

CHAPTER III:
WATER
AVAILABILITY
AND ITS USES

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"There is only so much of it circulating in nature and there is no more... Through the history the water cycle has served humans as the model of the natural world. Early civilizations saw in it a figure of the basic pattern of life, the cycle of birth, death and return to the source of being. More recently science has added to the ancient religious metaphor a new perception: the movement of water in an unending undiminished loop can stand as a model for understanding the entire economy of the nature.¹

Water has been the most important natural resource upon which all kinds of life forms depend. Only one percent water constitute as fresh water in the forms of the rivers, ponds, lakes etc. It is this negligible amount of water that sustains all forms of terrestrial and aquatic life on land.

The primary importance of water to the humans is that it satisfies basic household needs (drinking, cooking, washing, etc.) and economic needs. This is because water has multiplier effects on both agricultural and non agricultural activities. In agriculture water is not just another input, but a necessary means of production without which primary production is impossible. Water also plays a critical role in maintaining ecological balances; sustainability of water supplies is important for sustainability of the ecosystem (explained in the chapter V). Control over water also helps to determine social and political power at all levels².

Human occupations and migrations have been closely linked to climatic

¹ D.Worester, *Thinking Like a River*, in W. Jackson (ed), *Meeting the Expectations of the Land*. Northpoint Press, San Francisco, pg. 57

² Wood, Geoffrey, Palmer-Jones, Ahmed, Mandal and Dutta, *The Water Sellers: A Cooperative Venture by the Rural Poor*, 1990, Connecticut, p 3.

changes throughout known records³. Climate has had distinct impacts on human society and its evolutionary dynamics. For instance, it has been suggested that increased aridity in Africa led to the eventual rise of arid – adapted hominids and their migration to regions with more conducive climate regimes⁴. Human response to climate primarily arises due to changes in regional hydrology, i.e. an assured availability of water. Rather water availability appears to be the main reason for all ancient human civilizations to grow and flourish along major perennial river systems. For instance, civilizations in Egypt, Mesopotamia, India and China, all developed along perennially flowing Nile, Tigris-Euphrates, Indus and Hwang Ho rivers systems respectively.

Recent palaeolimatic, archaeological, and historical evidences across regions suggest considerable human adaptations, dispersal, and population dislocation, cyclic spatial and demographic reorganization such as abandonment and expansion, and human migrations due to climatic inducements⁵.

Besides dependence on natural hydrology humans slowly developed water storage systems to suit their needs. The excavations of the Indus valley civilization (3000 B.C. to 1500 B.C.), sites- Harappa and Mohanjodaro reveal the prevalence of a water harvesting system. Wells have been found at most house sites. Over seven hundred wells have been estimated.⁶ Excavations at Allahadino, a small Harappan settlement near Karachi, have revealed a well, which may have been used for

³ For details see- Meze, E., Migration caused by climatic change: How vulnerable are people in dryland areas?, *Mitigating Adaption Strategies for Global Changes*, no. 4, 2004, pp379-406

⁴ De Menocal P., Plio-Pleistocene African climate. *Science*, 1995, 270, pp.53-59

⁵ Gupta, Anderson, Pandey, and Singvi, Adaptation and human migration, and evidence of agriculture coincident with changes in the Indian summer monsoon during the Holocene. *Current Science*, vol. 90. no. 8. 25th April, pp 1082-1090.

⁶ Shereen Ratnakar *The end of a great Harappan Tradition*, Manohar publications, New Delhi, 200, pg.84

irrigation. The well stood at 1.25m higher than surrounding area, which was paved with stones.⁷ The excavators were of the opinion that the diameter of the Harappan wells was purposely kept small "so that the water level could rise higher and would overflow in an artesian fashion"⁸. These can therefore, be taken to the earliest wells of their kind. Historians hold the opinion that the Harappans must have had some method of irrigation because they cultivated winter crops like wheat and Barley⁹. This water could have come from the wells.

Dholvira, a major site of the Indus valley civilization dating back to the third millennium B.C. is located in the great Rann of Kutch in Gujarat. Being located in the arid area, there were perhaps no perennial sources of water in the forms of lakes and rivers. The inhabitants of Dholvira therefore created several reservoirs to collect the Monsoon runoff water flowing in the flanking streams of Manhar and Mansar. Stone bunds were raised across them at suitable points in order to divert the flow of water through inlet channels into a series of reservoirs, which were dug out in the sloping areas between the inner, and the outer walls of the Harappan city of Dholvira¹⁰. Water reservoirs were separated from each other by bund-cum-causeways, which facilitated access to different divisions of the city. A network of drains crisscrossing the citadel was also laid out to collect rainwater. In the times of scanty rainfall, the causeways enabled the water to get stored in the selected tanks. Most of the drains intersected each other and finally joined an arterial drain¹¹. Thus the entire system was set up to optimize conservation of available rainwater in the city. (See map IIIA for various ancient hydraulic structures of the Indian subcontinent).

⁷ Sunita Narain, and Anil Agarwal, *Dying Wisdom: Rise, Fall and Potential of India's Traditional Water Harvesting systems*, New Delhi, 1997, pg.19

⁸ *ibid*, pg.19

⁹ Shereen Ratnakar, *An aspect of Harappan Agricultural production*, *Studies in History*, vol.II, 1986, pp.137-153

¹⁰ *Dying Wisdom*, pg.19

¹¹ J.P. Joshi and R.S. Bhist, *India and the Indus Valley Civilization*, New Delhi, 1994, pg.31

The use of irrigation facilities by agricultural societies during the Vedic period was concretely textualised. There are references to artificial waterways- *kulya* and *khanitrima apah*- in Rigveda. These perhaps referred to the irrigation channels. The other expressions used for the same device were *Sushira* and *Soormi*. Lifting devices to draw water from the wells were also in use, called '*ansatrankosha*' and '*ashmchakra*'. These were probably made up of a leather bucket drawn over a pulley for lifting water from the wells. Rigveda also contain many notes on irrigated agriculture, river courses and dykes. The Chandogya, one of the principal Upanishads (the philosophical reflections of the Vedas, numbering 108 in all), points out¹²:

"The rivers...all discharge their waters into the sea.
They lead from sea to sea; the clouds raise them to
the sky as vapour and release them in the form of
rain..."

This is probably the oldest reference to natural processes within the hydrological cycle. It shows that as early as about 1000 B.C. attempts were being made to interpret and explain recurrent natural phenomena on the basis of direct experience.

Kautilya, the author of Arthashastra had realised the value of water in the expansion of agriculture and the subsequent benefit to the kingdom in the form of enhanced land revenue. Mauryans, the founder of one of the earliest empires in India attached special importance to water resources.

In the chapter entitled, 'The Activity of Heads of Department', Kautilya regarding the duties of the citizen, mentions¹³:

¹² *Dying Wisdom*, pg.13

¹³ *ibid*, pg.42

"He should build irrigation systems with natural water resources or with water to be brought in from elsewhere. To others who are building these, he should render aid with lands, roads, trees and implements and also give aid to the building of holy places and parks. If one does not participate in the joint building of an irrigation works, his labourers and bullocks should be made to do his share of works and he should share the expenses but will not receive any benefits from it. The ownership of the fish, ducks and green vegetables in the irrigation works should go to the king".

In another chapter, concerning the judges, he says¹⁴,

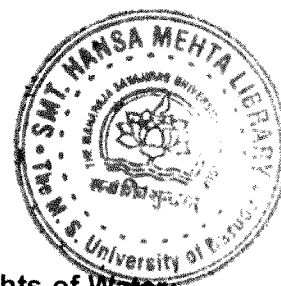
"In case of damage to the ploughing or seeds in another's field by the use of a reservoir, channels or a field under water, they shall pay compensation in accordance with the damage".

"Owners may give water in return for a share of a produce of various kinds from the sowing in the fields, parks and gardens watered by their dug out channels, structures based on rivers or tanks, or to others as it may be advantageous. And people, who use them on lease, shall keep them in repair. In case of failure to repair, the fine is double the loss."

The terms used in the original text relating to water harvesting systems are several - '*setu*' for embankment or dam for storing water; '*parivaha*' for channel; '*tataka*' for tank; '*nibandhayatana*' for canals from a river dam; and '*khata*' for a well.

A few more interesting points emerge from the Kautilya's Arthashastra. The land on which the tank was built was a state owned property and punishment was prescribed for a person who failed to co-operate in the building of an irrigated works. Similarly, fines were imposed for the damage to the embankments, or flooding of the lower tank by a tank constructed at a higher level.

¹⁴ *ibid*, pg.43



Political Economy of Ownership, Management, and Rights of Water

There are diverse opinions on whether water should be viewed as a need, a right or a commodity. How water is perceived in a particular context-as a common pool resource or an economic need –has ramifications on its governance. Its ownership, maintenance and uses define social relationships as well as economic and power equations in a given society. Recent studies indicate that rules of ownership determine how water will be shared; marketed; and managed.

In ancient times when the people traveled in groups, whoever discovered or possessed a particular piece of land first or cleared it for agriculture was believed to have a right to it and to any property (land and water).

This principle of discovery automatically led to the evolution of “riparian rights”. These refer to the rights of the landowner to use the water adjacent to or flowing through his property. A riparian owner had the right to use water for certain specific purposes such as, for drinking and irrigation. However he could not deny the riparian rights to the owners of the downstream properties along the waterway. In other words he could not dam or channel away the water from its natural course. A landowner could also create profit by permitting someone else a share of resource¹⁵.

¹⁵ Evolution of Water Rights, UNDP Report, 2004-5, by Jal Bhagirathi Foundation, Jodhpur.

In Arthashastra, Kautilya refers to the ownership and management of the village tanks in the following verses:

- Waterworks such as reservoirs, embankments and tanks can be privately owned and the owner shall be free to sell or mortgage them¹⁶.
- The ownership of the tanks shall lapse, if they had not been in use for a period of five years, excepting in the case of distress¹⁷.
- Anyone leasing, hiring sharing or accepting a waterworks as a pledge, with a right to use them, shall keep them in good condition¹⁸.
- Owners may give to the others in return for a share of the produce grown in the fields, parks or gardens.¹⁹
- In the absence of owners, either charitable individuals or the people in the village acting together shall maintain waterworks²⁰.
- No one will sell or mortgage, directly or indirectly, a bund or embankment built and long used as a charitable public undertaking except when it is in ruins or has been abandoned²¹.

Traditionally, water resources were generally managed by the local communities in the rural India which helped them in achieving a degree of self sufficiency and sustainability in meeting their water needs. In urban areas, State played a more substantial role in the planning and execution of the water management systems. Apart from the state, patronage for water bodies came from the generosity of the philanthropist and important

¹⁶ Kangle, R P. *The Kautilya Arthshastra* 1969, translated by Rangrajan, L N, *The Arthshastra*, Penguin Books, New Delhi, 1987, (3.9.33). Numbers refer to the book number, chapter and verse number in this book.

¹⁷ *ibid*, (3.9.32)

¹⁸ *ibid*, (3.9.36)

¹⁹ *ibid*, (3.9.35)

²⁰ *ibid*, (3.10.3)

²¹ *ibid*, (3.10.12)

personalities of the society. There was the minimum interference of the state in the management of the resources.

As compared to the British areas the Princely States had better capacities to for irrigation development and maintenance. They supported traditional water systems which were eco- friendly and ensured the repletion of the ground water. These are discussed later in the form of tank managements. Regarding the building, maintaining and ownership of artificial water storage systems in Gujarat, David Hardiman has made a number of relevant observations²². According to him, in Gujarat the finance of well building by merchants' capital appears to have a long history. In the 16th, 17th, and 18th centuries rural Gujarat became a part of the all -India and international expanding trade. Merchant capital helped to finance the extension of agriculture throughout Gujarat to take advantage of this trade. Central Gujarat became the core agricultural zone. Irrigated cash crops such as cotton, rice fruits and sugarcane were grown on a large scale²³. Wells were also built and owned by landlords to provide water for the tenants who cultivated their lands.

Generally building and maintenance of reservoirs requires community organization on a cooperative basis. In rural Gujarat there are evidences of this work being done largely on the village level. If necessary then funded by sahuikars and supported by rulers in the form of tax relief²⁴. As land tax was generally paid by a village as a corporate group through a sahuikar, this would have meant that the usurer would have administered the fund with the village elites organizing labour on the village reservoir by the subordinate villagers. For example in the Parantij Paragana (controlled by the Gaekwad), two grants of Rupees 50 by the state and the marwari

²² David Hardiman, Well Irrigation in Gujarat, Systems of Use, Hierarchies of control, *Economic and Political Weekly*, June 20, 1998, pp 1533-1544.

²³ *ibid*, pg. 1536

²⁴ *ibid*, pg. 1536

merchant towards the cost of rupees 300 needed for repairing the Sujra tank²⁵. An early colonial report on Dholka mentions a talav watering 150 to 200 bighas of land, which was kept in repair by an annual allowance deducted for the purpose from the village land-tax²⁶. In most cases the day to day upkeep was the responsibility of the villagers, According to another British source, there was 'a traditional and customary obligation upon the irrigators to do petty repairs'²⁷. Alexander K Forbes also gives evidence of the cultivators paying for the maintenance of the water tanks in kind. Usually one basket of the produce was charged per cultivator for tank maintenance²⁸.

The above discussion endorses the idea of strong village based control over irrigation resources in the past. Though the merchants/sahukars provided the finance to build wells, reservoirs, and other water storage facilities, they were operated and maintained by the farmers themselves. The water was distributed according to the arrangements made within the village²⁹. In stratified villages it was relative small elite which took the responsibility for organizing irrigation, which owned the wells, and which accordingly reaped the most benefit.

Traditionally wells have been the chief source of irrigation in the State. David Hardiman opines that in the state there have been no records to show as to how water from a well was distributed and there is further inadequate information on the form of irrigational water taxation-in cash, kind or labour, if at all it was to be paid. However the irrigation tax was

²⁵ J H Cherry , collector of Ahmedabad to commissioner of Deccan, March 31, 1824, *Compilation of Papers Selected from the Records of the Government of Bombay Revenue Department, Relating to Artificial Irrigation*, Bombay, 1838, pp 10-11

²⁶ J. Cruikshank, December 31, 1825, Report of the Dholka paragana, *Selections from Records of the Bombay government*, No.10, Bombay, 1853, pg.6.

²⁷ R G Gordon, *The Bombay Survey and settlement Manual*, vol 2, Nagpur, 1960, p 462.

²⁸ Alexander Kinloch Forbes, *Ras Mala*, Hindoo Annals of the Province of Goozerat in Western India, 1924, LPP 1997, vol 2, p 247-248.

²⁹ For details see well Irrigation in Gujarat, p.1538, col II.

levied by the government on the basis of crops grown in the field. Different water rates were charged for the Rabi and the Kharif crops³⁰.

There is one reference to the use of water in the Report of 1885 relating to the Siyanagar Peta of Amreli district of Saurashtra, which was under the rule of the Gaekwads of Baroda. It states that the custom of the country is that if a person wants water he should take it from his neighbour and this is freely done.³¹ One has to remember that the village economy of the peninsula at that time was only slightly monetized as compared to the mainland Gujarat.

Besides the sahuikars and the landlords, the state had a strong interest in irrigation, as higher taxes could be collected from irrigated lands. It is to be noted that accessibility and the nature of the irrigational facilities determined the variations in the land revenue rates. The tax burden on the artificially irrigated land was less.³² This reduction probably was to compensate for the cost of instruments made for the irrigation. For example in Rajasthan, *bara* or *vor* (land of first quality) was charged at the rate of one and a half while the *pivial* or the *piyal* land (irrigated) lands watered by wells and tanks were charged at a lower rate. In the same way when a cash crop like a sugarcane, was naturally inundated by the river water, it was more heavily taxed (Rs 5/bigha), than which was artificially irrigated by wells (Rs 3/bigha)³³. This testifies that the rural elite were very much aware of the environmental constraints on agriculture production and it was visible in the nature of taxation. Under the Mughals, though there was no specific tax on the irrigated lands, fields with valuable cash crops under irrigation were assessed at a high rate³⁴. In the Chikli region

³⁰ *ibid*, pg.1537

³¹ F A H Elliot, February 22, 1885, 'Settlement Report of the Damnagar Taluka', part I Siyanagar Peta, BRO, HPO. 263/36a

³² Mayank Kumar Claims on Natural Resources: Exploring the role of political power in pre colonial Raj, *Conservation and Society*, Vol.III, No.1, June 2005, pg.136.

³³ *ibid*, pg. 138

³⁴ Irfan Habib, 1556-1770, *The Agrarian System of Mughal India*, Asia publishing House, 1963, New Delhi, pp.207-12

of South Gujarat, for example, the Marathas demanded Rs.8-9 per bigha for the best rice lands and Rs.5-6 for per bigha for the inferior rice lands³⁵. In Dholka pargana, the Gaekwads levied a tax of Rs.10 per bigha on irrigated lands but only Rs.3-4 per bigha for unirrigated lands³⁶. The determination of the land revenue according to the means of irrigation also testifies the extent of intervention made by the ruling section of the society in the pre colonial period. The local officials had considerable discretion over tax collection, and it seems to have been their practice to encourage well-construction by granting tax concessions. During the colonial period it took a more definite shape with the introduction of various Water Acts which have been discussed later in this chapter.

It will be apt to locate water bodies and their maintenance in the British land revenue systems introduced in India. A distinctive feature of the early colonial land registration was the meaning of property. Revenue earning purpose determined what was to be registered and what not. The agricultural land that could yield revenue was property worth registration with private parties. The rivers, water bodies, woodlots and grazing grounds, were not considered properties as they did not yield any revenue³⁷. In the raiyatwari areas, settlement of land was made with individual tenants (*raiya*s) against payments of land revenue. Local tanks, woodlands, and grazing grounds not producing any revenue, were not settled. Of these, the water sources did not exist in the natural state. India had an indigenous need based irrigation system, which the British were not at all familiar. These irrigation works required regular maintenance. Revenue earnings were crucially dependent on the effective working of

³⁵ C.J. Prescott, Papers Relating to the Revision Survey Settlement of the Chikli Taluka of the Surat Collectorate, Sept. 11, 1865, Selections from the Records of the Bombay Government, no 381- new series, Bombay, 1899, pg.53

³⁶ Reports on the Resources of the District of Dholka in Guzerat, Selections from the Records of the Bombay Government, no.39, new series, Bombay, 1856, p.15.

³⁷ Brara Rita, Common policy as process- The case of Rajasthan, 1955-1985, Economic and Political Weekly, October 7, 1989.

the irrigation works. This fact compelled the state to become a provider. In the permanently Settlement areas such a problem did not arise. Estate owners were registered, but affairs within their zamindaris did not come under the purview of public law for at least a hundred years. Private contracts between zamindars and tenants, misleadingly called customary law, were effective on the natural resources including irrigation systems³⁸. In the raiyatwari areas it was the moral duty of the Collector to look after the then-existing irrigation works. As the revenues fell due to failure of water works, the East India Company government began to year mark large sums of money to organize repair works. The money was not efficiently spent as the revenue officials did not have the technical expertise for this kind of work. By 1819 a department of civil engineers was created. By 1830s this department could produce engineers who were fairly well-acquainted with the indigenous irrigation works³⁹. By 1880s the PWD could release a complete list of nearly 34, 000 tanks in the raiyatwari areas.

The British were more interested in building huge dams and canals, rather than also maintaining the traditional water harvesting structures, which during the pre colonial period were looked after and taken care of, by the village communities. It was only later that water was given importance to as its availability ensured the huge amount of money through the collection of the revenues. In the North India, under Canal and drainage Act of 1873, a provision was made according to which if the Government deems it necessary to invade the right of an individual in public interest; proper compensation would be paid to the person whose rights were

³⁸ Nirmal Sengupta, Property Rights, Incentives, and Efficiency: Natural Resources in Indian Legal System, Paper presented at the *Conference on law and Economics*, Indian Statistical Institute, New Delhi, January 11-13, 1996, p.5

³⁹ *ibid*, pg.6

invaded⁴⁰. This provision thus granted the State the power to take over any water supply in the possession of the individual.

It was the coming of the easement Act in 1882 and the Land Acquisition Act in 1894, that water was dealt legally, in connection with the land. The Easement Act of 1882 was the first legislative Act that explicitly provided for water rights.

According to this Act, the State recognized three kinds of rights⁴¹:

- Customary Rights
- Those be quested by express grants
- Those granted by status, e.g. Irrigation laws.

The Act also legitimized customary rights of the people and provided guidelines for the recognizance of such rights.

- By local customs
- By long use of precipitation

Under the Easement Act, an individual acquired the right to use water according to his necessities, but the State had the sovereign right of ownership over water, which could not be either breached or challenged by the individual. The landowner could use the groundwater, but it was subjected to the power of the State to regulate the use of water.

The result of such Acts was that the construction and development of water bodies by the community steadily declined, as the ownership and control was transferred to the State

⁴⁰Customary law and modern governance of Natural Resources in India- Conflicts and Prospects for accord and strategies, M.S. Vani, Paper submitted for the Commission on Folk law and Legal Pluralism, XIII International Congress, Thailand, April 2002, pg. 24.

⁴¹ *ibid*, pg. 26

Water storing structures in Gujarat

Most of the expressions found in the Arthshastra recur in several ancient Indian texts. Numerous inscriptions of different periods have been found in almost every part of the country with a wide range of information about dams, tanks and embankments. Two inscriptions engraved on a rock in Junagadh (Gujarat) provide some interesting information about the repair of an embankment, which was destroyed during a flood

The first inscription dates back to Saka year 72 (150-1581 A.D.) of Rudradaman, the Saka ruler. This inscription records the restoration of the lake Sudarsana by Mahakshatrapa Rudradamana. The lake had originally been constructed during the reign of Chandragupta Maurya by his viceroy Pushyagupta and was later improved under the reign of the king Ashoka, when irrigation canals from the lake were excavated by the Yavana king, Tushaspha.⁴² This lake was created by storing the water of streams like the Suvarnasikata and Palasini running from Urjayat (modern Girnar) hills. Shortly before 150-151 A.D., the swollen floods of the Suvarnasika, Palasini and other streams of Mount Urjayat caused a breach in the embankment, as a result of which Lake Sudarsana ceased to exist. The work of restoring the dam was carried out by the king Rudradaman's minister Suvisakha, a Pahalava (Parthian). He was the governor of the provinces of Suvarna and Saurashtra⁴³.

Several facts emerge from this inscription. The water from the lake was used for irrigation through canals, which was excavated by the king Tushapa. Four centuries later the restoration work was carried out by a Pahalava.

⁴² Hasmukh D Sankalia, *The Archeology of Gujarat*, Natwarlal and Co publishers, Bombay, 1941, pg. 7

⁴³ *Dying Wisdom*, pg.62

This is an evidence of the human skills and knowledge, which was used by them for the construct dams, lakes and irrigation systems even in the fourth century B.C.

Three hundred years later, the embankment of the Sudarsana Lake burst again as a consequence of excessive rain in 455-456 A.D. The massive breach was repaired and it was renewed under the orders of Chakrapalita, after two months of work in 456 A.D. Another inscription at Junagadh, at the time of king Skandagupta (455-467 A.D.), records the repairs to the embankment of the Sudarsana Lake by Chakrapalita.⁴⁴

The two inscriptions have several common features. Both mention the name of lake as *Sudarsana tataka* or *tadaka*. The inscription also mentions that the lake was created by *setubandhana* or embankment across the river Palasini. Kautiya also used the term *setu* for embankment. The other terms that have been used in the inscription of Rudradaman are '*pranali*' for canal and '*midhavidhana*' for the removal or clearing of silt from the bottom of the lake. Each of these inscriptions gives detailed measurements of the breach caused, and the time taken to repair and restore the embankment, which originally had an earthen core and stone facings on both the sides. The Sudarsana Lake perhaps fell into disuse sometimes in the eight or the ninth century A.D. due to the destruction of the embankment and was never restored again.

It thus was in use for over a period of more than thousand years. Therefore we can say that people from the earliest civilization had understood the significance of water, and had made several efforts to tap the rainwater. Examples of Dholavira and Junagadh in Gujarat testify to this statement. The state of Gujarat presents a picture of a rich and varied

⁴⁴*ibid*, pg.63

ecology. While the southern part of the state receives high rainfall during the Monsoon frequently resulting in floods, the Northern and Western parts of Gujarat are dry receiving scanty rainfall. Traditionally wells and tanks have been the principal means of water harvesting in Gujarat.

Step wells are found in all over Gujarat, but they are located more in the Northern and Central part of the state. They are known as 'vav' or 'vavadi' in Gujarat, whereas in Rajasthan and Northern India, they are called 'baolis' and 'bavadis'. The term stepwell itself indicate the style of its construction. Both parts of the term characterize its inherent feature (step and well). The long stepped corridor leading down to 5-6 storeys was a major constructional element in the building of a stepwell. The construction of stepwells in the arid climate of Gujarat is an example of the people's response to the adverse climatic conditions. Stepwells were only next in importance to ponds, tanks or artificial lakes in meeting people's water requirements in the Thar areas of Gujarat.

Sculptures and inscriptions in stepwells demonstrate the importance they commanded in the traditional, social and cultural lives of the people. It was a common custom among the women to make offerings of coconuts, grains and milk to the Goddess in the stepwells to obtain a good husband, progeny and prosperity. After marriage, couples would go to pay homage to the water deity and receive a boon of fertility. Stepwells were used for various reasons and their location often suggested the way in which they were used. When it was located within or at the edge of the village, it was mainly used for the utilitarian purposes and as a place of social gatherings. When the stepwells were located outside the village, and on the trade routes, they were often frequented by travelers and caravans as resting place. One could still find the traces of stepwells on the military and trade routes from Patan in the North to the sea coast of Saurashtra. When they were used extensively for irrigation, a sluice was constructed

at the rim to receive the water and lead it to a trough or pond, from where it ran through a drainage system and was channeled into the fields. Minerals, salts and other substances dissolved in the water of a stepwell often had the quality of brightening or strengthening materials like cloth and metals. It was widely believed that the water of a stepwell called 'sari' in southern Saurashtra, helped to sharpen the swords. Many stepwells were also constructed in the State of Baroda. Of these the most notable are the celebrated Navalakhi (meaning nine lakhs) stepwell at the Baroda district of Sevasi, Mandala at the Dholka taluka and Sojitra at the Petland taluka of the Baroda district

The other water storing structures of Gujarat were **tanks**.

The general reasons for building tanks are: low rainfall, increasing population, preventing soil erosion, and storing water for situations of water scarcity etc. Tanks serve various purposes including the ground water recharge by reducing the runoff and enhancing the water stagnation time. There is a positive correlation between water impounding in the tanks and ground water charge. Ground water withdrawal through tube wells needs to be balanced by recharge through simple technologies, such as tanks. Since tanks are neglected and remain devoid of water for most part of the year, recharge is a problem. Depletion of ground water has serious consequences. It not only reduces the availability of potable water to people and their livestock, it also reduces the quantum of surplus water that can be used for irrigation and enhancement of agricultural productivity⁴⁵. The dry climate in North Gujarat and Saurashtra, and the limited period of monsoon in South and Central Gujarat led to the building of numerous tanks. Tanks were either built for drinking water or for irrigation. Reservoirs like 'talav' were important not only as a direct source

⁴⁵ Deep Narayan Pandey, Sacred Water and Sanctified Vegetation: Tanks and Trees in India, Paper presented at the Conference of the *International Association for the Study of Common Property*, in the Panel "Constituting the Riparian Commons", Bloomington, Indiana, U S A, 31May-4 June 2000, p1.

of irrigation, but also because they allowed the water to percolate into the soil and top up surrounding wells. In close association with the traditional water management, we find interesting practices of plant ethno-forestry.

Often around the tanks numbers of trees were planted. The basic reason for the plantation of trees in the embankment area is that trees protect the soil from being eroded. In India, embankments are found to have been planted with *pipal* (*Ficus religiosa*), *bargad* (*Ficus benghalensis*), *gular* (*Ficus glomerata*), mango (*Mangifera indica*), and *neem* (*Azadirachta indica*). Age of the tank can be often guessed by the age of the surviving tree. According to A. Mishra, "once the trees are felled the tank too goes into peril. If the tanks are imperiled trees follow the suit"⁴⁶.

Alexander Forbes throws light on another advantage of a tank- the cultivator used the slime of a dried -up tank as a manure, upon lands intended for irrigation and then for cultivation⁴⁷. Forbes also observed that small reservoirs of water called kunds, and more imposing wavs, or baolis, and sometimes majestic tanks are more or less indispensable accompaniments of places dedicated to the religion of the Hindus. Like the Christian churches of the Middle Ages, the Hindu temples of Gujarat are usually in situations highly favoured by nature. The awful gloom of the grove, the romantic beauty of the mountain glen, the brightness of the river's bank, the wildness of the cloud-enveloped peak, or the solemn calm of the ocean bay, are the accessories of which the religions of Shiva and of Adinath know full well how to avail⁴⁸.

Wells since centuries have been the principal source of irrigating the land. They were either built by labour from within a village, or by professionals who were apt in doing this work. As the rock cut wells were difficult to build, skilled well constructors were hired to perform the task. They were normally from a specialist caste, known as the *Ods*. They were

⁴⁶ Mishra A, *Aaj bhi khare hain talab*, Gandhi Shanti Pratisthan, New Delhi, 1993.

⁴⁷ *Ras Mala*, vol. II, pg.244.

⁴⁸ *ibid*, pg.308

professional reservoir and well diggers.⁴⁹ The building of a stone lined well with the elaborate water lifting device was extremely expensive costing anywhere around Rs 150-1000 depending upon depth and width, it was not always possible for the ordinary peasants to manage the sum on their own. Thus they had to borrow the amount from the moneylenders at the interest rate of 12 percent. This meant the mortgaging the future produce of the land and perhaps even the well itself to the usurers. This is the reason why the usurers were always encouraging the peasants to undertake the construction of the wells. This also enabled them to dictate the crop to be grown by the peasants. During the medieval time a large part of Gujarat was a part of an expanding all India and international trade and the merchant capital helped to finance a large scale extension of agriculture through out Gujarat. Irrigated cash crops such as cotton, rice, fruits and sugarcane were produced on a large scale for export to other parts of India and abroad. Wells were often built and owned by the landlords to provide water for the tenants who cultivated their lands. Reservoirs and the other water storing structures were also largely constructed and financed by the rulers, as a large scale production always lead to good revenues.

The Solanki dynasty, which ruled from the Anhilwada Patan in North Gujarat from A.D. 941 to 1212, developed an extensive system of reservoirs in that area. Famous monument of the king Bhimdev's reign was the Rani's vav or stepwell at Anhilpur constructed under the auspices of the queen Udaymati. The date of its construction is placed at 1032 AD⁵⁰.

The successor of Bhimdeva I, Karna (1064-1094 AD), after defeating the Bhil chieftain Asha Bhil at Ashapalli (Ashval) near Ahmedabad, commemorated his success by constructing a reservoir called Karna Sagar.

⁴⁹ V.K. Jain, *Trade and Traders in Western India, AD 1000-1300*, New Delhi, 1990, p. 28.

⁵⁰ M.S. Commissariat, *A History of Gujarat, With a Survey of its monuments and inscriptions*, vol.I, 1573-1758, Orient Longmans, Bombay, 1938, pg.1xii

and found a new city of Karnavati. The river Rupen was diverted at Modhera to take water to the Karna sagar reservoir- a distance of about 20 miles⁵¹. It is said that the reservoir survived for centuries as a great irrigation lake, and was in use till the year 1814, when a heavy fall of rain caused the River Rupen to break through the great embankment and Karna Sagar ceased to exist.

Karna Solanki was succeeded by his only famous son Siddhraj (1094-1143). He while fighting a long war with the Parmars of Malwa (the war continued for almost twelve years) built "Sahashralinga *talav*, or Tank of the 1000 temples of lord Shiva'⁵². The reservoir was of immense size, with numerous shrines on its banks. The tank was multilateral and in its center was an island on which stood the temple of Rudreshvar. The tank now lies in ruins.

In the medieval period, the famous water storing structure was Hauz-I-Qutb, or the Kankaria Tank, built by Sultan Qutub-ud-din in 1451 in Ahemadabad. It was a regular polygon of 34 sides and enclosed an area of 76 acres. It had number of sluices to supply water for irrigation⁵³. After the fall of the Mughal power in Gujarat, when James Forbes visited Ahemadabad in 1781, he did not find the tank in a good condition. It was in 1872, that the tank was placed under the restoration work under the then district collector, Borrardile⁵⁴. The bank of the tank was strengthened by planting number of trees. At one point of time in 1879, it was proposed to connect Kankaria Lake with the River Khari, by a canal 11 miles long to supply water to Chandola Lake, but the plan was dropped later.

⁵¹ V.K. Jain, *Trade and Traders in Western India*, AD 1000-1300, New Delhi, 1990, pp. 30-32

⁵² *A History of Gujarat, With a Survey of its monuments and inscriptions*, pg.1xvi

⁵³ Achyut Yagnik and Suchitra Sheth, *The shaping of modern Gujarat*, Penguin books, 2005, New Delhi, pg.14

⁵⁴ *Bombay Gazetteer*, vol. IV, Ahemadabad, 1896, pp. 17-18

The Mansar Lake in Ahmedabad contained water throughout the year and had an area of 6 hectares. Other notable lakes were the Malik Shaban, Sarkhej, Malav, Khan and Sonaria.

There were numerous ponds, reservoirs and wells in the Kaira district. The Khari River was dammed with earthen embankments, and the water was used to irrigate rice fields in the vicinity. These embankments required constant repair, and the rights to the water of Khari were always a source of conflict amongst the villagers. In 1850's the British built a permanent masonry dams with sluices on the river.

In Baroda, wells and tanks were the chief indigenous sources of irrigation. Several large tanks and small lakes existed, but number of them shrunk considerably during the summer season.

Gopi talav was a famous reservoir built by Malik Gopi- a noble of high rank during the early years of reign of Muzzaffar Shah II⁵⁵. This talav had steps to reach the water and where there were no steps; there were sloping descent to the basin. The reservoir after was filled with rainwater, flowed along the countryside through a large canal. When a French traveler Jean De Thevenot, visited Gujarat in 1666, noted that the reservoir had already started to silt for the want of proper care⁵⁶. However no trace of Gopi talav now remains in Surat. During the reign of Farrukhsiyar, in 1719, the stones of the tank were used in building the outer wall of the city.

Khasherao Jadhav, a Baroda state official, argued in the report of 1916 that the country north of Gujarat was best suited for irrigation through reservoirs rather than through the wells. The water was at a great depth, making well irrigation difficult. As the area was prone to floods during the Monsoon, the reservoirs constructed in the past were able to both check

⁵⁵ *A History of Gujarat, With a Survey of its monuments and inscriptions*, vol.II, (1573-1758), pg.356

⁵⁶ *ibid*, pg.356

and store the water for the local use. He felt that they should be restored.⁵⁷ Similar systems of irrigation were found in the kingdom of Champaner from Baroda, ruled by the Chauhans in the 14th and the 15th centuries. Reservoirs of all sizes were constructed, allowing extensive irrigation in this region. It was after the fall of the dynasty in 1484 the works began to decay and by the end of the 19th century only the traces of the previous works remained⁵⁸.

James Forbes, who resided at Dabhoi near Baroda in 1777-78, stated that there was generally a tank in each large village. They were enclosed with strong masonry, and their banks were adorned by Banyan, mango and Tamarind trees. In Dholka pargana, near Ahmedabad, reservoirs were used on a large scale for irrigation. The countryside sloped gradually from north to south, and the reservoirs were constructed to take advantage of this natural feature. There were large and strong embankments. The overflow from one reservoir thus filled the one below it⁵⁹.

Reservoirs can be filled either by rain or by flood inundation. An Englishman, Hove, a keen observer of the water storage system, while traveling in central Gujarat, saw many large reservoirs close to rivers which were filled from floods in the rivers. The bank of the reservoirs was built up above the level of the riverbank, being planted with trees to strengthen them. A sliding sluice was constructed in the bank of the reservoir adjoining the river, which was left open when the river was in full flow. When the reservoirs were filled with water completely, the sluices were closed. Then sluices in other parts of the reservoirs were opened, allowing the water to flow into the channels, which took the water into the

⁵⁷K Jadhav, *Jamabandi revision Settlement Report of the Dehegam Taluka of the Kadi Division*, May 6, 1916, 1916-17, Baroda 1918, HPO, BRO, pg.18

⁵⁸J. L. Jenkins, March 7, 1889 'Jarod Taluka Settlement Report', BRO, HPO, 263/26, pp 6-7.

⁵⁹J. Cruikshank, December, 31, 1825, '*Report on Dholka*', pg.6

fields. At times wells were also filled by the same method. When the level of water in the reservoir fell below the level of the sluices, lifting devices were used to raise the water into the channels. As the water did not have to be raised to any great heights, a considerable area was irrigated in this way. Hove calculated that a 12-acre farm could be watered using an 'araghatta'- type device in five hours.⁶⁰

Therefore, scientific indigenous system of water storage and management were in use in most parts of the Gujarat region. In desert areas, like Saurashtra and Kutch, reservoirs were constructed to store rainwater while in south and central Gujarat, the water storage structures were built, to collect river water also, at the time of the floods. However, after the advent of the British, began the process of the building of large dams and canals for irrigation. Village communities began to breakdown and thus began the neglect of the indigenous system of water management. Tanks were earlier built and maintained by the village communities.

The number of tanks began to decline after the breakdown village communities. A *kund* is a small depression with stepped sides, with its central portion sunk deeper in the form of a well. They were primarily used for the irrigation purposes. A '*kundvav*' was a lesser-known form of stepped tanks. It had steps on the three sides and a pavilion on the fourth, which connected the tank with the well shaft. The majority of these structures were found in the Northeastern Gujarat.

Advent of the British

The British in their desire to maximize economic benefits assumed complete control over the natural resources of India and while doing so they disturbed the very fabric of sustainability of the Indian villages. This led to a total neglect of the water management systems built by the village

⁶⁰ Well Irrigation in Gujarat, pg.1536

communities of India over the centuries. Their revenue systems (Ryotwari system in Gujarat), denied customary rights to landowners, and impoverished the peasantry. With the introduction of private property in land, village headman and the state appropriated for themselves the ultimate ownership of the soil. Traditional Indian arts, crafts and industry and the stock of traditional knowledge, without the patronage of the state and the rural gentry began to lose out. Besides, where community management systems existed, which were based on an intricate web of reciprocal relationships also began to break down under the pressure of the market economy. Therefore, there was also a decline throughout the country in the locally developed system of water harvesting. The land revenue system introduced by the British deprived the local communities, especially, the peasants of any financial resources to continue or preserve the water harvesting system.

Writing about the early land settlements under the British Rule, the nationalist economic historian, Romesh Chandra Dutt, states⁶¹:-

"The dominions of the last Mahratta Peshwa passed away under the British rule in 1817; and from that year, the land revenue was continuously raised. In 1817, the revenue realized from the newly acquire territory was 80 lakhs, in 1818, it was raised to 115 lakhs and in another few years it came up to 150 lakhs. The village community system broke down under this pressure and the Ryotwari system, introduced by Sir Thomas Munroe, suggested the introduction of a similar Ryotwari system in Bombay, i.e. a system of separate settlements and individual cultivators"

About the settlement operation in Gujarat and Deccan, he states⁶²,

"Every effort was made lawful or unlawful to get the outmost out of the wretched peasantry, who were

⁶¹ R.C. Dutta, *Famines and Land assessments in India*, 1900, Kegan Paul, Trench Trubner & Co Ltd, London. Reprint BR publishing Corporation, 1985, Delhi, pg. 39

⁶² *ibid*, pg.32

subjected to torture in some instances cruel and revolting beyond any description, if they could not or would not yield what was demanded. Numbers abandoned their homes and fled into neighbouring native states; large tracts of lands were thrown out of cultivation. And in some districts, no more than a third of the cultivated area remained in occupation".

The British took over, without compensation, vast tract of community forests throughout the country "an act of robbery", as ecologist Madhav Gadgil puts it⁶³.

"... surpassed only by the usurpation of continents like North America and Australia by the European settlers".

The domestic economic- ecological system was turned around to produce goods not for local people's needs but for the metropolitan markets of the colonizing powers. The pattern of agriculture also changed from subsistence farming to cash crops for the colonial market. These changes to an extent led to the destruction of the institutions that managed and maintained, through community participation, a series of traditional water harvesting structures.

With the progress of British rule in India, there was also a shift in emphasis from minor irrigation works like tanks, wells and small river channels to large canals commanding extensive areas. The latter were large works and little importance was given, in comparison, to smaller works. The British undoubtedly emphasized over the development of large-scale irrigation schemes to promote the production of export crop, rather than local food production.

The British however at times themselves realized and admired the skill of the Indians in the construction of water harvesting system. Arthur Cotton,

⁶³ Madhav Gadgil, Towards an ecological History of India, EPW, vol XX, 1985, pg.1918

the pioneer of modern irrigation in India, himself noted in 1874, about the local water storage systems⁶⁴;

"There are multitudes of old native works in various parts of India. These are notable works, and show both boldness and engineering talent. They have stood for hundred of years... When I first arrived in India, the contempt with which the natives justly spoke of us on account of this neglect of material improvements was very striking, they used to say that we were a kind of civilized savages wonderfully expert about fighting but so inferior to their great men, that we would not even keep in repair the works they had constructed, much less even imitate them in extending the system".

Later Cotton paid tribute to the skills of the native engineers⁶⁵;

"It was from them (the native Indians), we learnt how to secure a foundation in a loose sand of unmeasured depth. In fact, what we learnt from them made the difference between financial success and failure, for the Madras river irrigation executed by our engineering works in the world, solely because we learnt from them.. With this lesson about foundations, we built bridges, weirs, aqueducts, and every kind of hydraulic works.. we are thus deeply indebted to the native engineers".

Thus the Indian native works were even acclaimed by the English but lost it out to big dams and large irrigation canals. One such example is the former Baglan kingdom, which during the medieval times had an excellent network of small dams but eventually lost out to the apathy of the state.

The Small dam system of the Baglan region

Baglan kingdom was a region in the Sahayadri Mountains, with fertile river valleys in the area running north of Nasik to the Tapti River. The region incorporated in itself the western Khandesh region (including the towns

⁶⁴ Nirmal Sengupta, Irrigation: Traditional Vs Modern, EPW, vol XX, 1985, pg.1919

⁶⁵ *ibid*, pg.1924

like Navapura and Pimpalner) and some southern part of the former Baroda state (Songadh). (See map IIIB).

In his book, 'the Agrarian System of Mughal India', Irfan Habib says⁶⁶:

"We are told for example, that in Baglana, 'they have brought into every town and village thousand of canals, cut from the river for the benefit of cultivation,' and these were managed, probably according to the co-operative *phad* system, which still survives in that area".

Small dams were central to the irrigation system in Baglan. The Baglan kings normally accepted the overall paramountcy of more powerful rulers, paying tributes to them. Between 1317 and 1347, they were under the paramountcy of the rulers of Daulatabad. In 1370, they were paying tribute to the king of Khandesh. In the 15th century they were under the allegiance of the sultans of Gujarat, and in 1573, they became the tributaries of the king Akbar⁶⁷. When British came to this region in 1818, they found a whole network of dams in the area, locally known as '*bandharas*'. The dams were constructed of the blocks of black basalt stone with high quality cement. They were thick at the base, tapering to the top. The dams raised the height of the water in the river (making it resemble a weir). Channels were constructed on one side, taking water to subsidiary channels, and then to fields. These channels were excavated from the earth, with earth banks⁶⁸. The channel needed constant maintenance, with silt having to be cleared from their bed and heaped on their banks or adjoining fields. Many of the dams had fallen into ruins by 1857. The largest number of dams was near to the western border of Khandesh, along the Sahayadri range towards South Gujarat. Parts of the Baglan kingdom, even lay outside the boundaries of the British territories. Towards the north of the upper valley of the Jhakri River was Songhad- a town of the Baglan kingdom. Some

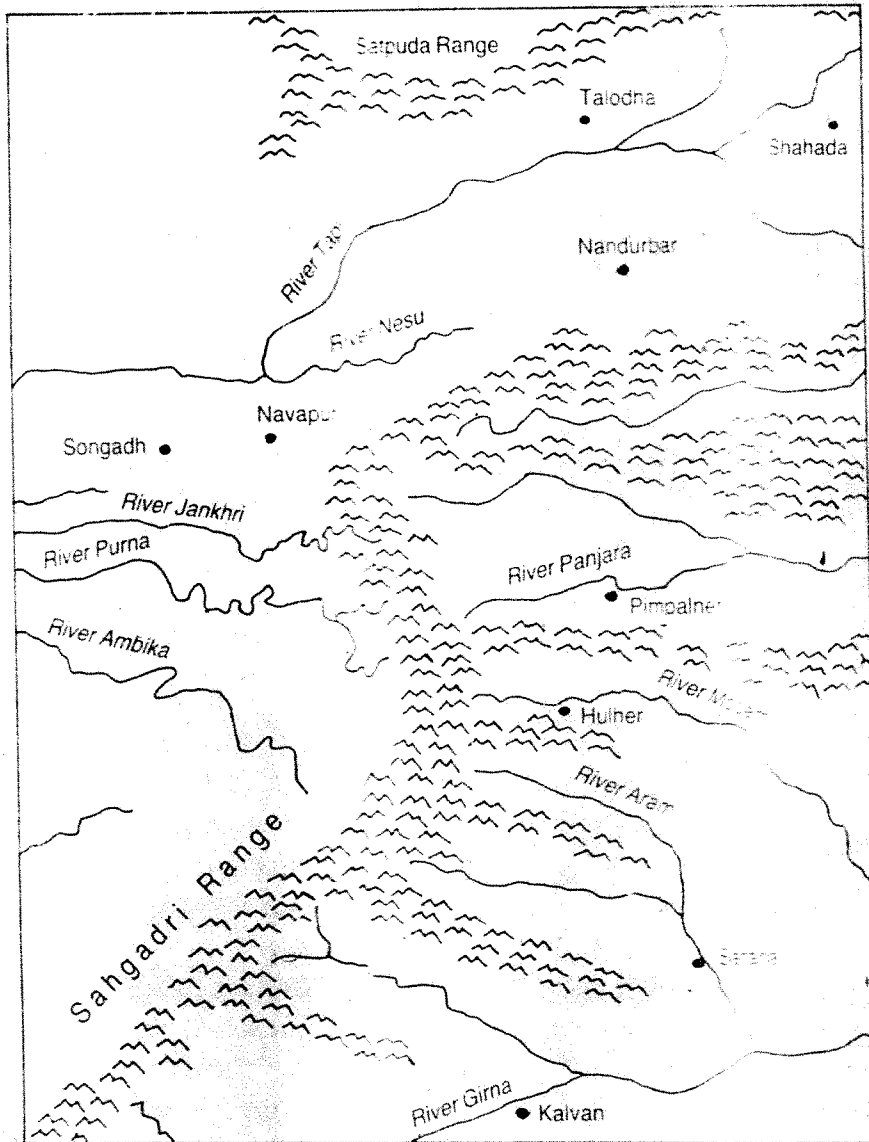
⁶⁶ *The Agrarian system of Mughal India*, pg.31

⁶⁷ D. Hardiman *Small Dam system of the Sahayadris*, in *Nature, culture and Imperialism, Essays on the Environmental History of South Asia*, Oxford University Press, Delhi, 1995, pp.190-191

⁶⁸ *ibid.* 193-194

Map III B
The Baglan Region

186

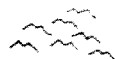


Scale (Km.)

0 10 20 30

— Rivers

• Towns



Mountain Ranges.

The Baglan Region.

Source: David Handman, Small dam system of the Sahayadris, in Nature, Culture and Imperialism, essays in Environmental History of South Asia, OUP, Delhi, 1995

parts of the Dangs were also a part of this kingdom. In these areas, the landscape was suited to the dam building with rivers running off the mountains down the valleys. Local tradition traces the origin of these small dams to the Muslim rulers, which was perhaps because the Muslims were great builder of the canal system. (It could be traced to the rule by Muslim minister Malik Amber- 1610-30)⁶⁹.

These small dam and canal system was controlled by the peasant community- known as *phad*. This defined as, 'A system of irrigation under which a number of small holders join together for the economic use of the water supply available, for the growing of irrigated crops on a regular plan'. Thus these small dam systems were constructed as a result of co-operation between the State and peasants. The existence of small canals and rivers led to an increase of agricultural production of the region. The chief crops were *bajra* (54.46 of entire cultivation) and *jowar* (10.38 of entire cultivation)⁷⁰. When British occupied this region, they imposed a uniform tax per unit of irrigated land. The rate was fixed high- the aim being to encourage the peasants to concentrate on growing the most valuable crops, so as to maximize tax revenue. Although the rates were lower on rice and sugarcane, it was higher on less valuable crops (not cash crops), which occupied a greater part of the region. To pay new high rates, peasants took credit from the moneylenders and soon became a part of a vicious circle of debt.

With the passage of time, the number of dams showed a continuous decline. In 1857, there were 97 *bandharas* in Baglan, in 1881-82; there were 49 and 31 in 1900-03⁷¹. The system therefore disintegrated under the British rule. It could be said that small dam system of Baglan region was brought due to a number of causes. The British hardly took any

⁶⁹ *ibid*, pg. 196

⁷⁰ *Gazetteer of the Bombay Presidency*, vol.XIV, Nasik, Bombay, 1883, pg.406

⁷¹ *ibid*, pg.401

interest in preserving these small systems; they seemed to be interested only in building large dams and canals. High rate of taxation broke the peasant communities and deforestation was also an important cause for the ruin of the *bandharas* (especially in many parts of Nandurbar-a part of the Khandesh region).

What is significant here is to note that the system of small dams is more environmental friendly than big dams and canals. They do not drastically alter the surroundings and serve local needs better. Large dams and canals often have a disastrous impact not only on environment but also on ecology. The British built a huge system of canals and dams in southern and northern part of the country. Most of these works were financed by loan capital. Hence in the sanctioning the constructions, the emphasis was placed on the prospect of their remunerativeness⁷². Big projects like Jamuna canal in Punjab, the Ganga canal in the Doab area, the Sarda canal in years, were also responsible for the environmental degradation, besides providing water for large irrigational purposes. In 1843, the western Jamuna canal was held responsible for the outbreak of Malaria in Karnal. The same canal was held responsible for the poor drainage, water logging, salinity and fever in Aligarh. According to Elizabeth Witcombe⁷³:

"The British India's irrigation history succeeded financially and physically, where the natural order permitted. It failed where nature dictated-where the technical and economic resources of government were insufficient to solve the problems posed by environment and the interaction of perennial irrigation with it. Canal did not control the vagaries of nature, but compounded them".

⁷² Elizabeth Whitcomb, *Irrigation*, in *The Cambridge Economic History of India*, vol.II, c.1757-1970, pg. 682

⁷³ *Nature, Culture and Imperialism, Essays on the Environmental History of South Asia*, pg 92

Gujarat- Rivers and Rainfall

The Sabarmati, the Mahi, the Narmada and the Tapti are four principal rivers of Gujarat. Besides, these, there are small rivers like the Khari, the Hathmati, the Meshva and the Bhogwa in Ahmedabad, the Shedi, the Mul Khari, the Vatrak and the Mohar in Kheda, the Kim and the Dhadhar in Bharuch and the Mindhola, the Purna, the Ambica, the Auranga, the Par and the Damanganga in Surat⁷⁴. During the Monsoon, the water in the river often reach the dangerous levels while during the extreme summer season, they get completely dried up.

It has been noticed by certain scholars that the drainage system in Gujarat is unique and the rivers generally get flooded. In the 19th century the rivers got flooded about nine times, in 1810, 1822, 1833, 1835, 1857, 1876, 1884 and 1894⁷⁵. The river Mahi, the Sabarmati and the Narmada are equally liable to floods⁷⁶. Silting of the Gulf of Cambay is one amongst various reasons for the frequent floods in the state⁷⁷. All the rivers in Gujarat flow into the Gulf and consequently, there has been a rise in the bed level of the rivers.

The destruction of the forests is the other reason, which leads to the floods. Forests exercise great influence on the weather conditions. Besides, having moderating influence on the extremes of climate and preventing the subsoil water from sinking unduly below the surface, they also ensure the necessary rainfall in and around regions in which they are located. In the regions with uneven surface especially the hilly tracts, the

⁷⁴ R.L. Singh, *India: A regional Geography*, Ram Printograph, New Delhi, 1997, pg.4

⁷⁵ A Study of the Rural Economy of Gujarat containing possibilities of Reconstruction, pg.4

⁷⁵ *India: A regional Geography*, pg. 884

⁷⁶ *ibid*, pg.4

⁷⁷ *ibid*, pg. 884

roots of trees and grass in the forests help to check erosion by preventing the speedy runoff of rainwater and by releasing it slowly and by stages, thus saving the valuable topsoil from being washed away. It has been estimated that in India while the surface soil lost annually per acre in respect of grasslands is only 1.6 tonnes and that removed from the bare lands by running water amounts to 8.3 tonnes⁷⁸.

The British after they annexed certain parts of Gujarat and made it a part of the Bombay Presidency (Bharuch, Surat, Dangs, Panchmahals, Ahemadabad and Kheda), depletion of the forests took place on a large scale. Expansion of cultivation, opening of railway lines, requirements of timber for railway sleepers, export of teak to Britain and construction of roads are some of the reasons for the destruction of forests. From perhaps 31% of the total area of Gujarat in 1890, the wooded area (forest/woodlands plus interrupted woods) of the province had plummeted to 11% by 1910, and continued a steady decline to 9% in 1930, 8% in 1950 and 6% by 1970. Thus much of the destruction of Gujarat's forests had taken place in years before 1900⁷⁹, which was a period of expansion of railways on a large scale.

According to M.B. Desai, there has been a gradual decline in the quantity of rain in the British Gujarat, though the similar tendency is not quite noticeable from the table given on the next page⁸⁰.

⁷⁸ *Post War forest policy for India*, pg.31

⁷⁹ Edward S. Haynes; *Nature and the Orient in The Environmental history of South and South East Asia*, pg. 747

⁸⁰ *Rural Economy of Gujarat*, pg.19

Table III A

Annual Rainfall in British Gujarat 1935 - 1944.

Year	Rainfall (inches)
1935-36	21.83
1936-37	24.08
1937-38	43.50
1938-39	27.56
1939-40	26.18
1940-41	30.78
1941-42	43.71
1942-43	54.42
1943-44	36.97

However there seems to have been a slight decline in the number of days for which the rain falls. The table given on the next page testifies the fact⁸¹.

⁸¹ *A Study of the Rural Economy of Gujarat*, pg.6

Table III B**Annual Precipitations and Rainy Day, 1915-16 to 1943-44.**

Years		Ahmedabad	Kaira	Broach	Surat
1915-16	Rainfall	26.26	27.92	36.74	40.98
To 1919-20	No of Rainy Days	38	38	45	49
1920-21	Rainfall	25.96	23.63	25.25	38.95
To 1924-25	No. of Rainy days	33	32	51	54
1925-26	Rainfall	41.8	38.35	35.04	41.81
To 1929-30	No. of Rainy days	43	40	43	46
1931-32	Rainfall	38.24	35.39	30.26	48.84
To 1934-35	No. of Rainy days	40	41	38	51
1935-36	Rainfall	25.13	25.55	28.43	41.45
To 1939-40	No. of Rainy days	33	33	35	44
1940-41 To 1943-44	Rainfall	35.91	38.81	37.81	49.47

From the table given above, it is found that the Monsoon in British Gujarat as a whole was spread over 43 days on an average for the five years beginning with 1915-16. The rainy seasons came to be restricted to 40 days on an average for the four years 1940-41 to 1943-44. It has been found that in most of the areas of the Kheda district an annual rainfall of 30-35 inches spread over from 45-50 days is considered necessary for the successful harvests. If we compare these requirements with the actual facts in the table, it will be found that the situation is highly unsatisfactory,

particularly in regard to the duration of the Monsoon. When rainy seasons are concentrated over short periods two undesirable results follow.

Heavy rains lasting for a short time cause a violent run-offs which carry with them valuable top soil from the fields. Further, such heavy precipitations of short durations leave little scope for rainwater to be absorbed by the soil with the result that, soil water level goes down. Whatever the condition and possibilities of rain is, Gujarat was considered free from the acute famines till the disastrous drought of 1899-1900. There were again famines in 1911-12, 1915-16, 1918-19 and 1920-21. Thus famines had become a regular feature of Gujarat in the first part of the twentieth century.

For a region dependent on rain for cultivation, its failure became critical for the survival of the people involved in cultivation. There is a verse used among women of Gujarat, to the effect that if the rains do not fall in the first five days of Shrawan, a famine will ensue⁸².

*"If in the first five days of Shrawun,
The cloud-king do not begin to scatter his drops,
Husband, do you go to Malwa,
I shall go home to my father's house."*

When the fall of rain is long delayed the Hindus think that⁸³ Indra wishes to lay waste their town or village, and to deprecate his wrath by submission, they quit the place for the day, leaving it 'oojud' or waste and cook their dinner outside. This is called Oojani. In the territories of native chiefs, the raja issues a proclamation by the beat of a drum, the day before the oojani is to take place, that a fine will be imposed upon any person who presumes to light the fire within the town.

⁸² *Ras Mala*, vol. II, pg. 320.

⁸³ *ibid*, pg.321

Another method of inducing the rain to fall is to send for one of the persons called *Bhuvras*; who are supposed to be inspired by the local Devi. He is addressed as the *Mataji* and asked why the rains have not fallen. He then would fling his limbs saying that no offerings have been made to her. He then orders them to present certain kinds of food, which he describes as being sacred to the Devi. Next day offerings are put into broken earthen vessels, which represent human skulls out of which the *Yogini* delights to eat; they must be carried out side the eastern door of the city and then set down in a circle which has been previously sprinkled with water. As each householder has to present an offering, the number of vessels which are set down is sometimes very large. The dogs or the *Dher*⁸⁴ eat the food and if the rain fall it is believed that the Devei has sent it⁸⁵. Another mode of inducing a fall of rain – the outlet by which water passes off from the basin that the symbol of Shiva is set in must be closed up, and libations made until the ling is immersed. This process should be repeated for eight days, unless rainfall in the meantime. Kunbi and Bhil women sometimes parade the streets on these occasions, singing songs addressed to the goddess of rain⁸⁶:

*"The cultivator has abandoned the plough, O Meyhoola,
In pity to him do thou rain, therefore O Meyhoola,
The good man has packed off the good woman home, O Meyhoola,
Separated from her are her little children, O Meyhoola,
The stream is dry in the river's-bed, O Meyhoola."*

A boy accompanies the singers, bearing on his head a basket containing mould, with three sprigs of the *limb* tree (Forbes name for Neem

⁸⁴ (Dher is one of the depressed castes in Gujarat. The position of the dher of North and South Gujarat vary considerably, In Ahmadabad they are private rather than public servants, while south of Narbada the case is reverse. For details see Bombay Gazetteer, ix, part I, p 338)

⁸⁵ *ibid*, pg.321

⁸⁶ *ibid*, pg.322

tree/*Azadirachta Indica*) stuck in it. When the party approaches a Hindu house, the women come forth and pour water over the sprigs, so that the boy is drenched through; they make presents of grain at the same time to the women who form the procession.

Irrigation in the 19th and 20th century Gujarat

Irrigation in a country where the rain falls only for three to four months, occupies a significant place in the economy of the region. The methods of irrigation of fields changes with the time. Along with the various level of technological advancement, changes came into the methods of ploughing, sowing and irrigation of the fields. Earlier, rainwater was stored by the people for the drinking and irrigation purposes, in the form of tanks and *kunds*, however later wells began to be used in large numbers. Various methods and devices were then used to lift water out of the wells. With the beginning of the modern scientific inventions, like electricity, tube wells and pumps were then began to be used on a large scale leading to the maximum extraction of water. Large-scale construction of dams and canals were then initiated.

During the 19th and the 20th centuries, the chief sources of irrigation in Gujarat were:

- Wells
- Tanks, and
- Canals

The most important source of irrigation is wells. The difficulty about utilizing the rivers for irrigation is that most of them are very deep, and being perennial, 30 ft. below the sea level and are subjected to violent and enormous floods. Gujarat was neglected by the British regarding the irrigational facilities.

The evidence before the Royal Commission on Indian Agriculture of 1926 testifies the fact in the following figures: -

Capital Expenditure on Irrigation Works up to 1927⁸⁷:

Gujarat	Rs.24, 63,883
Deccan	Rs.9, 49, 84,574
Sind	Rs. 10, 22, 49.056

Here the question may arise as to why the state of Gujarat was neglected by the government? One of the reasons could be that Gujarat was considered less fertile compared to Punjab and Northern India, where many canals and dams were constructed for the purpose of irrigation. Cotton grown in Surat was considered of inferior quality.

Other reason for the neglect is cited by Alexander Mackay who visited the state in mid nineteenth century. In his report, he states that the Court of Directors of the East India Company always held the opinion, that

"There can be no question about the expediency of constructing tanks and wells, where there is satisfactory prospect of their being attended with adequate advantage."

Gujarat been a state of numerous stepwells, tanks and checkdams, thus was not given attention by the colonial government of its need of irrigation water. Later as discussed earlier, these modes of storing water fell into disuse as no steps were taken by the state to repair the existing reservoirs.

After 1780's there was a decline in irrigation in Gujarat. Whereas Hove had found that crops were regularly irrigated in the parts of Central and North Gujarat, which he visited in 1787-88, in the nineteenth century, crops came to be depended heavily on the rains. This decline in irrigation could be due to various reasons. This was a period of regular warfare in

⁸⁷ *Economic Life in Bombay Gujarat*, pg.2

the region, with the British, the Gaekwads, the Peshwas and the local chiefs struggling for the ascendancy. A campaigning army did shatter the economy of many villages within few hours. James Forbes marched with a Maratha force in Central Gujarat and observed how the wells and the reservoirs of the locality where they had camped during the night were exhausted⁸⁸ leading to reduction in the carrying capacity of the area. He remarked also of the Cambay area⁸⁹,

In this city and its surrounding domain are 50,000 wells, and some very fine tanks: but the nabob (nawabs), to prevent the maharatta armies from encamping near his capital, drained most of the lakes, and cut off their resources."

Hove had also mentioned about the members of warlike kathi community would hinder attacks by the Gaekwad's army by burning villages and crops and poisoning wells and reservoirs⁹⁰. Further, in the early years of the 17th century, the state suffered due to the number of famines and crop failures. The famines of 1812 and 1813 were severe and affected a large population on a huge scale. After 1813, scarcity of rains led to the failure of crops. The year 1834 was again one of scanty rainfall and locusts⁹¹.

Many sharehold villages could not bear such strain, leading to the collapse of *bhagidari*-style (land managed on the basis of shareholding) arrangement in many places. However the period after 1834 did not see any major famines till the disastrous drought of 1899-1900.

⁸⁸ Well irrigation, pg. 1538

⁸⁹ J. Forbes, *Oriental Memoirs: A narrative of Seventeen Years Residence in India*, vol.1, London, 1834, pp. 323, 363

⁹⁰ Hove, *Tours for scientific and Economical Research, Made in Guzerat, Kattiawar, and the Conkuns in 1887-88*, Selections from Records of the Bombay Government, no.16, new series, Bombay, 1855, pg.138

⁹¹ *Economic Life in Bombay Gujarat*, pg.170

The British when they assumed the power in Gujarat in many areas in 1817 did not encourage the water harvesting system and also failed to restore some excellent irrigation system. The large reservoir near Ahmedabad, the Karna Sagar, which has existed since the times of the Solankis – was fed from a dam on the river Rupen. This was washed away in the Monsoon of 1814. The English who occupied Ahmedabad in 1817, never made any effort to reconstruct this dam and the reservoir ceased to exist⁹². As R.G. Gordon later wrote⁹³,

" The repair of tanks was not attempted by government in the early years of our rule'.

Therefore the responsibility was left entirely to the cultivators, and with the disintegration of the village communities, the reservoirs were neglected.

Gujarat experiences uncertainty of monsoon. It may begin late, or terminate early, and at times there may be scanty showers only which show the need of irrigation in the area.

In 1849-50, the total land irrigated in Surat was⁹⁴ ;

By Wells	7,495 bighas
By Tanks	17,197 bighas
Total	24,692 bighas

Thus out of 756,603 cultivable lands in bighas in occupancy, and 426,799 bighas actually cultivated, only 24,692 bighas were irrigated.

Another region of Gujarat, which was mostly depended upon rainfall for irrigation, was Bharuch. The geological structure of the region made it difficult to either sink well or any other water storing structure. The

⁹² *Trade and Traders in Western India*, pg.30

⁹³ R.G. Gordon *The Bombay survey and Settlement Manuel*, vol II, Nagpur, 1960, pg.462

⁹⁴ Alexander Mackay. *Western India- Reports addressed to the Chambers of Commerce*, Milford House, London, 1853, pg.177

absence of extensive beds of sand and gravel (which is extensive in Ahmedabad and Kaira) made the sinking of well difficult and expensive. Thus in Bharuch in 1849, out of 1841 wells, 868 were exclusively used for drinking purposes and out of 973 wells available for irrigation, only 499 were in use, which made approximately one well available for irrigation per village⁹⁵. The same was the case with the tanks. Out of 1237 tanks, in the region, only 335 tanks were used for irrigation⁹⁶.

According to Alexander Mackay, there was hardly one tank per village in the state of Baroda. Even these tanks dried up during the month of March. Thus when the irrigation is needed most during the summer season, the supply of water actually ceased in most of the villages.

Canal and well Irrigation was more common in Ahmedabad and the Kheda district. The Hathmati and the Kharicut canals irrigated a tract of land lying between Sabarmati and the Khari River.

In 1823, according to Mackay, there were 2423 wells in Kheda, many of which were not in good condition. In 1849-50, out of 691,756 bighas of land in cultivation, only 28,657 bighas were irrigated⁹⁷ (less than 2% of cultivated land). The Kheda district had number of tanks. There were the Tranga and Nagrama tanks in the Matar taluka, constructed in 1901, having the capacity of 83 and 115 million cubic feet respectively. Further the Wangroli and Swat tanks in the Thasra taluka supported the crops during the bad weather. The Savli tank in the Kapadvanj taluka was put into operation in 1908-09.

Ahemadabad today exhibits many proofs of the extent of tank irrigation in the state. However during the visit of Alexander Mackay most of the reservoirs were in ruins, with state and people not taking any substantial initiatives in restoring them.

⁹⁵ *ibid*, pg. 178

⁹⁶ *ibid*, pg. 179

⁹⁷ *ibid*, pg. 180

In the Baroda division too, there were no large-scale irrigation works. There were small irrigation works, especially, "**Paddy Tanks**", which were used extensively for watering the rice, the chief of the monsoon crop. The number of small tanks in each taluka varied with the nature of the staple crops, soil and the capacity of the cultivators to irrigate the fields. Navsari, formerly a part of the Baroda State possesses fertile soil and possessed a large number of paddy tanks. Below is the resume of the various irrigation projects proposed, partially carried out and entirely completed by the end of 1907 in the Baroda division to ameliorate scarcity of water⁹⁸.

1. Haripura Tank: It was a small irrigation tank created in an area by bounding a ravine in the Vaghodia Taluka with an artificial embankment 6550 long to retain water from a catchment area of 5.5 sq miles. It was only a standby reservoir used only in the times of scarcity due to insufficient rainfall.
2. Karachia Tank: This structure was similar, as above constructed for the irrigation of rice fields. Its embankment was 8500 ft. long, with a catchment area of 45 sq miles and was irrigating an area of about 1000-1400 acres.
3. Orsang Irrigation Works: This was a small dam build on the River Orsang to use the perennial flow for irrigating rice lands in the Sankheda taluka. The dam was 2700 ft. long on a rock foundation built 6 ft. above the bed level of the river.
4. Khokhara Tank: this was a small tank, fed by perennial stream of Vachkadi river, usefull only in the years of scarcity. It had a catchment area of 4.5 miles with an embankment of 7,400 ft.

⁹⁸ *Huzur Political Office*, Correspondence related to irrigation works in the Baroda State, Daftar no. 549, section no. 177, and file no. 4, *BRO*, pp.171-175

5. Sarsi Tank: it was at Desar in the Savli taluka with a catchment area of 8 sq. miles, mainly used for irrigating the rice crop.
6. The Lachraj Tank: it was a small embankment for the irrigation of rice crops. The tank was 800 ft. long, with a catchment area of 2.5 sq miles. This tank was constructed during the famine of 1899-1900 for irrigating the rice crops. It was formed by bunding a natural depression, with an embankment 800 ft. long and impounding an available quantity of 10.5 million cubic feet from a catchment area of 2.5 square miles.

Navsari Division- Major Works⁹⁹

- (i) Umrat Irrigation Tank No.10: it was a stand by structure for the irrigation of the rice crops in the Navsari taluka capable of irrigating 800 acres of land.
- (ii) The Bandarpada Project: The Bandarpada weir and canal were an earlier works, in the Songadh taluka. It irrigated approximately 200 bighas.
- (iii) Chikli Weir No. 14\A: it was constructed in the Vyara taluka across the river and irrigated about 600 bighas.

Apart from these works, there were some other projects such as Doswada project no.11 in the Vyara taluka, the Valvi project on the River Mindhola in Vakal taluka and the Purna river project on the River Purna in the Vyara taluka were in the initial stages of their construction. Besides these, as stated earlier Navsari had small tanks in almost all the villages.

⁹⁹ *Huzur.Political Office*, Correspondence related to irrigation works in the Baroda State, Daftar no. 549, section no. 177, and file no. 4, *BRO*, pp.171-175

It is noted that in Gujarat the number of tanks was gradually on decline. Tanks are mostly used during the years of scarce rainfall. According to R.D. Chowksey, there was also a dearth of suitable sites for the storage reservoirs¹⁰⁰. The only feasible schemes were smaller and shallower tanks or dams with less storage capacity. Tanks are useful but there was little or no demand for them during the years of good rainfall, while in the years of scarcity, the tanks themselves had deficit supplies. The number of tanks in use for irrigation in British Gujarat, which stood at 4,721 in 1922-23, fell to 3,064 in 1942-43¹⁰¹. Another reason for the decline in number of tanks had been the process of silting up, over a long period of use without any maintenance and desiltation. As a result the capacity of the tank to hold water is being reduced by stages thus also reducing the carrying capacity of that village on a subsistence bases. While removing the earth from a tank in the Baroda district with the intention of deepening its bed, it was ascertained that as much as 30 ft. of its depth had been silted up¹⁰². The farmers did not have enough capital resources to maintain the condition of tanks or to undertake the work of repairs in the absence of help from the state or any philanthropic grants. The responsibility falls on to the government, which then never took interest in the maintenance of the condition of the tanks showing the indifference of the state to the welfare of its people. The British were more interested in constructing large irrigation dams and canals where the soil was extremely fertile (like Punjab and Ganga doab area). Gujarat however was not considered as productive and revenue yielding state as northern and western India.

By and large in Gujarat, most of the lands were irrigated by the wells. Of the 1, 16,525 acres in 1939-40, as many as 91,500 acres were irrigated from wells. This was little over 78% of the land under irrigation from

¹⁰⁰ *Economic life in the Bombay Gujarat*, pg.92

¹⁰¹ *Rural Economy of Gujarat*, pg.73

¹⁰² *Bombay Gazetteer*, vol. II (Baroda), pg.19

wells¹⁰³. Water from the wells was lifted chiefly by the means of a large leather bag- 'kos'. This was raised by the bullocks, pulling a rope attached to the bag over a pulley. At the top, the bag emptied into a trough, and from there water flowed from the channels into the fields. It was common to work more than one kos in a single well. In Ahmedabad, it was reported that almost all the wells were working with four kos and in the Kheda district, some wells were able to take up to eight kos at one time¹⁰⁴.

There was also manually operated water raising machine which consisted of a wheel five meters in diameter which was supported vertically on four poles, with a rope ladder around the rim on which the earthen pots were tied. The wheel was turned by the human power. The pots emptied water into the trough and then through channels into the fields. This device appears to be similar to the ancient water lifting apparatus known in Sanskrit as '*araghatta*'¹⁰⁵. These devices were used not only in wells, but were also found frequently on the banks of the river to lift the water to the level of the adjoining fields. The kos- *araghatta* type device was worked on the banks of the River Dhadhar in the Bharuch district.

Policy of water taxation in 19th and 20th century Gujarat.

Water, because of its importance in the generation of the revenues, soon began to be taxed. Initially the British assessed taxes on irrigated lands according to the existing practice in each locality. In some cases rates were determined according to the crops grown and in others according to the irrigation carried out. The tax settlement made in Gujarat from the mid 19th century onwards introduced a system of taxing land on the basis of its irrigated status. The village lands were everywhere surveyed and assessed for the tax. A dry crop rate was assigned to each field, with extra

¹⁰³ *Rural Economy of Gujarat*, pg.68

¹⁰⁴ Annual Collector's Report for Kheda district, 1851-62 and 1853-53, BA, Bombay, Revenue dept., 1858, vol. 29

¹⁰⁵ *Well Irrigation*, pg.1535.

charges being levied over and above this amount according to its capacity for irrigation. Distinctions were made between '*bhagyat*'-land irrigated by the well, '*himmayat*'- land watered from a channel through a reservoir, '*dhekudiat*'- land irrigated by water lifted from the adjoining river, and '*akasia*' (from sky) - terraced rice lands which were irrigated by rainwater draining from the higher ground¹⁰⁶. Once the field was classified, the extra tax had to be paid regardless of whether the field was irrigated or not in that particular year (this did not apply to the case of the *dhekudiat* land if a river changed its course, making irrigation of that land impossible). Every stone well had to pay additional charges according to its *kos* capacity. Even the tax *himmayat* varied from crop to crop.

When we reviewed the land tenure systems of the British in India it was clear that they asserted themselves to be the ultimate owners of the land and all its natural resources. In this light the land tax became a rent paid to the government for the use of the state land. According to David Hardiman this rent was further augmented with rents on the use of other resources 'owned' by the state. So the British appropriated water resources of India from the cultivators who had a customary right of use and then charged a rent for the privilege of extracting the resource.

In taxing the water rate, only precaution was taken that land was not charged with water rate when in fact water could not reach the land. On this basis, a *Himmayat* charge of Rs. 2 per bigha was imposed whether the available water as required or not. In the extremely hot season, a charge of Rs 4 in addition to the *Himmayat* charge of Rs 2 was levied. The latter tax on water was deeply resented by the peasants and it was actually understood by the government that if the ryot is not using the water given by the state, he is inefficient.

¹⁰⁶ Note by FGH Anderson, 1918, in Gordon, Bombay Survey and Settlement Manual, vol. II, pp. 461-67

In the words of the superintendent of survey of Gujarat¹⁰⁷,

"Water in the soil, and very close to the surface, is a gift of nature almost peculiar to the province of Gujarat. It ought, therefore, to be considered as one of the fertilizing elements of the soil and its value incorporated and included in the soil assessment whenever it is possible". No responsibility was placed on the government to ensure that there was flow of water, this obligation lay primarily with the cultivators, and they were obliged to pay their water rent whether or not water was available."

However there were protests especially from the influential patidars of Kheda regarding the heavy tax on the wells. It was calculated that each well had to pay a tax of about Rs. 95, which was not a lenient charge¹⁰⁸. Rich landlords dug the wells in their fields as an investment. Later on additional resolution of 1884 of the government stated that occupants of lands were entitled to enjoy the entire profits of improvements made at their own cost¹⁰⁹. This meant that now landholders had the right to exploit water resources under their land to any extent they liked and not be liable to any extra taxation. Later in 1890's, all the land was made liable to an extra 'sub soil rate' imposed in addition to the regular tax. The rate was calculated, depending upon the depth of the groundwater on a particular place.

The top category was that of sweet water available throughout the year at 10 ft. or less, which paid extra six *annas* in the rupee. Land with water tables lower than this, or with water of poor quality, paid lower rates. No tax was paid, if the water was 40 ft or more below the ground. In this way tax was to be paid whether or not water was actually extracted¹¹⁰. It was these two measures- the agreement not to tax 'improvements' and the new subsoil rates- gave an immense impetus to the development of the "market in well water".

¹⁰⁷ *Bombay Survey and Settlement Manual*, C.J. Prescott, vol.I Bombay, 1865, pg. 157

¹⁰⁸ *Well Irrigation*, pg.1539

¹⁰⁹ *Bombay Survey and Settlement Manual*, Gordon, vol. I, p. 150

¹¹⁰ *ibid*, vol. II, pp. 231-32

Well was also a chief source of irrigation in the Baroda State.

Table III C

Wells in the Baroda State, 1906-07.¹¹¹

Year	Irrigation purpose			Other than irrigation purpose		
	Wells		Tanks	Wells		Tanks
	Kaccha	Pacca		Kaccha	Pacca	
At the end of 1905-06	18,651	41,832	918	2,505	10,826	5,657
Constructed in 1906-07	95	436	04	27	212	06
Deduct those became useless	510	210	31	64	271	47
Balance at the end of the year	18236	42,058	891	2,468	10,767	5,616

The problems with the wells are that often they become brackish on the account of insufficient rainfall. The fresh water from the well is the result of surface percolation and when this percolation decreases or stops on the account of the scarcity of rains, the water often turns brackish on the account of the saline layers below. This is one of the hardships from which the cultivators suffered in the years of drought.

In Baroda State too, special rates were charged for the use of wells, which added up to the land assessment. It was noticed that in the Kadi district, digging of well was inexpensive, while in Baroda and Amreli, the cost of sinking of well was about Rs.1000- 1500. In Navsari, there were subsoil channels of water along the beds of dried up rivers and according to the

¹¹¹ BRO, Baroda Administrative Report, 1905, 1906, pg. 39

district officer, Mr. Khaserao Jhadav, the digging of wells along these channels proved to be more fruitful¹.

Table III D

Water rates fixed for the year 1928-29 for the irrigation (tanks) for the State of Baroda².

Name of the irrigation Tanks in the district	Fixed water rates			For perennial crops
All irrigation tanks in the district	Monsoon crops (Kharif)	Winter crops (Rabi)	Summer crops	
	Himayat at Rs 2 / bigha for all rice lands for which tank water is available even if no water is required. No extra charge if water is supplied for the protection of the rice crops.	Compulsory levy of Rs 2/bigha for all survey numbers for which tank water can be supplied for winter crops even if no water is required. No extra charge to be levied up to 2 waterings after which Rs	Rs 4/bigha for any number of watering if water is used. This is in addition to the obligatory rate of Rs 2.	Rs 10/ bigha including the obligatory rate of Rs 2.

¹¹² *Baroda Administrative Report, 1903-06, pg. 39*

¹¹³ *BRO, Report of the irrigation Committee, Baroda State, 1929, pp.38-39*

		1/bigha watering will be charged in addition for each subsequent waterings provided that the maximum of this levy is Rs 4, including Rs 2 of the obligatory rate.		
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Provision of irrigation facilities, ensured to the government, the enhancement of revenues. Therefore there is the direct relationship between irrigation and revenues.

Table III E

Revenue of Baroda and Navsari district¹¹⁴

Year	Baroda district		Navsari district	
	Assessment (Rs)	Collections (Rs)	Assessment (Rs)	Collections (Rs)
1907-08	34,115,014	29,40,795	17,50,044	17,22,173
1908-09	35,36,76	34,36,781	17,47,131	17,34,259
1909-10	34,40,220	34,29,546	17,07,568	16,95,324
1910-11	38,90,141	37,97,518	17,37,925	17,15,762
1911-12	37,93,516	35,83,760	17,37,925	17,15,762
1912-13	41,36,398	40,82,731	18,60,638	18,22,622
1913-14	41,38,478	40,94,019	18,79,90	18,50,152
1914-15	41,82,925	41,49,494	19,74,328	18,82,616
1915-16	42,99,080	42,56,073	19,15,412	19,04,408
1916-17	43,23,545	42,80,545	19,00,306	18,91,572
1917-18	47,06,959	46,66,230	18,89,862	18,79,688
1918-19	43,08,114	34,44,403	19,02,404	18,13,914
1919-20	43,63,149	42,52,885	19,28,111	19,20,741
1920-21	42,02,014	40,33,758	18,93,362	18,80,508
1921-22	42,70,109	42,15,273	19,23,403	18,90,235
1922-23	44,38,822	43,94,787	19,49,004	19,22,663
1923-24	46,20,215	43,78,116	19,82,616	19,75,466
1925-26	46,63,276	48,78,420	19,89,732	19,78,627
1926-27	46,03,276	45,21,508	20,28,48	20,25,504
1927-28*	46.64	46.07	19.80	19.73
1928-29	42.73	41.87	15.42	15.22
1929-30	47.37	45.90	20.12	19.86
1930-31	46.68	45.56	19.79	19.47
1931-32	46.93	45.71	20.01	19.88
1932-33	46.70	45.64	20.02	19.84
1933-34	46.82	45.82	20.20	19.79
1934-35	46.37	35.62	10.98	10.98
1935-36	46.46	44.99	19.86	19.75

¹¹⁴ Compiled from various *Baroda Administrative Reports* from the year 1906-07 to 1935-39, *BRO*.

* The figures from this year onwards show the revenues and collection in lakhs of Rs.

Therefore can we say that extensive irrigation directly led to the regular increase in the land revenues?

Increase in Population and Reduction in Carrying Capacity

We have been witnessing a huge increase in human population. Increase in population at times may lead to the reduction in the carrying capacity of an eco system or ecology of a region. Human carrying capacity can be interpreted as the maximum rate of resource consumption and waste discharge that can be sustained indefinitely without impairing the functional integrity and productivity of relevant ecosystems. However the increase in population at a large scale and the maximum use of earth's natural resources hamper the equilibrium of an eco system. This may lead to many changes in the environment of a region. Growth in human population may lead to extensive demand for food products which in turn exhaust the water supply, wooded resources, fuels etc.

In Gujarat, during the colonial period the human population increased at a rapid rate, which in turn led to the maximum use of resources.

The following table shows the increase in the population of the area under study.

Table III F

Increase in population ,1891-1941¹¹⁵

Region	Population				
	1901	1911	1921	1931	1941
Ahemadabads	722,218	759,796	811,476	900,605	1,249,181
Surat	6,37,017	6,54,109	6,74,351	6,93,613	8,81,058
Kaira	1,037,249	1,016,501	1,032,490	1,123,196	1,336,297
Broach	2,91,736	3,06,717	3,07,745	3,34,170	-
Baroda district	590,338	696,878	754,836	878,436	1,04,537
Navsari district	300,441	3,35,467	340,372	4,04,377	465,923

Growth in population directly leads to the rise in demand for agricultural products, which results in clearing the forests for cultivation. The following table shows the increase in the areas under different crops in Bharuch.

Table III G

Acreage of important crops in Bharuch¹¹⁶

Cereals	1874-75	1955-56
Jowar	78,601	1,41,712
Wheat	50,837	59,817
Rice	20,359	67,417
Bajri	16,087	21,607
Kodra	4,176	17,525
Others	NA	8,042
Total Cereals	1,70,060	3,16,129
Pulses		
Tur	14,250	21,487
Others	21,530	61,912

¹¹⁵ Data collected from various gazetteers of Ahemadabad, Surat, Kaira, Broach, Baroda and the Navsari districts.

¹¹⁶ M.R. Palande *Gazetteer of India*, Bharuch district, Ahemadabad, 1961, pg.202

Total Pulses	35,780	83,399
Cotton	1,79,233	5,64,454

The same trend can be noticed from the increase in the area of agricultural production in Surat.

Table III H

Acreage of various crops in Surat District¹¹⁷

Crops	1880-81	1953-54
Jowar	85,527	3,00,039
Bajri	6,329	6,714
Wheat	27,237	16,547
Rice	93,952	2,66,160
Ragi	12,275	34,849
Other	1,885	27,736
Total Cereals	2,72,281	7,08,131
Cotton	69,089	2,95,562

Environmental impacts resulting from food production-such as dry land salinity, demand for water, runoff of pesticides and fertilizers made necessary by centralized production/ monocultural agribusiness- are predominantly generated by the demands of growing population which leads to ecological overshoot. Ecological Overshoot occurs when human demands exceed nature's supply at the local, national or global scale. The level of overshoot is the amount by which nature's biological capacity is being used beyond its regeneration rate. It leads to the large-scale depletion of forests as a result of the increase in the lands under

¹¹⁷ *Gazetteer of India, Gujarat State, Surat district*, M.R. Palenkar, Ahmedabad, 1962, pp. 329-330

cultivation, settlement of growing population and the scarcity of non-renewable resource, like water.

Demand of water for irrigation and for human consumption on an extensive scale in addition to deforestation may at times leads to severe drought, which can be termed as the ecological overshoot of growing population.

Droughts ground water and water scarcity

It is common knowledge that droughts usually lead to famines if the water scarcity is not dealt with at the right time. Drought is an old phenomenon in Gujarat. It has been recorded in written as well as oral history of the region. However the nature of droughts and their impact on rural life are quite different today from what they used to be in the past. For Gujarat marked severe famines were those of 1631, 1696, 1718, 1731, 1747, 1791, 1812, 1899 and 1901.¹¹⁸

Water scarcity is clearly mentioned for the first time by the Famine Commission of 1901, which states that on account of failure of water supply in the princely states, people were often left with no alternative but to immigrate to British territories during the famines. The description of the drought of 1911 in Baruch also refers to the distress of people on this account¹¹⁹.

It was in the year 1899-1900 that Gujarat suffered from one of its worst famines. This disastrous year was known throughout Gujarat as '*chappan*' (fifty six) and used as a landmark for reckoning the dates and Ages.

In most accounts of the '*chhapaniyo*' drought all sought of descriptions can be found of how people coped with hunger, but there are no

¹¹⁸ Bela Bhatia, *Lush Fields and Parched Throats, Political Economy of Groundwater in Gujarat*, in *Economic and Political Weekly*, December 19-26, 1992, pA-142, col. III

¹¹⁹ Gujarat Relief Manual, Government of Gujarat, 1976, pp 13, 19-24.

corresponding accounts of the strategies they adopted to cope with water scarcity¹²⁰. This observation also applies to Bhailalbai Patel's brilliant account of the '*chhapaniyo*'. In his narrative here is no corresponding account of hardship caused by groundwater scarcity¹²¹. He mentions large-scale land alienation in the Baroda State where the revenue had not been remitted, unlike in most places under the British jurisdiction. The Gaekwad government chose to adopt strict measures for the collection of land revenue. Those who failed to pay were imprisoned for a few days, while the land of those landlords living in the cities was auctioned. In fact very interesting is his description of how the land of the landlords was thrown away at a pittance, Bhailalbai uses the revealing expression "*panine mule*". This Gujarati expression can be literally translated 'at the cost of water'. The use of this metaphor is consistent with the continued availability of groundwater during pre-independence droughts in Gujarat, in sharp contrast with the present situation. Though Bhailalbai does mention the existence of surface-water drought, and of increased dependence on ground-water for water needs¹²².

One of the outcomes of this drought was that the groundwater dropped considerably in many parts of Gujarat. This made irrigation by existing wells using traditional lifting devices difficult. It was to overcome this, the government, began to encourage the boring of tubewells at the bottom of the existing wells. To extract water from such wells, a steam or oil driven pump was required. From 1908 onwards, the Department of Agriculture began hiring out well boring equipment to farmers. In the Matar taluka of the Kheda district successful borings were an average depth of 15 meters below the bottom of the existing well, whereas in the Borsad taluka of the same district successful borings were on average 24 meters. By 1911, 14

¹²⁰ Lush Fields and Parched Throats, pA-143, col. I and II.

¹²¹ Bhailalbai Patel, *Bhaikakana Sasmarno*, Sastu Sahitya Vardhak Karyalaya, Ahmedabad, 1970.

¹²² J Gupta, 'Development Plans Caused Chaos: Water Problem in Gujarat', *The Statesman*, New Delhi, May 6, 1988.



boring machines were in operation in the Kheda district. This was a year of poor rainfall, and, in the words of the district Collector¹²³, Applications began to pour in by hundreds for boring sets from well owners.'

It was actually believed by the Bombay government that Gujarat could be made famine proof by such means¹²⁴.

Once again in the draught of 1918-19 the government had to liberally provide 'taquavi' loans for deepening of wells in the wake of massive crop failures.¹²⁵

Groundwater and Boring operations

In Baroda too, there was a great demand from the cultivators for the boring of their wells. In 1912-13, 20 boring machines were put up in the Navsari, Baroda, Petland and the Kadi division. 204 boreholes were made during the year in 76 villages, as against 119 of the previous year¹²⁶. (See map III C). The successful wells now gave 565 koses of additional water¹²⁷. In 1919-20, the department had whopping 103 applications for boring, of which 57 wells were bored, out of which 13 were unsuccessful¹²⁸. At this time the rock boring power machines were particularly successful and there was an increase in the demand of such a well. The total expenditure of the boring branch in this financial year amounted to Rs 15,273-11-7 and the earnings came to be Rs1, 184-0-8¹²⁹.

At times borings on such a large scale led to the reduction of the water table, which consequently resulted in the scarcity of water. This fact became obvious in the year 1923-24, when in the Baroda state; there was

¹²³ BA, General Department, 1913, Report of March 16, 1912, 95/77

¹²⁴ *Annual Report of the Department of Agriculture*, Bombay Presidency, 1910-11, Bombay, 1912, pg.13

¹²⁵ *Lush Fields and Parched Throats*, pA-143, col. III

¹²⁶ BAR, 1912-13, 1914, pg.30

¹²⁷ *ibid*, pg.31

¹²⁸ BAR, 1919-20, 1921, pg.172

¹²⁹ *ibid*, pg.172

an acute shortage of water supply in the wells and the tanks even for the drinking purposes¹³⁰.

This spurred the local boards to adopt measures for meeting the solution, but the number of applications for the boring of wells kept on increasing.

Table III I

Boring Operations in the State of Baroda¹³¹.

Sr. No.	Item	Year 1931-32	Year 1932-33	Year 1933-34
1	Applications received	29	49	45
2	Wells taken up	29	42	44
3	Successful bores	17	30	30
4	Increase of water in kos	28.5	38.5	35.25
5	Total depth bored in feet	—	—	2,978

Therefore, there was a continuous demand and supply of water through borings. No one perhaps ever estimated then, that water in Gujarat in next few decades would become scarce.

Well boring had become very expensive. On an average, the cost came to be Rs.142 per well and this sum had to be paid even if the boring failed. If it succeeded, then a pump had to be purchased and installed. It was calculated that the annual operational cost (including the cost of kerosene), repairs and the interest on the capital borrowed for the investment amounted to Rs.1, 284 for the smaller pump and Rs.3, 573 for the larger¹³². To make the situation worse, the First World War led to sharp increase of prices of fuel like kerosene, which made it difficult for the small farmers to

¹³⁰ BAR, 1923-24, 1925, pg.193

¹³¹ Data collected from BAR, 1932-33, 1933, pg.167 and BAR, 1934-35, 1936, pg.152

¹³² Well Irrigation, pg. 1540

undertake the boring operations (They then had to buy water from their rich farmers). On the whole, due to expenses involved in the boring of the well only rich peasants were benefited. Most of them were too poor to benefit, one of the chief reason being that land rates were too high. The wealthier farmers to save themselves sold the water of their well at a high rate to the poor peasants. In the Bharuch district this led to a rising by the poor peasants against the rich farmers in 1847.¹³³ This had put severe pressure on village based irrigation works. Significant portion of the peasant community became mired deep in debt, lacking the means to maintain even their own wells. As a result many farmers depended on the rains to irrigate their fields and thus at times lands even went out of cultivation during the drought period.¹³⁴

The owners of the wells had started selling water to the other farmers to pay off their debts incurred during the digging of wells. It was calculated in 1918 that an average bullock powered *kos*, could lift 1,080 gallon in an hour and such a *kos* could irrigate one acre of land in 54 hours- which given a working day of eight hours meant about a week. Pumps on an average could draw 4,803 gallons per hour, irrigating an acre in 12 hours¹³⁵. It was also calculated for one village in the Charotar tract that in 1920, two pumps had replaced 35 pairs of bullocks and the irrigated area in the village, had risen by a quarter.

The main finding was that when a pump was in use, the water level in the well fell rapidly¹³⁶. In the Borsad taluka in 1924, in the charotar tract, the pumps belonged to the wealthy farmers who sold the water at the rate of one and a half to two rupees an hour of pumping time. Some these pump

¹³³ Ibid, pg. 1539

¹³⁴ Ibid, pg. 1539

¹³⁵ *Annual Report of the Department of Agriculture, Bombay Presidency, 1917-18, Bombay, 1919, pg.87*

¹³⁶ *Jamabandi Revision Settlement, Report of the Bhadran Peta Mahal of the Petland Taluka of the Baroda division, Baroda, 1921, pg.68*

owners were reported to have made losses, as the pumping had rapidly exhausted the wells¹³⁷ reducing their carrying capacity. The peasants of the Charotar tract did not, on the whole, enjoy the benefits of irrigation. They were almost depended upon the rainfall, which in an average year produced about 750mm of rain. There were no canals in the tract, in fact Kheda district as a whole; only a small area in the Deskroi tract had such irrigation. In the tract of Charotar, almost all irrigation was carried out by *kos* and wells. We may thus point out that the process of over utilization of water that began during the colonial period continued into the post independence era leading to the drastic reduction in the water table in Gujarat.

Therefore by the end of 1930's, water had become a commodity. The landlords and the rich farmers were exhausting the groundwater not only by irrigating, but also by selling it. The knowledge of earlier technique of sustainable use that was visible in the water conservation through the use of check dams, reservoirs and the wells were gradually on a decline. In the colonial period, the major emphasis was on the wells. The introduction of mechanized pumps encouraged by the English did prove harmful in the long run for the ecological balance of India. After independence, with Green Revolution, technology continued leading to the extraction of water on a large scale prevailed and water was extracted on a large scale, forgetting that it is a non-renewable resource.

Large dams versus small dams

In the early years after independence, big dams have been promoted as the temples of modern India. The advantage of building a large dam seems to be numeraire, but the long-term effects involved in such a massive construction leads to greater number of problems in the long run.

¹³⁷ Well Irrigation, pg. 1540

The latest studies and experiences seem to favor small dams for example in Japan the trend is shifting toward small and easily manageable dams, which if struck by a disaster would lead to small scale environmental, economic and human damages.

The Narmada Valley project has remained intensely controversial ever since details of it first became public. Environmentalists all over the country have been firmly opposing the project, because this would set in motion fundamental changes in the river valley basin. The principal focus of opposition have been the two giant reservoirs, the Sardar Sarovar in Gujarat and the Narmada Sagar in Madhya Pradesh, which between them would hold more water than any other dam on the Indian subcontinent.

In a country in which, the forest area is already markedly below the set standard; the Narmada project will submerge and destroy 40,332 hectares of forest area. The Sardar Sarovar will inundate an additional 13,744 hectares of forests¹³⁸. The destruction of forests will further lead to the disappearance of hundreds of species of flora and fauna. The construction of big dam also leads to the siltation, which reduces the storage capacity of the dams. Besides, water logging is also associated with large-scale irrigation schemes, which lack effective drainage to enable surplus waters to be flushed away leaving salt behind during the evaporation.

What is required is the careful planning. It is necessary to compare and contrast the utility of big and small dams. Small dams and check dams, do not involve huge environment degradation, besides they are easy to manage. The ancient system of storage of water needs to be revived. Many lakes, tanks, *kunds* and stepwells that are damaged and neglected, need to be repaired and brought in use. The storage of water in reservoirs

¹³⁸ Claude Alvaree and Ramesh Billorey, Damning the Narmada: The Politics Behind the destruction, *The Ecologist*, vol. 17, no. 2/3, March/June, 1987, pg. 63

will also help in maintaining the groundwater level-the problems from which number of regions in Gujarat is suffering. The installation of tube wells and electric pumps have played their part in the depletion of the water level. Technology should be used within the certain set limits and not for the purpose of exploitation.

The big dams not only have an impact on the surrounding environment but it also results in the displacement of people and submergence of land. The worst sufferers are the small farmers and various tribes as they are displaced from their ancestral homes.

India has a long tradition of water management , which was developed on the values of rainwater harvesting, conservation, and effective utilization, These traditional methods of water management still survive in some parts of Rajasthan, Gujarat, Tamil Nadu, Andhra Pradesh , Karnataka, Kerala, and the North east. The British had neglected them which led to severe conditions during the times of droughts. The miseries of the people were aggravated in the form of greater frequency and severity of famines. In present times acknowledging their relevance and initiating a movement for restoring the role of the community in the management of common resources are affirmative steps towards identifying the appropriate solution to the deteriorating water situation. We have taken the very resource we depend upon for our sustenance as granted and we may soon have to pay the price for it .The inextricable links between tanks and trees are vital for the sustainability of development intervention and attempts to either revive the system or constitute the riparian commons.

The environmental benefits of traditional water harvesting structures, are improved soil moisture, increased bio-mass production, improved water quality, enhanced land value and flood moderation. The community based

water- harvesting structures have also contributed to social cohesion and self- reliance. That was visible in pre- colonial times¹³⁹.

¹³⁹ Dayal, R and Pand G C Traditional water Harvesting systems: role of government and non-government organizations, *Journal of Rural Reconstruction*, 1999, 32(2):75-80