductive 'sada' lands into vegetable growing zone. A new well, very close to the old unlined well, has been constructed and is lined. It has a diameter of nearly 15 m and the water is pumped up sometimes for all 24 hours. It worked well for a first few years but started showing adverse impact. Need was replaced by greed and this led to overexploitation of fresh ground water leading to incursion of saline water. It is claimed that the bund is not maintained properly and hence saline water enters the fresh water channel which brings in salt water during the height of summer.

A serious thinking on the problem indicated that if the breaches in the bund alone were responsible for it, they would have created the problem throughout the year. Why is it restricted only to two months of summer? Is it not due to overexploitation during earlier part of the year? The problem here is, thus, not entirely related to the bund. The old well used to supply fresh water throughout the year because the resource was exploited to a limited extent and for the satisfaction of the need. When the need was changed to greed, the environment has taken its revenge.

3. When one moves to extreme upstream part of the creek, it is observed that the situation is rather encouraging. The farmers, here, have no problem due to breaches in the bund nor have they any problem of a seasonal shortage. One of the farmers has dug a new well very close to the original bank of the creek that has as its catchment the entire hill behind. Water is being pumped up and taken up the hill slope as is the case with the farmer in Case 2. The location of the well is away from the direct path of water entering the breached bund. The farmer here appeared very enthusiastic and hoped to expand his cultivated area by extending coconut orchard in the creek itself.

A note of caution is, however, necessary. The happy situation is not likely to perpetuate and the farmer may face the same problem as is faced by the one in Case 2, if the water is recklessly exploited. This is also seen from the response of the adjoining farmer who suggests that the problem does not exist now but may appear in future. He has also reiterated the relation between water supply in wells and kharland bund. He indicated to have observed that the well water used to change level inresponse to tidal water when the bund did not exist; this is not happening now.

4. The fourth case is that of farmers located on steep bank a little upstream side of the bund. Here, the problem is encountered during the rainy season. Prior to construction of a bund, rainwater used to be drained off quickly. Now it stagnates and this makes farming impossible during the rainy season. Earlier too there were problems, and transplantation used to be delayed. But, today, even this is not possible and only one crop after rains is a norm. These farmers also indicated the problem of poor maintenance of bund, especially the lids that are expected to prevent saline water from coming in. This creates problems even for the second crop.

Before construction of the kharland bund, farmers had their own system of maintaining their old bunds constructed alongside their fields. On construction of the main bund, these bunds are getting neglected. Better maintenance of the main bund as well as these old bunds is likely to solve one of their problems.

Discussion of the Results

From the foregoing, it is amply clear that the problem associated with khaland bund is not as simple as is perceived by the local residents. There are varied dimensions which are location specific. The differential use of water by varied groups of individuals has also influenced the nature and extent of the problem. In author's opinion it is a case of poor management of available water by the residents and farmers as also poor maintenance on the part of kharland development authorities.

Any solution to the problem of this type requires co-operation among the residents as also between the residents and various agencies involved. The farmers have approached kharland development authorities in connection with the maintenance of the bund. They have been told that the authority is created for the consruction of the bund and its maintenance is basically a responsibility of the local residents. The salt water comes in not only because of breaches but also because of theft of lids. Locals should keep the vigil. A co-operative society of villagers would help. This is being taken up seriously.

The present author also discussed the problem with the kharland development authorities and suggested that some measures need to be taken to increase recharge of fresh water. The possible measures could be construction of check dams to prevent free flow of water or Kolhapur type of bund which would allow the water to flow downstream during peak rainy season but prevent its flow after cessation of rains. It was pointed out the local farmers do not have the resources for the purpose and kharland development authorities should do it as a natural concomitant. They indicated their helplessness saying that it was not their province and farmers should approach either irrigation or agricultural department for the purpose.

While there is some truth in what the kharland development agency says, a time has come to take a more comprehensive approach to development of these lands. While construction of a bund solves some problems, it creates new ones which were not visualised. It is also noteworthy that similar problems are being reported from other areas too. What is, therefore, required is to have a more comprehensive approach involving all the groups having a stake in the issue and that alone would help to arrive at a proper solution.

References

Atkinson, P. (1979), “Research Design in Ethnography”, in The Open University (ed),‘Research Methods in Education and Social Sciences – Research Design, 3B’,Milton Keynes, 43-81.

Goetz, J.P. and LeCompte, M.D. (1984), “Ethnography and Qualitative Design inEducational Research”. Academic Press, London.

Govt. of Maharashtra 91976), “Kharabhoomee Abhyasagat Ahawal”, Bombay. (1982), “Khara Bhoomee Vikas Samiteecha Ahawal”, Bombay.

Phadke, V.S. (1982), “An Analysis of the Socio-economic Characteristics of the BombayMetropolitan Region with special reference to its Rural Rimland”, Unpublished Ph.D.Thesis, Department of Geography, University of Mumbai.

Vaidyanathan, G. and Phadke, V.S. (2002), “Kharlands of Maharashtra – Their PresentStatus and Problems”, Paper Presented at the Seminar on ‘Resources of theContinental Shelves’ organised by the Society for the Indian Ocean Studies,Mumbai Chapter and Communicated for publication in the Proceeding of theSeminar.

WATER MANAGEMENT PROBLEMS OF GROWING SETTLEMENTS - A CASE STUDY OF DOMBIVLI

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The topic of the present paper is "Water Management Problems of growing settlements – a case study of Dombivli, a city in Thane District.

In the past location and development of settlement was mainly governed by physical or geographical factors, such as availability of water, land relief, sources of livelihood and social safety.

History shows large number of evidences of the settlements which developed in proximity to perennial sources of water, such as rivers, lakes, such settlements which clustered around water sources are termed as "Wet point settlements". But in due course of time development in science and technology helped to come out of the rigidity of physical factors and economic factors such as cost of land, distance from city core, availability of economic opportunities and accessibility conditions were given prime priority.

Heavy concentration of secondary and tertiary activities and the resultant clustering of population at the major metropolitan cities pressurized the residential population in the nearby areas resulting in urban sprawl or suburbanization.

Dombivli, a class I city at present is a product of same process. It is located in Kalyan Tahsil, It is at a distance of 20 km from Thane and 6 km from Kalyan and it is a railway station on central railway. It is a growing town and its vicinity to Mumbai and Thane, availability of train services from the place and availability of cheap land during the period of 1960 – 70 gave it a position of suburb of Mumbai

[Locational Map & Tabel 1.1]

Growth of population in Dombivli since 1951 – 2001

Year	Population
1951	8,106
1961	18,407
1971	51,108
2001	5,50,266

Population growth in this suburb from 1951 to 2001 suggests increasing concentration of population.

The thrust of this paper is to present the problems related to the water management of growing suburban settlements – a case study of Dombivli.

Attempt has been made to put before you some observations and possible solutions to meet with requirements of water.

The Observations are :-

1. The location of Dombivli does not appear to be suitable site for large human settlement in relation to water availability.
2. There are no perennial water sources like river or lakes.
3. As Dombivli is situated near the creek, at a height of 15 ft. above the creek level, underground water is not worth drinking as it is brackish in taste.
4. The annual rainfall averages up to 250cms which is quite sufficient to support large population, but the relief of land is such that there is no scope to natural storage as Dombivli is situated in a narrow coastal plain.

The rain water flows immediately towards the creek area. There is no land left for percolation of water due to concretization of land.

With respect to these above facts, the paper tries to explain how water management becomes unmanageable, when economic factors weighout the geographical considerations. How wrong selection of site leads to the failure of water supply in the city with phenomenal growth.

To evaluate the observations different planning authorities and citizens form different residential areas were interviewed.

The Findings are as follows :

1) a) In West Dombivli the native agricultural residents,
   b) Old Dombivli areas such as Devi Chauk, some parts of Shastri Nagar, Thakurwadi and Reti Bandar
   c) Pendse nagar, Zaran, Ram Nagar and residential areas along Agarkar and Savarkar Rd.
   d) Gograswadi & Patharli have more complaints about regular K.D.M.C. water supply.

2) a) The major complaints were related to non-availability of 24 hrs water supply.
   b) People living in multi-storied buildings do not get water with sufficient force and pressure.
   c) The quality of water is unhygienic due to leakages in drainage pipes which follow the water pipe lines.
   d) Increase in water-born diseases.

In relation to problems raised by the citizen the **Planning Authorities** were interviewed. It can be summarized as :

1] In Dombivli the water supply is obtained from River Ulhas, i.e. from –
   a) Tata Reservior at Lonawale
   b) M.I.D.C. managed Barvi Dam at Badlapur,

2] Both Kalyan Dombivli Municipal Corp. (K.D.M.C.) and M.I.D.C. supply water to K.D.M.C. areas which is more than (approximately) 227 million Ltrs. of water.

3] During 1970 – 80 the per capita supply of water was 135 Ltrs. per day. When Dombivli was included in Metropolitan class it was raised upto 150 Litres/capita/day, which is comparatively less than Mumbai and thane 220 and 250 Ltrs. respectively.

4] According to planning authorities the above mentioned required standard rate of supply the water is sufficiently available with K.D.M.C.

5] The problems related to water supply are at micro level like insufficient ground level tanks, out dated pipe lines, leakages in pipe lines, illegal connections, etc.

6] The solutions to over-come the water scarcity, construction of pump-houses, zonation of residential areas and supply water with equal pressure were adopted.

After examining the problems of citizens and arrangements made by the planners the fact emerges that in future, with the rapid rate of expansion of city, increases in population, the gap between demand for and supply of water will go on increasing. In such situation following measures can be suggested to minimize the gap.

Environmental Measures –

As there are geographical constraints such as distance, lack of hilly landscape, nature of rocks, the construction of bunds and percolation tanks is not possible.

In these circumstances, 'Roof Top Rainwater Harvesting', which is low cost and effective technique can be suggested. The rainwater from the top is diverted to surface tank or pit through a delivery system which can be later used for several purposes. Also it can be used to recharge underground aquifers by diverting the stored water to some abandoned dug wells or by using hand-pumps.

The advantages of this technique are –

a) It has little maintenance cost.

b) It improves under-water quality by dilution.

c) It helps in improving soil moisture.

d) It is also helpful in reducing soil erosion by minimizing run off water.

Administrative measures :

Administrative authorities have planned following measures :

a) To construct two major Elevated surface Reservoirs to meet with the demand from population in western part of the city.

b) Strict implementation of the supply of 150 litres water / person / day irrespective of area, so that equitable distribution of water will be possible.

c) Installation of machinery to increase the force of water.

d) Metering of water and regularization in water billing, strict recovery of water bills to lessen down the deficit in revenue.

e) To create water literacy among citizens to economize the use of water.

To conclude it can be said that adoption of environmental measures, with administrative planning, supported by high water literacy will help in diluting the intensity of problems related to water management.

WATER MANAGEMENT APPROACHES AND PARADIGMS A CASE STUDY OF AKRSP (I), AHMEDABAD, GUJARAT

Dr. K. K. Khatu[1]

Introduction

World over the water resources specialists have anticipated hard times unless measures to control misuses and abuses to water are vigorously implemented and necessary reform procedures are carefully followed by those who manage waters. India unfortunately is no exception to this very situation, as already many regions within country are experiencing the pinch of water scarcity. The development scientists of our country also expressed umpteen times, on various occasions and on political forums this very concern. Gujarat is one such state in western part of our country where water scarcity problem particularly for both human consumption and crop cultivation has always experienced inadequacy. Some of the state's water demands are supposed to be quenched by the Narmada project. Additionally many existing major, medium and minor irrigation projects in the state will hopefully act supplementary in balancing the total demands for waters. All such attempts sound fine but in reality much needs to be done, managed efficiently and made meaningful to the citizens.

Aga Khan Rural Support Programme – India, AKRSP(I) is one unique non-religious, non-profit agency (registered under u/s 25 of the Company Act, 1956) and supported by funds from Aga Khan Foundation, Ratan Tata Trust, EU, Ford Foundation and the government. Agency's mission is, '*It exists to enable the empowerment of rural communities and groups, particularly underprivileged and women, to take control over their lives and mange their environment, to create better and more equitable society'.*[1] This mission statement is evolved after the avowal made by His Highness The Aga Khan at the time of initiation of the agency in 1983. It says, '*AKRSP(I) can contribute in India to the creation of an enabling environment in which rural people can identify their needs and priorities and with professional support, organize themselves to improve the quality of their lives'.* However, it started working only in three environmentally distinct regions (See map-1) e.g. rain fed and tribal areas of south Gujarat (Bharuch, Narmada and Surat districts), drought prone areas (Surendranagar District in central Gujarat) and the coastal areas (Junagadh district in west Gujarat). The choice of these areas was governed by a simple logic that NGOs cannot replace the state, but can provide a few models of participatory actions and that too with grassroots instigated development. By working on community based natural resource management in three environmentally varied regions with influencing divergent natural resource systems, AKRSP(I) now hopes to evolve development models and approaches for replication. The agency has had sufficiently long experience of working on 'Community Management of Natural Resources (CMNR)', programme in Gujarat. However in recent times, the agency undertook the 'Sustainable Community based Approaches to Livelihoods Enhancement, SCALE', programme (2002-2012) sponsored by EU lasting for a decade.

AKRSP(I)'s approaches

No development programmes succeed unless the implementers simultaneously follow well thought approaches. In case of AKRSP(I), the community based approach is religiously followed while making

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interventions to effect development in locally strewn natural resources systems i.e. land, water and biomass. In this paper however, only water is being referred, as that has been the subject of this national conference. Various types of interventions therefore, initiated in these environmentally diverse areas are, availability of water for drinking, crop cultivation and thereby increase in productivity and replenishment of water resources wherever damages are being done. While implementing programmes, the consideration to availability of basic services, intensification in agriculture, instilling gender sensitivity and diversification in livelihoods is carefully provided. The attempts are also made to attain some kind of balance between equity and sustainability of resources. Targeting poor communities in general and the tribal - the deprived in particular have been invariably kept in focus. Moreover the gender sensitization attempts are purposefully made to bring them in the mainstream of development.

Watershed plus approach faithfully followed in hilly tracts of Bharuch and Narmada districts is to improve rural livelihoods of small and marginal tribal farmers, where rainfed agriculture is only option and the remote location of the areas generally exclude them from the development tempo. The traditional watershed treatment approach addresses only the environmental degradation and the consequent low biomass production by the appropriate physical treatment of natural resources, basically land and water. In contrast the watershed plus includes the economic interventions that ensure higher biomass production and help lead the farmers to have increased incomes. Moreover community based institutional interventions ensure sustainability by providing benefits and maintaining equity even in absence of any sophisticated external agency. AKRSP(I)'s experience showed that there is always a high value-addition by combining physical and associated interventions such as instituting capacity building, infrastructure support and marketing measures.

AKRSP(I) is determined to promote an integrated approach of rural development (including watershed plus) to enhance incomes of the poor (including tribal communities) all over the programme areas. Besides diversification of crops (promoted and controlled on the basis of water efficiency models), there has been increasing emphasis on the horticulture, floriculture and aromatic plants. Additionally special efforts are made to increase biomass availability mostly in public lands. Many of these efforts are becoming supplementary to the tribal sub-plan and other rural development schemes of the government. One of the approaches being leveraging government funds to cover larger number of farmers, the community organisations like small saving groups, Mahila Manch, farmers federations, etc., are encouraged to take lead in resolving the local problems. Mass awareness campaigns to make efficient use of water for agriculture, non-polluting already scare water resources and conservation have been the strategy followed while mitigating the local development problems.

Participatory irrigation management (PIM) was another approach very religiously followed by the agency. This concept of participatory irrigation management is to transfer management of irrigation system from the traditional mangers – the government to farmers – the beneficiaries. This calls for change in the methods, attitudes and the style of the irrigation beneficiary. The water users associations are the first step to happen in this regard. But as the associations' work proceeds the members concerned should address the associated governance problems including social components of irrigation management. Advance recovery of contributions, volumetric pricing of water, gender representation, equity issues for poor and tail-enders and resolution of water conflicts emerging out of distribution of water, etc., are the main concerns for the participatory canal irrigation management systems.

Drought coping is another approach that encompasses preparedness and therapy particularly in the areas of water scarcity like in Surendranagar district. Frequent occurrence of low and erratic monsoon in the district has practically made the lives of many farmers insecure. Recurrent uncertainties and vagaries of monsoon often made the communities to migrate to other areas of better water storages. Some times they had to migrate along with their cattle too. Therefore AKRSP(I)'s approach is to increase the resistance levels of the communities to drought situations by safeguarding and strengthening the existing water resource base. The agency believes that providing alternative means of water supplies, regulating existing water distribution and storage systems may help in redressing the situation. Moreover providing an early warning system in place can bring down the severity to the anguishes of the masses. The situation in the district was alarmingly worst in 2003, as for three consecutive years the rains disappeared from the scene. The livelihoods of the people were badly hit as the food, fodder, drinking water and employment opportunities completely vanished as if supernatural powers played a thrill.

The Junagadh district in west Gujarat has been suffering from water salinity problem. Both because of over withdrawal of ground water for the agriculture purposes and seawater ingress, the fertile areas of region have been facing problems. AKRSP(I) therefore, attempts to check the ingress of sea water (at least proposes to reduce its advance towards the landward side, and simultaneously controls the water usage by propagating efficient use of water for agriculture purposes. Additionally the agency wants to follow an approach of searching and/or building new fresh water resources in the area and thereby attempt to arrest as far as possible the ill impacts of saline waters. Recharging of groundwater is one remedy but self-imposed restrictions on overdrawing water from the aquifers could be another. This double barrel approach may help redressing in the region.

Having faced with multiple water management problems in dissimilar environmental regions, the AKRSP(I) now strongly feels that never any piecemeal approach can work. The river basin approach therefore, could be an appropriate answer to the situation. In eastern and southern parts of Gujarat, most of the rivers basins like Sabarmati, Tapti, Narmada and Damanganga are spread over much larger areas and therefore, pose problems of intervention for the development agency. Only in Saurastra region the rivers are short in length and many of the river basins are manageable. AKRSP(I) has now selected Meghal river basin in Junagadh district for an integrated water development. The approach has been of participatory development as the inhabitants on either bank of the river are on their own decided to take up necessary measures to control the water resources.

Anil Agarwal, the founder director of center for science & environment (CSE), New Delhi once stated "The Real Green Revolution is about rainwater harvesting. Let us catch water where it falls. Let it transform human lives. Let it change social existence. If this happens, the world will be transformed. The world will merely be an agglomeration of ecological-rainwater harvesting-democracies". AKRSP(I) has already accepted this very simple approach by installing roof water harvesting structures in areas of water scarcity in Surendranagar district and thus made very successful attempts to provide sensible solution to water thirsty people. Simultaneously the agency has made them to understand the importance of storing the roof rainwater and to make use of it during dry season.

This also led later in recharging the aquifers thus enabling them to reduce salinity to reasonable levels. The constant propaganda about the limited use of conjunctive use of water for various cropping patterns has also helped in arresting the salinity problem to some extent. The water intensive crops that need high and frequent doses of water are consciously discouraged in all water scarcity areas of north and west Gujarat. The policies to that effect were designed and religiously followed too. Though this is expected to happen in case of all farmers, some farmers particularly the rich and those who own large land holdings are some how remained out of beat. Therefore much work is yet to be done to bring them under the fold.

Last but not the least for effective implementation and sustainability in following the approaches, agency always relied on the community organisations that are specially promoted and facilitated over the years. Much importance is being given to the people's active participation and expressed concerns. In many places now the community organisations like Farmers Groups, Water Users Organisations, Mahila Vikas Mandals, Mahila Manchs, Federations, etc., are provided with necessary training inputs and they in turn cater their services efficiently to get the needed results. In fact AKRSP(I)'s strength now lies in sustainable community approaches for livelihoods enhancement in its all programme areas.

Gender sensitization has been a recently introduced approach, which made the people think about the drudgery that being experienced by many housewives in areas of water scarcity. The access to the drinking water facilities all through the year therefore remained the aim of many interventions. Group wells, percolation tanks, farm ponds, check dams construction and rainwater conservation, etc., have therefore kept on high priorities and the participation of people is also sought at every stage of such facilities development. This thus ensures sustainability besides giving the people a sense of confidence and self-reliance ability.

Distribution and management of water are two aspects, which are looked into at every stage of its availability for either drinking or cropping purposes. The people are constantly reminded of their share and attitude towards the water resources and thus a regular monitoring is provided whenever and wherever necessary by the intervening agency. Impacts are most desirable and rewarding as the people gradually learn and become aware of their skills, strengths and capacities. The use of modern techniques like sprinklers, drip, rotation of crops, balanced use of ground water (conjunctive use), etc., once introduced then the things start happening the way agency proposes. Thereby the farmers learn and eventually disseminate their knowledge / wisdom to other where the water problems persistently make situations intolerable and impossible.

AKRSP(I)'s Actions

The Gujarat Panchayat Act of 1993 provides constitutionally some rights and duties to the district, sub-district and village functionaries. Village-level Panchayats are concerned with social welfare, including water resources planning and drinking water. In 1995 this was specified when village-level water committees were formulated, with responsibilities including water supply, efficient use of water and payment of water taxes, maintaining infrastructure and enhancing health and hygiene awareness. In fact the community organisations are the best remedy to get resolved many of the regular problems including the water availability, accessibility, distribution, utilization and management. This used to be there in the past though on a small scale and in a few places, but over a period as the population has grown and greed has increased the people have become more self-centered, thus leaving the good customs on flipside.

The degraded ecosystem has affected the life of the residents within the micro-watersheds. There is always a scarcity of fuel, fodder and water for drinking and domestic use. The depleting vegetation cover has resulted in excessive soil erosion exposing barren rocky wastes. The steep rocky hill slopes facilitate high runoff leading to poor ground water recharge and increased siltation in the village tanks and ponds. According to the local people even today shepherds from adjoining Taluka regularly visit to graze heards of sheep and cattle. In addition to this there is the problem of direct impacts of human and livestock population. Thus a heavy pressure exists on the scarce biotic resources. The main actions suggested for development of land and water resources in the area are being implemented through sphere head groups (SHTs) of AKRSP(I) often in collaboration with community organisations specially promoted in the areas.

AKRSP(I) therefore, has been focusing on construction of check dams, percolation tanks, water harvesting structures, group wells, etc., for conservation of water on one hand, while it also focuses on promotion of micro irrigation devices like drips and sprinklers for optimum water use. To ensure equitable distribution of water there has been efforts to capacitate farmer managed canal irrigation systems and lift irrigation schemes. Along with the irrigation needs, drinking water needs of the community in general and drought prone area people are also addressed through a promotion and construction of roof water harvesting structures, revival of defunct water supply schemes, drinking wells, etc. In a nut shell AKRSP(I) main aim is to ease the tense situation with regard to water scarcity problems in various pockets of the programme areas. This is however now becoming unsustainable as the resource base of ground water is being depleted with increased irrigation. Therefore, the need to focus on water management addressing the demand side of water and integration of management of surface and ground water for optimal productive and allocation efficiency have become most urgent. Micro-watershed level planning requires a host of inter-related information to be generated and studied in relation to each other. Remotely sensed data provides valuable and up-to-date spatial information on natural resources and physical terrain parameters. Geographical Information System (GIS) with its capability of integration and analysis of spatial, multilayered information obtained in a wide variety of formats both from remote sensing and other conventional sources shall always prove to be an effective tool in planning for micro-watershed development.

Salinity Control

The Gujarat state government is constantly working on some lasting solution to the chronic water shortage in arid parts of north and southwest Gujarat. Though there is an ambitious centralized project like the Narmada dam, it yet appears to be a long cherished dream in view of many hurdles. People's participation in community-based rainwater harvesting has now begun to dispel the myth that drought is due to paucity of rain. It is in fact due to unchecked flow of storm water drains that could have been conserved and harvested. Practically every summer, both the rural and urban areas of these arid regions reel under water shortages. In the coastal areas the problem is further compounded by salinity ingress into ground water aquifers. The government machinery responds with its usual quick fix solutions by providing water through trucks and trains. While a large number of people continue to depend on the fate accompli or the government water tankers, in some areas people have begun to take the matter in their own hands. The interventions made by AKRSP(I) are by way of drip and sprinkler irrigation, conjunctive use of water, judicious and balanced of use of water both in production and domestic consumption levels, practicing water conservation measures, following the river basin development approach, etc.

Many examples of people's initiative in organizing rainwater harvesting can be seen in a few villages of Junagadh and Surendranagar districts in Gujarat. Many of the Mahila Manchs had come forward to contribute their free labour and helped construct the check dams. In a few villages the water storage and distribution works are entirely managed by such community based organisations. In Gujarat, one phenomenon that recurs with unfailing regularity is drought. Every year its arrival is signaled by the migration of hundreds of families from their villages to wherever work and wages are available, at least temporarily. These migrant families always express the sense of security when they are in the city. This situation regularly prompted many such families to leave home in December every year and stay until May in places where they get work, wages and water. They return home prior to the onset of the monsoon, hoping to start sowing their land gain. But drought drives them away again. The cycle continues until careful interventions are in place. The criticism, however, is not about the government's response to the crisis but about its total reliance on crisis management measures and failure to develop a long-term strategy to deal with the recurring droughts. It needs to collect a comprehensive information on droughts (occurrence, spread, magnitude, involved population, measures both short and long term, etc., to understand the specific developmental and intervention needs of various regions such as Junagadh, Surendranagar and other parts of northern Gujarat and promptly draw up plans and action programmes accordingly.

Water scarcity is a problem that has been worsening steadily in the state in terms of frequency and intensity. For the last couple of years, the government has been declaring some 20 out of total districts that are getting affected by water scarcity. The official figures for one sample year 2000 were 17 districts, 155 Talukas and some 9,500 villages. The state administration always attributes such deterioration to an erratic monsoon. But researchers, scientists and non-governmental organisations (NGOs) say that meteorological factors are only partially responsible for the water scarcity. The problem, they say, is a cumulative one, caused by the lack of foresight at the level of leadership in evolving a region-specific development strategy.

Though the state is experiences droughts occasionally, the government consistently ignores two problems namely poverty and the scarcity of drinking water. The government's promises to provide drinking water are difficult to be fulfilled since such promises create an atmosphere of political patronage, makes people dependent and thus kills community initiatives. It is believed by many that the droughts are being viewed as issues of abduct poverty. Therefore, the government transfers its resources to the affected through employment assurance scheme (EAS). In fact the revenue from the professional tax goes towards EAS wages. In other words essentially that income from one section is transferred to another. Thus, the government's response to the crises appears entirely of providing relief and not finding a long-term solution to the problem. It is in this context the efforts of AKRSP(I) like NGOs in seeking long term solutions are absolutely warranted. Therefore, evolving a development policy that would be specific to the region can prove to be better.

Anil Shah, chairman of the Development Support Centre (DSC), cites three factors that have aggravated water scarcity overuse of groundwater resources, unequal distribution of water and the present system of pricing of electricity and water. The depletion of groundwater resources manifests itself in a fall in the level of the water table and an increase in salinity and fluoride content. The fall in groundwater levels is a direct result of the rampant use of bore wells, which go as deep as 1,200 feet (360m). Indiscriminate drawing of water has led to an increase in salinity. Aquifers that lie 7 to 12 km inland on the Saurashtra and Kutch coasts permeate brine. In some areas, the problem is compounded by the presence of fluoride in the water. Considering the topography, the course of the rivers and their drainage and the geology of the these programme areas they are not suitable for agriculture.

Technological Breakthroughs

Drip irrigation is of recent origin. Though within country, it is being used on a limited scale in many irrigated areas mainly for coconut, coffee, grape and vegetable production, the. Systems (DIS) are extremely effective in arid and drought prone areas where water is scarce in west and north Gujarat. AKRSP(I) has therefore, propagated and encouraged many progressive farmers from a few select areas in the water scarcity areas to use this method of irrigation. As a result of subsequent, sustained efforts by AKRSP(I), the government, agricultural universities and private sector manufacturers, the use of drip irrigation systems spread through the drought prone areas of southern and western India including Gujarat. The use of DIS, however, is primarily to irrigate high value, horticultural crops with a few exceptions where the same is used for vegetable and other commercial crops. The gradual rise in the area under DIS irrigation in the past a few years is due to the significant increase in the successful use of these systems in the neighbouring states like Maharashtra.

Drip irrigation system delivers water and agrochemicals (e.g., fertilizers and pesticides) directly to the root zones of the irrigated plants at a rate best suited to meet the needs of the plants being irrigated. Thus, this system makes efficient use of water, especially when compared to conventional methods of irrigation such as furrow, border, basin and sprinkler irrigation systems, which, under arid and drought conditions, suffer from an high rate of water loss and have a low degree of water use efficiency. Drip irrigation system is gradually getting popular in the arid parts of Gujarat. The use of drip irrigation helps saving great amount of irrigation water. The water use efficiency was also much higher using the drip method of irrigation, especially when combined with the use of mulch, which effects in further saving of irrigation water. Unlike at Dapoli in the Konkan Region of Maharashtra State, where despite an annual rainfall of about 3000 mm, the period between December and May is often a time of severe drought, drip irrigation systems were used to irrigate mango and cashew crops, in Junagadh too people had willingly opted for the drip irrigation for horticulture crops. Thus the situation is fast changing for the better.

The principle operation and maintenance requirements associated with the implementation of this technology include the need for regular cleaning of the system and careful monitoring of the quality of the source water, as the drip irrigation systems are very sensitive to the clogging of the drippers. The system also requires a relatively high degree of skill to design, install and operate, and are susceptible to theft, damage and disruption by rodents that destroy the drip pipes and drippers. The use of this technology requires skilled personnel. AKRSP(I) has therefore, formally trained select young farmers in these operations and thus helped them to be self-reliant. Because of the relatively high capital cost of the piping systems necessary to implement this technology, the initial funding for the project requires some subsidy. However, regular operation and maintenance of the system is the responsibility of the individual operator. AKRSP(I) has made special arrangements with the government for necessary subsidy and also encouraged the concerned production company to make necessary changes in design to suit the costs to the pockets of large number of farmers. This was necessary as the capital costs involved in the establishment of a drip irrigation system are high compared to the costs of establishing conventional irrigation systems. However, the labour requirements and operational costs are low. The net result is that the benefit-cost ratio for DIS is very favourable compared to conventional systems since the payback period for investment is short. Another advantage of drip irrigation systems includes a high efficiency of water use and greater crop yields compared to other irrigation methods. The lower labour requirements result in relatively low operational costs, with savings in labour cost otherwise associated with conventional systems.

Water policies

Gujarat has been gradually learning lessons from recurrent droughts and other water storage, distribution and utilization problems. The state government is well aware now for tackling the water problems. However the concerns have been expressed over the lack of a comprehensive water policy. The recent Jal Disha document is in fact an outcome of such concerns. Gujarat is well aware of heading for an ecological disaster unless some concrete measures are not put in place and made obligatory for the water users. It's not uncommon for a tropical country like India to experience droughts related to monsoon failures. What is alarming about the recent droughts in Gujarat is that they are related to hydrological factors, where even drinking water becomes unavailable for a vast section of the people not directly dependent on agriculture. Surface and ground water resources had been exploited to provide water for consumption and for other household chores. No attempts were made to control the unrestricted use of water particularly by rich farmers and the industrial complexes. According to official sources, many of the irrigation tanks and reservoirs in west and north Gujarat go dry every alternate year. This trend is different from the earlier droughts in Gujarat when lack of rains led to crop failure, which in turn resulted in food scarcity. Intermittently having monsoon failures over past a few years had led to a 'hydrological drought', throwing a big chunk of the state's population into a drinking water crisis. The government's approach has been to manage drinking water supply from other areas and provide subsistence wages to the rural poor by way of relief work. The water of Narmada is expected to give a great relief. But time alone will prove it or disprove it. It is not economical and sustainable solution to transport drinking water over large distances on a permanent basis. To find a permanent solution to the crisis, the orientation, approach and implementation of the water policy needs to be changed. NGOs like AKRSP(I) has been making very conscious efforts and trying to take an approach that may help resolve the problem in future. Therefore, in this very context the community based approach undertaken by AKRSP(I) and introduction of innovative methods of water conservation are more appropriate and become quite sustainable. It is not alone the development of water resources but also its management is important.

Water Advocacies & Water perspectives

Considering the prospects of water development – a scenario of 2025 in the state, one may like draw the attention towards following suggestions; a. accord a policy-level recognition to traditional sources of water such as Talavs (lakes, tanks), virdas (shallow holes into which groundwater seeps and is collected for drinking) and vavs (stepped wells), b. construct a chain of check dams and storage dams for harvesting water at the village level, c. modify the present structure of property rights over groundwater, d. set a limit to the depth of bore wells, e. monitor groundwater levels, f. prevent people from using a well if the water level goes below a stipulated depth, g. encourage drilling of community bore wells, h. fix power tariffs on a pro rata basis, i. adopt an extension and innovative approaches in irrigation, j. adopt dry farming methods and alternating cropping patterns, and k. alter the pricing policy for agriculture so that people follow less water intensive crops.

Table : 2 West flowing medium river basins of Gujarat

S. No.	Name of the River	Village/Distt. (Origin)	State	Length (Km.)	Catchment Area (Sq. Km)
2	Shetrunji	Dalkania	Gujarat	182	5514
3	Bhadar	Rajkot	Gujarat	198	7094
4	Aji	Rajkot	Gujarat	106	2139
5	Dhadhar	Panchmahal	Gujarat	135	2770
6	Dammanganga	Nasik	Gujarat-Maharashtra	143	2357

Source: Web page

Table: 3 Drinking water availability

India & Neighbouring states of Gujarat		Percentage of households having drinking water availability								
Discription		Within Premises			Near premises			Away from premises		
Type		Total	Rural	Urban	Total	Rural	Urban	Total	Rural	Urban
1	India	39.0	28.7	65.4	44.3	51.8	25.2	16.7	19.5	9.4
2	Rajastan	32.9	19.8	75.8	43.3	51.6	16.0	23.8	28.6	8.2
3	M. Pradesh	24.6	14.0	55.2	51.2	58.7	29.5	24.2	27.3	15.3
4	**Gujarat**	**46.5**	**29.2**	**73.5**	**38.3**	**50.0**	**20.0**	**15.2**	**20.8**	**6.5**
5	Maharashtra	53.4	38.9	73.2	34.3	43.9	21.1	12.3	17.2	5.7

Source: Census of Gujarat 2001

MUMBAI'S WATER SOURCES, SUPPLY AND MANAGEMENT

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The city of Mumbai was originally a cluster of seven islands inhabited by fishermen. In 1534 Mumbai was handed over to the Portuguese who offered it as dowry to Charles II of England in May 1664. in 1668, the East India Company took over Mumbai & started developing it as base of their commercial activities Land reclamation was started.

The residents drew water from wells & tanks, which were inadequate for the growing needs. Search for a suitable site for impounding the monsoon runoff was started in 1845. The site existed away from the Island City. Right from the first day of Piped water supply, long conveyance system bringing water by gravity have remained the characteristics of Mumbai water supply.

Mumbai's water supply system is unique and complex. The water supply system has grown over the last 130 years and it is amongst the eight largest water systems of the world.

The main function of the water supply Project department is to plan, design, execute and commission the infrastructure such as dams, weirs, convene system, pumping facilities treatment plants, high level storage reservoirs major distributary water mains etc.

Vehar Lake Scheme

It is the Mumbai's first piped water supply scheme commissioned in 1860. the valley at the origin of river Mithi located near village Vihar was chosen for creating an impoundage to collect runoff and serve as a source of water. Three earthen dams and stone masonry overflow section were constructed. The impoundage is called as Vehar Lake. A pipeline of diameter 1200 mm of cast iron pipe carried water supply of 32 million liters per day (mld) to a population of 700 thousand. During the year 1872, the height of this dam was raised and the water supply through the lake was increased to 68 mld. The Scheme is still in operation.

Tulsi Lake.

It was decided in the year 1885 to develop Tansa as the next source of water supply. Meanwhile, a critical situation of water storage arose and led to the immediate of development Tulsi Lake, upstream side of Vehar Lake on the river Mithi. The scheme consisted of an earthen damned a necessary dam and a 600-mm diameter pipeline to carry 18 mld water to the services reservoir at Malbar Hill. A Slow sand filter were constructed at service reservoir and subsequently shifted to the site near the lake. the Scheme is still in operation.

Powai Scheme

Powai Scheme was taken up on a tributary of Mithi river, as an emergency = measures to mitigate the anticipated water famine in 1891, this has added the water supply by 4 mld. However due to the inferior quality of water from the catchment, water is nowadays supplied to Aarey Milk Colony for washing and agricultural purpose.

Tansa Scheme

In 1886, it was decided to tap river Tansa situated about 110 km to the north of the city. The potential of Tansa was so large that it satisfied the needs of the city for nearly five decades. This source was developed in 4 stages. The 1st stage was completed in 1892, by constructing a masonry dam. Water was conveyed through closed masonry aqueduct in the hilly region and through 1200-mm diameter cast iron pipeline in valley portions, 77mld supply was added to the city.

During the 2nd stage to Tansa Scheme in the year 1915 additional pipeline of 1250mm diameter was lard in the Valley portion for conveying increased water supply of 82 mld.

In the 3rd stage. It is popularly known as Tansa. Duplicate works, the was raised to increased the storage capacity. 2 meld steel pipelines of 1800 mm diameter were laid along the shorter route between the source and the city. These pipes crossed Tank Creek over a steel bridge at Kasheli, which also carries road traffic along Mumbai Agra Road (NH.3). These works were completed in the year 1925 and the city water supply was increased by 68 mld.

The 4th stage of Tansa Scheme was completed in the year 1948 when the storage capacity was increased by providing 38 floodgates. The dam was also strengthened by providing pre-stressed anchors through the body of the dam.

The water supply has been further increased by 181 mld. After completion of Tansa work city was getting 194 mld of water for the population of about 2 million.

- A 2800 meter long masonry dam was constructed across rive Tansa.
- The impoundage thus created was utilized by constructing a 42 km long closed masonry aqueduct in the hilly region.
- A 53 km long 1200-mm dia pipeline through the valleys, conveying water right upto the heart of the city.Tulsi Lake.
- Elevation of this distant source was so high that 77 mld water flowed from the dam to the city by force of gravity.

Vaitarna Scheme

After Independence, Mumbai stood poised for unprecedented industrial and commercial growth. The Vaitarna cum Tansa Scheme was conceived planned and executed to meet the increased water demand by a team of Municipal engineers under the able guidance of Late N V Modak. The impoundage on Vaitarna was names “Modak Sagar” by the corporation in the memory of his valuable services.

- Construction of a 90 mtr high and 50 m long concrete dam across river Vaitarna.
- First concrete gravity dam, using precooked control concrete.
- Construction of 7.2 km long tunnel between Vaitarna and Tansa.
- Laying of 2400 mm diameter pipeline from Tansa to the city for a length of 76 km
- This pipeline in these days, was the largest and longest pipeline of this type ever laid in the world.
- On its completion in 1957, this scheme brought additional 490 mld of water supply to the city.=20

Upper Vaitarna Scheme

This scheme was executed by the Govt. of Maharashtra as a hydro electric cum water supply scheme. The work completed in 1972, made available additional 544 mld of water supply to the city.

Upper Vaitarna Water. After generation of power, was released into the river course which flowed into Modak Sagar and ten conveyed to the city. A pipeline of 3200 > 2750 > 2400 mm diameter was laid by the corporation.

Tunnel to carry water across the Thane Creek was bored to carry the entire water supply under the creek. Another tunnel known as Mulund Kandivli tunnel was constructed through the hills of the Borivli National Park for the growing suburbs in western parts of the city.

Upto this time, it was a unique features of Mumbai's Water Supply that it was entirely by gravity -and that the catchments of Tansa, lower Vaitarna and upper Vaitarna dam were so protected that the water hardly needed filtration. Only chlorination was done to ensure disinfections of water.

Despite the water supply schemes mentioned so far, large-scale storage in water supply started arising towards the end of 1960's - followed by the rapid rate of growth of population during 60s. A master plan was prepared for integrated development of water supply and sewerage Project, was planned to be implemented in 3 phases.

Each of these 3 phases envisaged additional water supply of 455 mld to drawn from Bhatsa river. This project was taken up in 1974-7, involved abstraction of water from a small impoundage created by constructing created by constructing a were at village Pise, 48 km downstream of the Bhatsa Dam. The project envisaged construction of piping, treatment and conveyance facilities at Pise, Panjarpore and Bhandup. The 1st two stages of the project were commissioned in 1981 and 1989 respectively.

Stage I comprised construction of weir of Pise, a structure to house 7 pumps each of 90mld capacity and a 2235 mm diameter steel main to convey raw water to Panjarpore where it is clarified water is pumped into the Vaitarna mains near Village Yewai. The blended water carried through the old mains in delivered through a tunnel to Bhandup where a major water treatment cum pumping cum reservoir complex was set up.

Bhandup Complex

➢ It was established in 1978.

➢ To provide for full two stage treatment to 1910 mld of water.

➢ It was at that time the largest treatment plant in Asia.

➢ It includes plant for pumping the filtered water to master Balancing Reservoir (MBR) of 246 ml capacity

➢ MBR feeds all the service reservoir in the city and suburbs by gravity.

➢ This stage was commissioned in 1981, taking the city's water Supply to 1983 mld.

Stage II

Comprised expansion of the pumping station at Pise construction of pre chlorination plant at Pise. Laying of 2235 mm pipeline from Pise to Panjarpore, Construction of MBR II of 130ml at Yewai hills and laying of 48 km long 2345 mm diameter transmission main.

In addition 2 tunnels of 3000 mm diameter one across Thane Creek and another between race Course and Malbar hill Reservoirs were constructed. This stage was commissioned in 1989, augmenting the city's water supply to total of 2438 mld.

Stage III

Envisages the provision of additional pumps at Pise and Panjarpore, laying of 2235 mm diameter pipeline from Pise to Panjarpore, complete two stage treatment of plant at Panjarpore and laying of 31 mm of 3000 mm diameter of pipeline between MBR II at Yewai and Bhandup. The total water supply reach 2890 mld.

The Distribution System

It comprises 26 service reservoirs of different types constructed at different periods of time. The network of water mains has total length of about 2400 km and diameter varying from 80 mm to 1800 mm laid over the last 136 years.

The entire water distribution network of Mumbai is divided into 106 water Supply Zones. Fed by 26 service reservoirs.

Each zone is fed for limited hours as the demand is more than the supply. Supply from each reservoir is continuously monitored by the 3 local control stations located in South, West and eastern parts (Babulla Tank- South, Ghatkopar Station-Eastern, Parle Control Station- Western) of the city. They also record consumer complaints and coordinate the supply during modifications and maintenance activities.

The master control station is located at Bhandup Complex.- it does the budgeting of the available water supply from different sources, monitors the inputs, outputs at the filtration plants and regulates the flow from MBRs to Service reservoirs.

The network of water mains for each of the zones is analysed on computer.

- *The internal tuberculation in water mains and leakages through cracks in pipes, pipe joints often led to complaints regarding reduced pressure and contamination.
- With intermittent supply every source of leakage during water supply hours becomes a source of contamination during non supply hours due to high sub surd water table and backflow from consumer service connections.
- The roads in the city are narrow and crammed with other utilities. Replacement of the existing mains or laying additional mains under these roads is a difficult task.
- In order to solve these problems without interrupting the daily water supply. The technique of cleaning and internal cement mortar lining of small diameter water mains appeared o be most suitable. The cleaning removes the internal tuberculation and the mortar lining provides a smooth internal surface. The leakage through the pipes or joints are plugged.

Water quality monitoring - for monitoring the quality of raw and treated water, laboratories equipped with modern equipments have been set up at the treatment plants. These labs monitor the physical, chemical and bacteriological parameter continuously.

About 900 samples / month are collected from various sampling points in the distribution system for analysis and monitoring.The defected leak points are rectified and a sample is taken again. With the help of the epidemic-logical section of the Health Department of the Municipal Corporation, the areas reporting large number of cases of water borne diseases are identified. The water mains are flushed through hydrants and water supply id rechlorinated by mobile Chlorinators.

Future Projects

The present trend in growth of population indicates that by the year 2021, the population in Mumbai will stabilized at around 150 million. The water demand will be around 5400 mld. To meet this demand, the Govt. of Maharashtra has been requested to alloacate the resources for meeting further needs of Mumbai.

Due to unplanned population growth and the migration to the Indian cities, the current water scenario in every Indian city including Mumbai is quite alarming. Mumbai caters to 12 million resident and another 2 million floating population. The BMC's capacity to supply is only 2900 million liters a day (MLD), whereas the demand is more than 3400 MLD, leaving a gap of 500 MLD. This gap could increase further with the increase in population. With phenomenal growth in population the pressure on water resources has intensified. Per capita availability of water has plummeted from 5000 cubic meters per annum in 1955, to less than 2000 cubic meters today. Increased demand for water from agriculture, domestic and industrial, will only worsen the situation. An alternate water management technique is the need of the hour for better use of water resources.

The present paper makes an attempt to the address the existing problem of water management in urban and rural areas and explores the possibilities of reviving traditional water management skills and implementing the same according to the specific needs of the area

Rain Water Harvesting

Rainwater is free source nearly poor water. It can be used for potable and non-potable use. But for potable uses rainwater must be treated to remove disease-causing germs. Today in many parts of the world, including Hawaii and the entire continent of Australia promote rainwater as the principal means of supplying household water. In Hong Kong, rainwater is collected from skyscrapers to supply water for their domestic use. Sri Lanka has a long-standing tradition of harvesting rain by using palm leaves, tree trunks and rocks. Water is captured from rooftops through a variety of gutters. Rainwater harvesting experiences in Anuradhapura district indicate that the household collects rainwater not because of lack of drinking water, but because of the better quality of water. In Japan nearly 500 buildings in Tokyo, have installed rainwater-harvesting system. The government offers subsidies for each rainwater project. China has been successful in large-scale rainwater harvesting and the potential is vast in this area. Now there an increasing awareness among Chinese to use rainwater for domestic use and several programmers are underway across the country. Singapore harvests the rain that falls on most of its land despite industrialization.

Rainwater harvesting is essential because surface water is inadequate to meet our demands and we have to depend on groundwater. Considering the increased need for more water in a city like Mumbai, it is necessary that some thoughts be given to tap the rainwater to augment the water resources. In Mumbai where the ground surface is heavily concretized the main way to harvest rainwater is to tap the rainwater falling on the terrace of the buildings. The aim is to prevent this water from running off in BMC's drain and diver it to bore wells that will take it beneath the ground. Thus in residential or commercial buildings the pipes on the terraces should be connected to a bore well. This process is termed 'recharging' the groundwater. In the city of Mumbai, an area of 437 sq. km. with an average rainfall of 2000 mm has the potential for harvesting 2394.92 MLD of water. Even if we collect only 70% of the water falling over rooftops, in that area, 589.34 MLD of rainwater can be harvested.

The earth absorbs Rainwater falling on the ground and it constitutes the groundwater. This water is stored amidst the loose soil and hard rocks beneath earth's surface just as sponge stores water. And just as water can be sucked out of a sponge, so can groundwater sucked out from beneath the earth through bore wells. Since the water cannot pass through concretized surface one needs to develop techniques that can make the rainwater seep into the earth.

There are two main techniques of rain water harvesting

- Storage of rainwater on surface
- Recharge to the ground

The storage of rainwater on surface is a traditional technique and structures used were underground tanks, ponds, check dams etc. Recharge to the ground water is a new concept of harvesting and the structures generally used are pits, trenches, dug wells, hand pumps, recharge wells, recharge shafts, lateral shafts with bore wells etc

Free flow of storm runoff into the tanks and water bodies must be ensured. The storm run off may be diverted into the nearest tanks or depression, which will create additional recharge. Methods of artificial recharge in urban areas include water spreading, recharge through pits, trenches, wells, and shafts etc., rooftop collection of rainwater and induced recharge from surface water bodies.

It has become necessary to revive community and household management of water. It is only by mobilizing people as well as enacting the legislation that promote water harvesting can these aims be met with. In order to achieve this efforts should be people-oriented. A survey of developments shows that numerous projects have been undertaken to local water harvesting both in rural and urban areas. Certain state governments like Gujarat and Madhya Pradesh have begun encouraging rainwater harvesting. To promote rainwater harvesting in urban areas, where it can help to increase water supply, measures have to be taken to recharge groundwater and reduce storm water runoff. All steps must be taken to educate the people and to spread the message that water is a precious natural resource.

State governments should provide the necessary technical and financial assistance to communities and household to implement the rainwater harvesting system. All building plans should provide for water harvesting and builders and planners should be given clear technical guidelines. Also awareness should be created among general public the benefit and concept of rainwater harvesting. Since October 2002, BMC has made it mandatory for all new constructions covering an area of more than 1000 sq meters to install rainwater-harvesting system that will tap the terrace water and make it flow to a bore well. Though BMC has made it mandatory for all new construction in Mumbai to install rainwater harvesting system, it has not got the sufficient attention it deserves from the builders and developers and the general public.

Privatization of Water

People need to have access to fresh and clean drinking water in order to stay alive and healthy. The importance of the availability water will be felt more and more in the future, as water scarcity increases all over the world. For this reason alone water can be called as ‘oil of the 21st century’. Many private companies who are looking for avenues for expanding their business would like to capitalize this ‘future oil boom’. These companies especially multinationals exploit the water shortage in the country to their advantage and increase their profit. They are more concerned with profit making than caring for the people. Despite the problem that the city is facing because of lack of clean and drinking water more and more private companies are encouraged to do business. In a city like Mumbai sale of bottled drinking water (manufactured by private companies) is very uncommon till recently. But today it has become a reality. In Mumbai people depend on government and municipality to provide clean and fresh drinking water at an affordable rate. But by privatization of water people will be forced to pay more for the water to benefit the private companies. The policy of provision of water by government worldwide should be linked to the policy of poverty and education.

Privatization will benefit more foreigners than local population, which may face the problem of loss of jobs, as private companies are more concerned with the profits than providing employment to the local people.

Privatization will endanger the environment as a result of bulk water export. Private companies will try to acquire the ground water for their business and sell elsewhere where it would fetch them good profits. The agitation of the local villagers against the Coca Cola bottling plant in the village of Plachimada in Kerala highlights this important issue of treating public resources as commodities to be exploited for profits by a private company. The bottling plant of the Hindustan Coca Cola Ltd. is on 38 acres of land, a major portion of which was formerly under paddy cultivation. The company is extracting four to six lakhs of water daily to produce various brands of soft drinks. The tribals as well as the farmers in the neighbourhood complain that the water levels in their wells have fallen drastically over the last three years. The groundwater extracted from the premises is thus utilized for commercial gain by the private company. The social activist Ms. Medha Patkar joined villagers in their agitation against the company.

Similarly the local adivasi population in Vada in Thane district has access only to slushy water from the Vaitarna River as their local fresh water source is diverted to the Coke-Kinley factory to make bottled water for the affording city population. This emphasizes the fact that public resources like groundwater and river water should not be exploited as commodities for gains. There is an increased risk of corruption due to the commercialization to water supply and operation.

Reference

M.C.G.M. – Department – Water supply projects

Times of India – November, December 2004

Website www. mcgm.gov.in

'Parisar Varta' Pune

Survey of Environment –2003, The Hindu Publication

"Human Scape" May 2004, Published by Foundation for Humanisation –Mumbai –54

"Down to Earth" Science and Environment Fortnightly, Various Issues

Times of India, March 22, 20041

Source: Texas Natural Resource Conservation Commission March 2004

Advantages of using rainwater

- Rainwater promotes self-sufficiency
- It promotes water conservation
- It also helps in conserving energy as the energy input needed to operate a centralized water system is bypassed.
- Reduces strains on Municipal water supply
- Rainwater is one of the purest sources of water available. It's quality almost always exceeds that of ground or surface water. It does not come into contact with soil or rocks where it can dissolve minerals and salts nor does it come into contact with many of the pollutants that are often discharged into local surface waters or contaminate ground water supplies.
- Rainwater is soft. It can significantly lower the quantity of detergents and soaps needed for cleaning. Soap scum and hardness deposits do not occur. There is no need for a water softener. Water heaters and pipes are free of the deposits caused by hard water and should last longer.

WATER CONSERVATION –
CASE STUDY OF A MICRO LEVEL PROJECT

Mrs. Bharati Unni

Water is a very essential resource and it is necessary for the well being of the societies all over the world. Though the nearly 71 % of the earth is covered with water, today world is facing acute shortage of water. Many conflicts between different regions, states and countries are occurring mainly due to the question of their share of water.

"There is a clash between two cultures. A culture that sees water sacred and treats its provision as a duty for the preservation of life and another that sees water as a commodity and it's ownership and trade as fundamental corporate rights"

- Vandana Shiva

India is likely to fall in the water stressed category, before 2025. The problem of water is not necessary due to the population growth alone, it is also because of the excessive and unplanned use of water. Deforestation and mining have destroyed the ability of water catchments to retain water.

The present study is an attempt to highlight the micro level project implemented by an individual who had a wide vision and could perceive the social and economic problem of the tribals living in remote areas.

Waliv is a village in Vasai taluka of Thane district. It is situated along the foothill and slopes of the offshoots of Western Ghats

The area under study was 36 acres of barren unproductive, stony hilly land which was gifted to renowned Dr. Samant by government for development of a leprosy hospital.

This land was taken up as a challenge by Doctor.

Due to his strong will power and determination, he has been successful in converting this unproductive barren land into a productive forested land. In the year 1971 the land was surveyed by geologist. Contour mapping was done; experts in the field of agro climate and botany were consulted. Experts were consulted for the identification of underground water spots. On the basis of guidelines given by the experts. The process of implementation started, initially at a slow pace.

Initially a few trees were planted along the slopes of the hill mainly Subabul, teak, eucalyptus and bamboos were planted. After realizing that eucalyptus could have a negative impact on the soil, new plantations of eucalyptus were curbed. Simultaneously at the foot of the hill where one of the underground water spots was identified, a huge well was dug.

In this process of construction of well and tree plantation, the tribal communities from the neighbouring villages were involved. In other words employment was created for the tribals.

The next stage was of preparation of level plots for agriculture. Every year two to three plots were added. It being a rocky area it was a difficult task. The stones and the rocks were used for construction of well and bunds. The lands leveled were maintained with the help of bunds – first stones were laid and then mud was spread to make them strong.

This water from the well was used for the inmates in the hospital {about 100} and for the garden. Two more wells were constructed at the foot hill region. One was used for irrigating the land and the other for dairying purpose. From a few cows there are about 30 cows today. An area which was deficit and the people living there had to buy food grains is now independent producing food grains and vegetables and also selling the surplus food grains.

Dairying has also added income of the community. The tribal from the neighbouring villages have got employment throughout the year. In addition to this the contribution of the community living in the hospital towards development is tremendous. The leaves falling on the ground added biomass. Grass also, started growing in large quantity. This solved the problem of fodder. The cow dung mixed with this hay was used as organic manure. Bamboo and teak wood worth lakhs of Rs. have grown on this, once upon a time barren land. Even firewood is available from this forest. A gobber gas plant was installed. The area which had nothing, has now been able to feed hundred inmates in the hospital and also a large number of villagers (tribals) have got employment in this land.

There are many gullies dug, several channels were dug to carry water to the huge trenches dug at the lower level of the slopes. This increased the water in the area, the huge depression (trenches) dug at the foot of the hill contain water which can be used for atleast three to four months of the year. One of the trenches contain water for almost 8 to 9 months of the year due to its strong storage base. Every year more trees are added hence the recharging of water has started. Now the underground water has increased and the neghbouring lands have started getting water in large quantity.

In the above project the NSS volunteers of our college are involved since 1984 – 85 . They participated in 'shramadan'. The intention of involving youth in the project is to create environmental awareness and sense of responsibility, towards our nation.

Though this is a micro level project that has been studied, it may be concluded that if more and more people take a lead in similar micro level projects in their local environment, which they know best, then the vast stretches of barren land can be converted into agriculturally productive land / forest land just in about two decades. Here Dr. Jagdish Samant (a great social worker) has seen water as sacred and treated its provision as a duty for the preservation of life – he was supported by local tribal community, hospital inmates, the donors and many voluntary organizations.

WHERE THERE IS A WILL THERE IS A WAY!