CO-OPERATION AND COEXISTENCE ON WATER MANAGEMENT BETWEEN INDIA AND PAKISTAN

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MASTER OF PHILOSOPHY

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CERTIFICATE

This is to certify that the disseratation entitled "CO-OPERATION AND COEXISTENCE ON WATER MANAGEMENT BETWEEN INDIA AND PAKISTAN", submitted by Ms. Smriti Sharan in partial fulfilment of the requirement for the award of the Degree of MASTER OF PHILOSOPHY of this University, is her original work and has not been previously submitted for any other degree of this or any other University. It may be placed before the examinees for evaluation.

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Smriti Sharan

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CHAPTER - I

INTRODUCTION

Water covers about three-fourths of the earth's surface. Almost all of this water is in the oceans. Of the 5% that is fresh water, 4% lies frozen in the polar regions. Thus all water in the lakes, rivers, atmospheric moisture, soil and vegetation and underground water amounts to only one percent of the total. Of the one percent too, rivers account for 0.1% only. Since ground water is not available everywhere, the importance of the river water increases manifold.

Agriculture is the greatest user of water accounting for nearly 80% of all global consumption. The demand for irrigation is increasing as efforts intensify to feed the worlds growing population. It is gradualy being realised that water is a finite resource to be conserved and protected. But only in the regions of chronic shortage, is fresh water respected as giver of life, else where water is generally treated as an inexhaustible resource, free to be wasted.

However, increasing population pressures are making us aware of the limited nature of land and water and how critical water will be to the quest for greater self sufficiency in food. River basins are precious natural resources. If properly developed they can substantially augment food and water supplies, improve transport, provide energy and develop industries. With population growth threatening to outstrip food suppliesand new and cheaper resources of energy in urgent demand, harnessing natural water resources for human needs takes on an importance which is difficult to exaggerate.

Moreover the importance of water resources to society and also to the government is also great. With our complexed metropolitan civilisation and advanced technologies there has been new demands for water.

Sophisticated industrial processes, central power stations and advanced sanitation systems are major modern demands, while the ancient uses like the agriculture still represent the predominant consumptive use out of the international water resources.

Waterborne commerce remains a major mode of transportation and lifeline of many large cities. Thus water can be called a fundamental resource. In most regions it is a finite and scarce resource. Its importance to man can never diminish but the claims on it seem destined to increase both in complexity and in quantity.

To solve the above mentioned problem water management seems to be essential which very simply put will mean an efficient and optimal use of water resources so that there is a fairly regular distribution of it under the various heads and also through the different parts of the year.

Integrated management may be contemplated in three ways. First of all it may imply systematic consideration of the various dimensions of water: surface and groundwater quantity and quality. The key aspect here is the acceptance that water comprises an ecological system which is formed by interdependent components. Each component may influence other components and therefore needs to be managed with regard to the interrelationships. At this level of integration, attention for management is directed to joint consideration of such aspects of water supply, waste treatment and disposaland water quality.

Second, integrated water management can imply that while water is a system, it is also a component which interacts with other systems. Inthat respect, it directs us to address the interactions between water, land and environment, recognising that changes in any one may have consequences for the others. This perspective is broader than the first and requires attention as well as expertisein both terrestial and aquatic issues. This also includes the issues as the floodplain management, erosion control, nonpoint sources of pollution, preservation of wetlands and agricultural drainage.

A third and even broader interpretation is to approach integrated water management with referance to the interrelationships between water and economics,and social development. This stresses upon the relationships between environment and economy. Here the concern is to determine the extent to which water is both an opportunity for and a barrier against economic development and to ascertain how to ensure that water is managed and used so that development may be sustained over the long term. At this level interest turns to the role of water in producing hydroelectricity, in facilitating transportation of goods and in serving as an input to manufacturing or industrial production.

Keeping in view the three approaches to water management in mind, the level of cooperation and coexistence between the two countries i.e. India and pakistan , may be studied. Both the countries are primarily agricultural in their economy. Moreso the Indus basin falls in the water scarce zone thereby enhancing the importance of the Indus riversystem and it's efficient utilisation. This further brings us to the disputes that arose regarding the use of the Indus waters and the subsequent treaty that was signed between the two countries.

CHAPTER - II

THE HISTORY OF CIVILIZATION IN THE INDUS VALLEY

During the course of both ancient and modern times some human societies managed to evolve to levels of great socio-political complexity. The Study of these high cultures presents problems of great magnitude and few attempts that have been made to explain them, have not met with any great success.

The river System of the Indus now mainly in Pakistan, takes the credit of having nurtured one of the earliest civilizations of the world. The fertile plain of five rivers watered by the five great tributaries of the Indus viz the Jhelum, Chenab, Ravi, Beas and Sutlej - had a high culture which spread as far as the sea and along the western seaboard at least as far as Gujrat. The lower Indus region known as Sind in Pakistan now forms a semi barren desert though it once formed a well watered fertile land.

The Indus civilization was confined essentially to the vast plain of the greater Indus valley- the Indus and the Ghaggar - Makra river systems and also along the Arabian sea coast. The culture, however, does not seem to have penetrated deeply into Baluchistan hills. All the known sites are situated along the hilly borders at the

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The Indus civilization was confined essentially to the vast plain of the greater Indus valley- the Indus and the Ghaggar - Makra river systems and also along the Arabian sea coast. The culture, however, does not seem to have penetrated deeply into Baluchistan hills. All the known sites are situated along the hilly borders at the strategic passes and on main overland routes such as the site of Pathani Damb on the Mula river, Gudri in the Solan Pass, Dabur Kot and Kaonri in the Loralai Valley located on the ancient line of communication leading to southern Afghanistan. Then there is the site of Periano Ghundai in the Zhob valley of northern Baluchistan which joins the Gomal Pass. The distribution of the Harappan sites, at first sight, give an impression of an °Indus Empire' encompassing part of Pakistan and western part of Modern India.

Against the above mentioned backdrop a chronological evolution of settlements in this region can be attempted.

Somewhere around the fourth millennia, the border formed by the Iranian plateau and the Indus plain, sheltered a hive of hidden tribal and village societies, appropriately cellular but sharing a common level of living and technology. In their obscure valleys they were diversely reaching the cultural optimum which their rugged surroundings permitted. Occasional contact between one community and another and with the outside world is manifest, but for the most part the tribes or regions were self contained on the basis of local crops which they learned to irrigate by the concentration of floodwater and the small herds of animals which they tended to. Any further integration of political or cultural type was barred by the environment.

The fertile plain formed by the five rivers formed a high culture, which gradually spread. The two factors namely the terminal ocean and the flanking plain were together responsible for the sudden emergence of the next cultural phase i.e. of the Indus civilization.

These smaller cultures survived and grew due to related, positive roles played by pastoralism and agriculture. An important element must have been the relations established between upland valleys and flood plains of the neighbouring Indus system. Another important element could have been the arteries through which the long distance trade flowed, particularly those originating in the main centres of wealth wherever they may have been. It is probably this trade which provided stimuli for the development of an incipient urbanism in one part of the region. For example in Southern Afghanistan and Seistan this led to the growth of sites such as Shahri-Sokhta or Mundigak,into towns or even caravan cities.

The attempted colonization of the valley continued intermittently, failure succeeding failure, until at least a leader more determined, far sighted and fortunate than the rest, won through.

One of the most favourable factors confronting him was of course, the great river system itself. Flanked by wide expanses of fertile alluvium which was renewed regularly by the annual flood. The scrubland and marshes contained wildlife, the rivers provided ample fish, which served as food, and continue to do so till today.

These very same rivers were the arterial routes to the sea and the Persian gulf and to the Himalayas on the other.

Classical writers show that when in 326 B.C., Alexander crossed the Indus, the climate of North western Indian subcontinent was as warm as it is today, though perhaps a little moister. The river valleys were fertile and well wooded, though the coastal strips to the west of the Indus, now called the Makran and much of Baluchistan were already dry and desolate. But in 3000 B.C. the climate was very different. The whole Indus region was well forested providing fuel to burn bricks. The Himalayan region too served as a lumber producing region. Along these same tracks metals and gemstones were brought along by long range traffic. And by the same intellectual interchange a currency in ideas now became feasible with unprecedented ease and scope. In contrast to the upland valley with its scanty soil, uncertain water supply and close horizon, the lowlands overall provided with spacious opportunities indeed.

On the other hand, there was a debit side too. The annual snow-melt flood rejuvenate the soil but when unrestrained, it turns into an angry destroyer; and it is now suspected that normal flooding was supplemented from time to time by abnormal inundations due to geomorphological factors which require further investigation.

In these discouraging conditions, irrigation and indeed the general economy of a city of the plain involve tireless planning and co-ordination and yet can readily succumb to weariness and indifferent control. So exuberant and at the same time so menacing an environment demands from the outset a society strong in heart, disciplined, numerous and imaginatively led, els it had perished long before a vast city such as Mohenjodaro could have risen as its memorial.

Speedy success is therefore an almost inevitable precondition of the nuclear centres of the Indus civilization. Excavations suggest that the civilization settled down for several centuries with a remarkably sustained equanimity to the exploitation of and intermittent battles with its environment. Aided by some sort of irrigation which is now deeply buried by post-Indus aggradation but may in principle be assumed that it grew food crops and cotton, it kept considerable herds; and traded with its neighbours of the Persian Gulf.

THE EARLY INDUS PERIOD

Around the middle of 4th million B.C. a development which is of profound importance seems to have begun through out virtually the whole Indus system. One is aware of a spread of settlements, doubtlessly resulting from a growth of population caused by, and centered upon, the vast possibilities of agricultural productivity which were opened up by exploiting the flood plains of the Indus system. The first settlement of the Indus plains, when viewed from the Indian subcontinent marks an event of great cultural significance.

Also characteristic of these new settlements is a convergence of traits of material culture suggestive of the sort of cultural unification which will appear in the succeeding Indus civilization. These people belonged to several cultures, primarily distinguished by different types of painted pottery. Each culture had distinctive features of its own, but all were of the same generic pattern as those of the Middle East. Though their settlements were small, rarely more than a few acres in extent, their material standards were comparatively very high. The villagers dwelt in comfortable houses of mud brick with lower courses of stone made good pottery. They also knew the use of metal.

The village cultures had varying customs, for the secluded valleys of the Brahmi Hills and the comparative simplicity of the lives of the inhabitants did not encourage very close contact. Thus the northern villages made red pottery and the southern buff; the people of the Kulti culture in the Makran-burnt their dead, while those of the Nal culture, in the Brahui hills, practised fractional burial. It seems that the Kulti people made contact with the earliest Mesopotamian civilization by sea.

The first region for consideration includes Lower Sind and the edges of the Indus Delta.

The southern group of sites is that associated with the type-site of Amri. The settlements still rise for the most part well above the flood plains of the Indus; and are found in tributary valleys for example the site of Othamanjo Buthi or on piedmont ground situated between the western hills and the plains. The site of AMRI is important because it has been proved that there existed a pre Harappan phase lying beneath the Harappan culture. The ancient settlement lies within a mile of the river Indus, on the right bank, near the edge of the alluvial plain.

In the south, on a promontary which in those days was probably on a coast, although now far inland behind deltaic formations, is the fortified settlement of Tharro. Another fortified settlement is at Kohtras Buthi, south west of Amri. To the north, lie other small sites such as Pandi Wahi and Gazi Shah. West of Tharro lies ALLAHDINO, the main settlement here belonging to the Harappan period. About 160 kilometers northeast of Amri, on the left of the Indus (today some 20 miles from the river, but still near one of its ancient flood channels) and close to the agriculturally productive land lies Kot Diji. The ancient site is located on the solid ground below a small rocky outcrop.

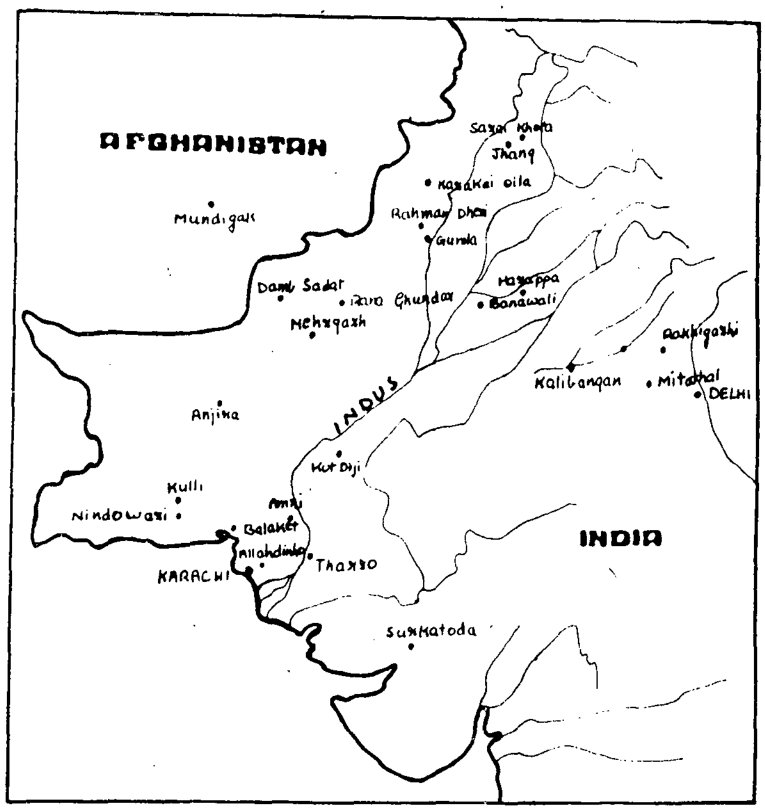
About 50 km west of Kot Diji on the right bank of the Indus lies Mohenjudaro, now some three miles from the river, but squarely on the flood plain. The continuing depositon of alluvial silt with each year's floods has raised the whole land surface in this area more than 10 meters since Harappan times, and as the water table has risen correspondingly archaeologists have so far been unable to plumb the lower levels of this vast site.

Other sites are in Dera Jat, Dera Ismail Khan and Bannu districts. In the Bannu basin - LEWAN DAR DARIZ site has been excavated. Here a huge factory site has been discovered manufacturing great numbers of specialized stone tools, including perforated ring stones, querns etc. At both Rehman Deri and Lewan there is evidence in the form of turquoise and Lapis Lazuli beads of continuing trade links with Central Asia. Another settlement is SARAI KHOLA, 240 km north east of Bannu. In the southern indus at Jalilpur there seems to be development of the early Indus period. Following the Ghaghra-Hakkar river course north eastwards into the territory of modern India, is the site of KALIBANGAN. It is located at the bank of now dry river Ghaggar - 200 km south east of Harappa. The settlement at Kalibangan was surrounded by a massive rampart, also of mud brick for defence against floods/humans/animals.

In the plains of Indo-Gangetic divide - an early Indus culture phase can be recognized. The main sites are Banwali, in the dried up Saraswati Valley and Siswal and Rakhigarhi to the south in the Drishdawati valley. On the western borders there is considerable Baluchi influence.

From the map attached along with (MAP NO.1) it can be seen that all these above mentioned sites had got located along the Indus river system. Right from Amri, Alladinho, Tharro, Balakot at the mouth of Indus to Jalilpur, Harappa, Banwali Lewan, Rehman Deri or Sarai Khola northwards - all the settlements derived the lifeline out of Indus waters.

SITES OF EARLY INDUS PERIOD



SOURCE: BRIDGET AND RAYMOND ALLCHIN — THE RISE OF CIVILIZATION IN INDIA AND PAKISTAN. Pg. 132.

(MAP 1)

consequential floods. This amply demonstrates the importance of the river system in giving birth and sustaining one of the ancient most settlements.

From a closer study of all these settlement patterns, a few approximate conclusions can be arrived at namely -

Throughout the whole of the Indus plain, regular agricultural settlements, based on wheat and barley and domestic cattle, sheep and goats began to appear during this period. These settlements had regular constructed houses, often with surviving traces of town walls. "There was a process of cultural convergence and increased homogeneity in realm of ideology and religious beliefs."[1]

The early Indus period was one of incipient urbanism. The essential basis for the mature urbanism must be seen as the gradual build-up of population and its spread through the Indus, the growth of technology and agricultural know how along with the establishment of socio-economic interaction sphere over an enormous area.

THE MATURE INDUS SITES

The mature Indus phase encompassed almost a little

1: Bridget and Raymond Allchin: "The rise of civilisation in India",(Great Britain, 1982).

less than half a million square miles. Within this area almost seventy sites are known of which the great majority lie on the plains of the Indus or on the dry course of Ghagger or the Hakra river which once flowed to the south of the Sutlej and then southwards to the east of the Indus with the Thar desert on its left bank.

Outside the Indus system, to the west a few sites lie on the Makran coast, the farthest being Sukta-gen-dor. A few cites occur beyond the marshes of Kutch for example the trading post at Lothal. This was a flourishing port town that carried on trade with the Middle east and beyond. Evidence of a floating dock has been confirmed by way of excavations. However the two most important cities were Mohenjodaro and Harappa. Here emerged the civilization in the sense of an organised government over a comparatively large area and this happened nearly simultaneously in the river valleys of Nile, Euphrates and Indus.

Harappa was a large, well laid out town situated on the left bank of Ravi, in the Punjab while Mohenjodaro its twin city was located on the right bank of the Indus, some 250 miles from its mouth. Another site where a city settlement existed was at Kalibangan in the valley of the old river Saraswati. Here agriculture flourished as has been proved by the evidence of furrows and grains that were found there. In these major cities some buildings worth mentioning are the granaries, the Great Bath, The Central Hall etc. The plan of houses, the roads, the well covered drains, the special sheds for craftsmen all these display a high level of urbanization that existed during this time. Other sites are Sandhanwala in Bhawalpur, Judeirjodaro in Sind. Further South in Sind are Amri and Chanhudaro. Smaller sites are at Rojdi in Saurashtra and Desalpur, Surkatoda in Kutch. Allahdino, Balakot and on the eastern borderlands of the Indus system are Mithathal, Banwali and Alamgirpur.

The Indus civilization in its maturity was the result of the concurrence of 3 major factors.

The first and perhaps the most important in terms of its actual character was its direct development from the cultures and existing population of the early Indus in the Indus plains. These included many incipient urban communities and centres of local trade and craft specialization, already involved in long distance trade. They also included a wide spectrum of semi-urban and non-urban communities engaged in a whole variety of activities with widely differing lifestyles.

The second factor was the environment offered by the Indus system, whose principal character is that of a great river flowing through a desert and all, that this implies.

The Indus and its tributaries have laid down a much larger area of alluvium than that compared to Egypt and Mesopotamia. A further aspect of environment that must be borne in mind is that it was subject to rapid change and development. This was principally due to the continuing deposition of rich alluvium through out the plains to such an extent that it not only raised the level but must have correspondingly made significant increases in their area during the early and mature Indus phases and thereafter the effect of man on this environment could only be to hasten these processes. Thus the environment offered by the plains would have varied somewhat with time and have provided the optimum condition for intensive agriculture at certain stages and places.

Third factor was the stimulus offered by contacts with other societies outside the Indus system. Indications are that mature Indus period urban society had evolved considerable social stratification and division. There was a distinct agricultural population and there existed widespread trade. The cultural uniformity of the settlements over the wide areas leaves no doubt that the relationship between city centered communities of agriculturists and craftsmen and those who provided means of transport, communication, must have been a stable one. This in turn indicates a strong and firmly based system which held them together and maintained their relations.

THE END OF THE CIVILIZATION

In any interpretation of this process two considerations are important. First and foremost is the annual impact of the Indus flood which raises the flooded area and simultaneously raises the water table. Today the Mohenjodaro landscape is only preserved from disastrous inundation by large annual expenditure on a series of protective banks or bunds, so, no doubt, from the outset considerable engineering was already needed when the new city rose upon its far lower flood plain. Even so, the swollen river broke through from time to time; its alluvium has been identified at intervals in deep sections and houses were raised to safer heights, sometimes with help of mudbrick platforms. Any relaxation in the supervision of the bunds, any accidental weakness in their structure, any exceptional volume in the spring torrent must have been immediately fatal. And a population harassed by this recurring enemy may well have tired a little as human societies under continuous stress, are apt to do.

A convergence of causes may be thought to have induced an increasingly rapid decline.

The other factor is this - millions of well baked bricks went to the building and rebuilding of Mohenjodaro which implied burning of forest wood for kilns which could have led to deforestation of the surrounding region. This in turn though partially compensated by growing crops must have checked the transpiration of moisture and reduced the rainfall. If at the same time energy and discipline were flagging and irrigation channels and bunds inadequately maintained the total deterioration must have been appreciable. Desert was encroaching on the sown.

"In rough terms the civilization was wearing out its landscape whether by excessive zeal or excessive indolence."[2]

THE SEQUEL TO IVC

If we infer, provisionally, that in the central Indus region the civilization ended within a century of 1500 B.C. there remain a 1000 years with no written records. "In due course the northern plains encountered the Indian Bronze Age, where the ceramic excavations came to be known as Painted Grey Ware. (1000-500 B.C.) This ware has been found at a number of sites notably Ropar. In every case the grey ware overlay the Indus material with a clear intervening gap."[3] On a number of sites over the Indus

2. Mortimer Wheeler, Early India and Pakistan to Ashoka (Bombay, 1959).

3. Ibid.

plains, superimposed vestiges of later cultures have been found. At Harappa itself remains of Jerry built houses of reused brick have been found built into the debris overlying the Indus city, and the intruders buried their dead in alien fashion with alien pottery in a cemetery known to archaeology as cemetery °H'. These have been found at two sites one being Bhawalpur. At Chanhudaro, some eighty miles south of Mohenjodaro a shoddy late Indus phase was succeeded by a squatter culture of lower grade named the °JHUKAR' culture after another site in Sind. The Jhukar squatters made coarser pottery than their Indus predecessor and used round button seals There is an approximation of age between the end of the indus civilization here and the arrival of the squatters though actual continuity is not implied. After an interval, more squatters i.e. the °JHANGAR' people replaced the Jhukar culture. The whole succession is undated and leaves us little wiser but is sufficient to show a continuing cultural deterioration in this region after the end of the civilization and to suggest recurrent links with Iran and Caucasus.

Evidence of scattered objects of indubitably of western (Iranian or Caucasian) origin are at least sufficient to suggest infiltration into north-western India, in the centuries closely following the end of the Indus civilization and may be associated with the reckless movement of the Aryans from Iran and Afghan into Punjab. However any sound proof is distant. The coastal sites especially those in Kutch and Kathiawad lay beyond the Aryan impact and thus Rangpur reveals a basic microlithi industry, followed by chalcolithic and late-chalcolithic. An observation of greater importance could be that coastal sites such as Lothal, Rosadi (Mid Kathiawad and Rangpur) did not get obliterated but were transmitted into successor cultures.

By the beginning of the christian era, desiccation, natural or artificial, had set in. The lower reaches of Ghaggar-Hakra river system became completely uninhabitable. It is not unlikely that witnessing the increasing aridity, the population trend by now was towards the habitation of the more fertile eastern zone. In fact there is some evidence to show to show the migration of tribes from Punjab into eastern Rajasthan and further deep into central India. The possession of fertile tracts by different warring groups might have been the underlying cause for frequent wars and migrations.

Gradually came to the phase when Brahmanical and Buddhist cultures came to flourish here. Cities of great commercial, political and cultural importance stood along the highways.

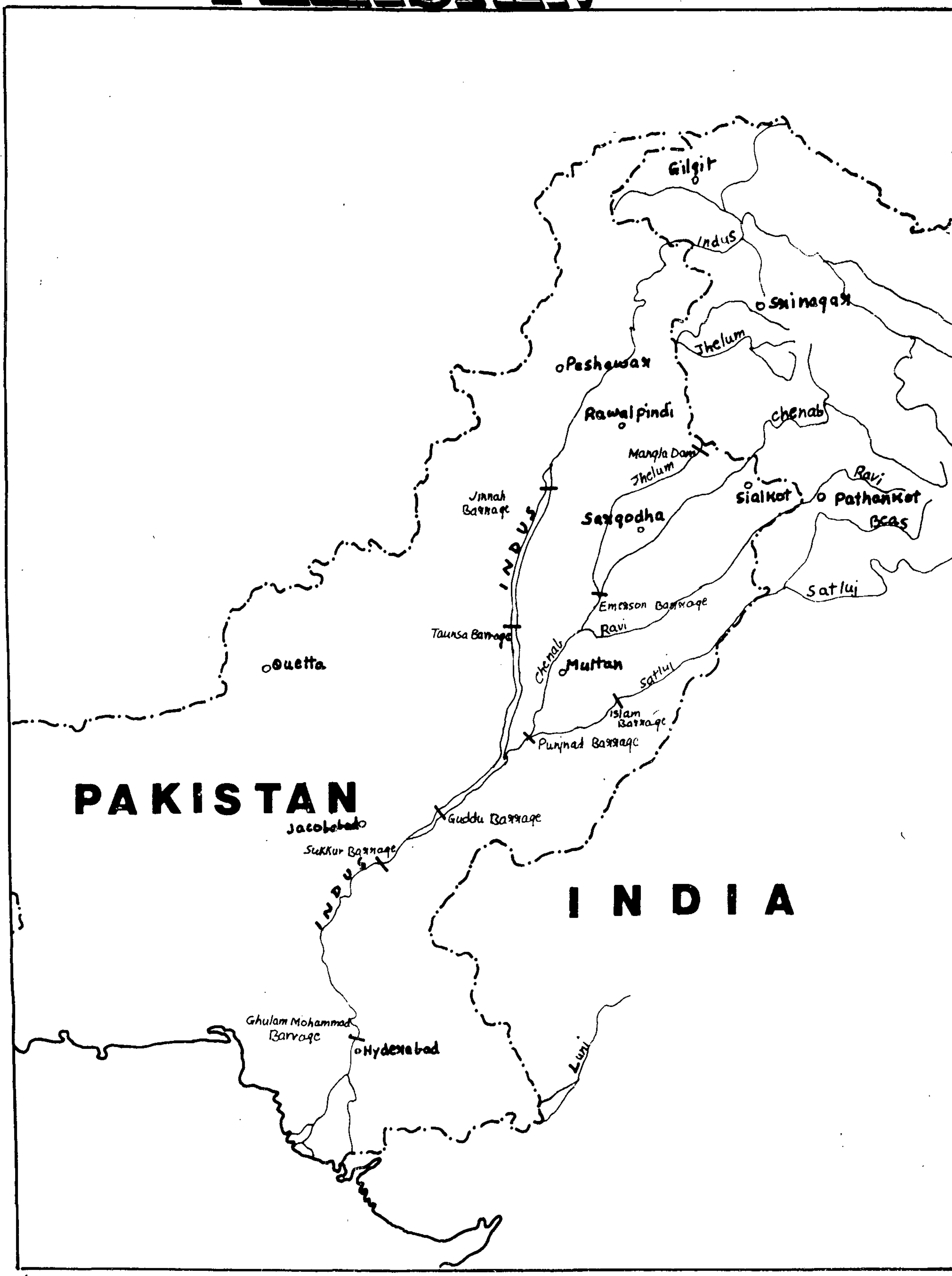
THE PROTO RAJPUT PERIOD (C.400-AD to 1200 AD)

This was a period of great turmoil. Foreign tribes such as Huns and Gurjaro began to pour into Northern and Western India via Sind and Baluchistan. Archaeological and linguistic evidence prove that many of these people were from central Asia and essentially pastoralists or nomads in nature. These tribes gradually split and settled down in this region. Gradually kingdoms got formed and the history beyond this is dotted with several invasions from Central Asia and Afghanistan.

However, there have been several circumstances that compelled man to move once more to dried and hilly areas and to make them habitable thereby demonstrating that nature and man have been in a continuous interaction in this area that is formed by the Indus river system.

One thing that has been proved beyond doubt is that the river provided with the life-giving water for settlements and for crops. A close look at the map of present Pakistan and Western India confirms this pattern (MAP NO.2). Closer to Makran coast, along the lower reaches of Indus excellent crops of cotton and rice are still grown. Higher up towards the middle course this is replaced by wheat and millets. An effective canal system has enabled to harness the water

PRESENT INDIA AND PAKISTAN



(MAP 2)

resources of Indus in a better way.

Within India Beas and Sutlej form a fertile doab most of which falls within Punjab. Not only is this a region of dense settlements but also an agriculturally productive land.

This sums up the history of civilization in the Indus valley. Settlements continue to exist though many a changes have come about. But most of these changes have been in order to adjust to the changing natural environment and also the creeping aridity.

CHAPTER - III

AN INTRODUCTION TO THE RIVER SYSTEM

1. THE BASIN :

In the north-western part of the Indian subcontinent is the land of the Indus. The Indus is the river of the north-west India and of Pakistan and in terms of the extent of dependent agriculture it can very easily be called the most important river of the world.

The main river Indus is about 2,898 kms long. Its Principal tributaries from the west, the Kabul river and the Kurram river both together are 1127 kms wide. The five main tributaries of the east i.e. the Jhelum, the Chenab, the Ravi, the Beas and the Sutlej have an aggregate length of 4,508 kms. This makes the Indus system one of the largest river systems in the world.

[1]"In terms of volume of water carried, the Indus ranks with the Columbia river of Canada and the U.S. The aggregate mean annual flow of the Indus river and its tributaries, when they emerge from the Himalayan foothills is about 170 M.A.F. more than twice that of Nile, three times more than that of Tigris and Euphrates and ten times the annual flow of the Colorado river. From the Himalayan melt-

1. N.D. Gulati : The Indus Waters Treaty; Chapter II. (Pg.18).

waters to the Arabia sea, the Indus river system has an drainage area of 450,000 square miles which approximately aggregate the total area of France and Italy. The Indus and the Eastern most tributary Sutlej, both rise in the Tibetan platean, north and South of the Kailash mountains. The Kabul and the Kurram rise in Afghanistan. Most of the Indus Basin however lies in India and Pakistan - °the catchment in Tibet and Afghanistan is only about 13% of the total area of the basin. The contribution to the river from this catchment outside the Indian Subcontinent is even smaller in proportion.

[2]Out of the total drainage area of 450,000 square miles, about 175,000 sq. miles lies in the Himalayan mountains and foothills and constitute the water supply while the rest of the basin lies in the plains. This forms an arid country where until the nineteenth century desert or semi-desert conditions prevailed except for the narrow fringes along the river courses.

Within India, the Indus Basin lies in Jammu and Kashmir, Himachal Pradesh, Punjab, Haryana and Rajasthan. Most of the basin in Pakistan lies in North West Frontier. Province (NWFP), Punjab and Sind. According to the pre-1947

2.N.D. Gulati : The Indus Waters Treaty; Chapter II.

subdivisions the Indus basin in India comprised of the British provinces of Punjab, N.W.F.P., and Sind; the then Princely States of Jammu and Kashmir, Patiala, Nabha, Faridkot, Jind, Kapurthala, Bikaner, Bhawalpur, Jaisalmer, Khairpur, Bilaspur, Mandi, Chamba and several other small states in the Punjab hills and N.W.F.P. Also the tribal areas, together with parts of the British province of Baluchistan and Indian States of Jodhpur and Jaipur.

More than 46 million people lived in this basin in 1947, with agriculture forming the pivot of their economy.

In the Indian territory now, the basin lies between 72° 33' to 79° 50' East longitude and 28° 52' north latitude to 79° 50' north latitude. The state wise distribution of the drainage basin within the territory is given.

TABLE - I

	[3]Indus Basin	Statewise Drainage Areas
	State	Drainage area in Sq Km
1.	Jammu and Kashmir	193,762
2.	Himachal Pradesh	51,356
3.	Punjab	50,304
4.	Haryana	9,939
5.	Rajasthan	15,814
6.	Chandigarh	114
	Total	321,289

(2) PHYSICAL FEATURES

The northern and western boundaries of the Indus basin are clearly marked by mountains and hills. Towards the south however the limits of the basin are relatively obscure. There is nothing in the lie of the land to show the watershed. There is total absence of rain along the Indus watershed towards the south, and hence delimitation of the Southern end of the boundary is not of much help.

3. Source - The Irrigation Commission Report, Volume 3, Chapter XVIII.

The north-west mountain wall, comprising the Himalayan ranges and the Sivaliks, with altitudes from 2,000 to 26,000ft. has a great influence on the physiography of the Indus region and the hydrology of the Indus rivers. The Himalayan ranges protect the plains from the cold winds from the north; at the same time, they prevent the rain bearing or the monsoon clouds from the Indian Ocean from escaping into Central Asia. The perpetual snow and glaciers in the Himalayas form a natural reservoir from which the rivers draw their perinnial supplies of water. The monsoon rain falling on the lesser Himalayas and the Sivaliks is the chief source of summer water supplies and of floods.

Striking the north-west mountain wall, the plateau has a broken and irregular configuration with elevation from 2000 to 1000 ft. Except for a belt 50-75 miles wide north of the outcrops of the Aravalis in the south east and the northern watershed of the Luni river towards the west, the rest of the basin comprises of the Indus plains, with elevations generally below 1000 ft. The Indus plains have been built up by the rivers of the Indus system and consist of relatively flat tracks between these rivers the Indus, the Jhelum, the Chenab, the Ravi, the Beas and the Sutlej each called a loab. There is a narrow fringe of plain country west of the Indus and large flat areas south of the Sutlej and Indus. The southern Indus tract is interspersed with

Sanddunes in erstwhile Bhawalpur and Sind in Pakistan and Rajasthan in India.

The overall slope of the plains about 0.75 foot per mile, is along the general direction of the rivers, from north east to south west; the lend in Punjab (India), Haryana and adjoining parts of Rajasthan being higher than that in Punjab distinct of Pakistan. Thus the Indus and Jhelum emerge from the foothills and enter the Plains in Pakistan at levels considerably lower than those of the Indus plains in India.

Most of the area in the plains is irrigable and cultivable when irrigated; the physiography permits the construction of large canal systems a single canal commanding an area as large as two to three million acres. It has often been claimed that there is no other comparable area in the world that has similar natural advantages for the development of large scale canal irrigation. The flat plains of the Indus basin with a number of large perennial streams flowing through them are indeed ideally adapted for the development of such irrigation. The soils of the region vary from light sandy to clayey; a characteristic feature being the presence in the soil profile of relatively large quantities of salt. In the hilly areas large tracts are culturable but the parcels of land which can be irrigated from a given point on a stream are much smaller than in plains. For example canals that are called Kuhls, can command from a few hundred to a maximum of say 20,000 acres. In the submontance plateau, condition are intermediate between those in the hilly regions and the plains.

(3) CLIMATE

Two important features of the meteorology of the Indus region is the regular alternation of two seasons summer and winter and two well defined rainy seasons.

Winter rains occur between the end of December and the end of February and are almost exclusively due to the cold season storms or cyclones from the north-west; the main rainy season from the end of June to the middle of September is due to South-West monsoon. Climatically the area may be divided into 3 natural divisions, representing fairly homogeneous meteorological conditions namely the Himalayan zone, the sub Himalayan zone and the Plains. The Himalayan zone has moderate temperatures in summer and is very cold in winter. The plains are subjected in extremes of climate. Winter in this region is cooler than anywhere else in the plains of India. Summer is characterised by fierce dry heat the sub-Himalayan zone is intermediate between Himalayan Zone and the plains.

Rainfall :

There are 239 rain gauge stations in the basins. The density works out to one station for every 1,460 Sq. Km. The number of rain gauges being insufficient, the establishment of more rain gauges to obtain a balanced distribution over the entre basin is suggested. The rainfall data appears in the annual volumes of the °Daily Rainfall of India' compiled and issued by the India Meteorological Department Such volumes are available since 1891. The major part of the basin receives a rainfall of over 600 mm.

In the Himalayan zone precipitation occurs both in summer and winter,varying in intensity not only from region to region but also from year to year. The annual rainfall is maximum on the southern slopes, at elevations from 3,000 to 5,000 ft. It exceeds 50 inches in a belt about 80 miles wide, east of the main stream of the Jhelum, the maximum being 75 inches in Himachal Pradesh, in the catchments of Ravi and Beas. In most of the upper Indus catchment, the annual precipitation is less than 35 inches being as low as 3 inches at Leh. The sub-Himalayan zone has an annual rainfall of 30 to 40 inches towards the eastern end and about 15 inches in the west. In the Plains, the annual rainfall decreases generally from north-east to south-west, from about 30 inches to less than 5 inches in most of Sind.

Except in the upper catchments of the Indus, the Jhelum and the Chenab, in the Himalayan zone, where the annual precipitation is more or less equally divided between summer and winter, in the rest of the basin most of the rain falls during a period of 3 months. This extends from July to September while the other nine months are relatively dry. Some winter rains occur in the northern parts of the plains, the average varying from about 8 inches near the foothills decreasing to about one inch or less in Sind, erstwhile Bhawalpur and Rajasthan. Snowfall in the Indus basin is confined to elevations of 5,000 feet and above in the Himalayan zone. As noticed elsewhere in the subcontinent, here too the notable feature about the rainfall, is that lower the rainfall, the lower is its dependability for agriculture.

The Indus plains with its extremes of climate, low and undependable rainfall, thus represents one of the arid regions of the world and, except in a narrow belt near the foot hills and the river margins, subject to inundation during floods, no cropping is possible without the aid of an artificial supply of water. In regions like Sind, erstwhile Bhawalpur and Rajasthan where the subsoil water is deep or brackish, even the drinking water is difficult to obtain.

However the soil is alluvial and agriculture is possible all the year round provided irrigation waters can be made available. In such a case two or even more crops can be grown in a year.

In Ladakh the climate is dry and healthy. While the south-west monsoon is the main source of precipitation in Jammu and Kashmir and Kishtwar, it is the winter precipitation that is more important in Ladakh, Gilgit and the higher ranges. During the winter, the snowfall is heavy on the Pir Panjal range, the heaviest falls being in January and February. In the valley of Kashmir and the mountain ranges to the north and east, this is the chief precipitation of the year but it decreases rapidly eastwards to the Karakoram range where the winter snow occur much later and the maximum is received in April.

The air in Ladakh region is invigorating and extraordinary extremes of cold and heat can be noticed. The shade temperatures are cool but it is almost blistering under the direct heat of the sun. Though this stretch of the Indus lay well over eleven thousand feet high, the daytime temperatures march over 100^0 f. The summer heat is so great and so sustained that it brings grain to maturity in two months time.

Temperature :

During the winter season in January, the mean temperature over the catchment varies from 10.0°C or below in Jammu and Kashmir to 12.5°C in Punjab, Haryana and Himachal pradesh and 12.5° to 15.0° in parts of Rajasthan.

During the summer season in April, the mean temperature in Jammu and Kashmir is lower than 25°C. In Punjab, Haryana, Himachal Pradesh and Rajasthan it varies from 25°C to 27.5°C. In certain portions of Rajasthan it goes upto 30°C.

During the rainy, in the month of July, the mean temperature varies from 30°C in Jammu and Kashmir, Himachal Pradesh, Haryana and Punjab to 32.5°C in parts of Rajasthan. Towards the end of the monsoon season, in the month of October, the mean temperature in Jammu and Kashmir, Himachal Pradesh, Haryana and Punjab is less than 25°C. However, in certain parts of Punjab and Rajasthan it varies from 25°C to 27.5°C.

A table given below shows annual normals of temperature and relative humidity at some selected places located within the basin.

TABLE - II

TEMPERATURE AND HUMIDITY IN THE BASIN

	Station	Annual Normals of temperature		Annual normals of Relative Humidity
		Maximum (°C)	Minimum (°C)	
1.	AMBALA	31.2	17.3	62
2.	LUDHIANA	31.2	22.6	64

(Source : Irrigation Commission Report Volume III - Chapter XVIII - The Indus Basin Page No. 441.)

Evaporation :

Practically no data on evaporation is available for the Indus basin.

4. THE RIVERS

The Indus system of rivers (Map to be attached later) comprises of the main river Indus and its major tributaries, the Kabul, the Swat and the Kurram from the west. From the east flow the Jhelum, the Chenab, the Ravi, Beas and the Sutlej. The Swat joins the Kabul before the latter falls into the Indus, opposite Attock; the Kurram falls into the

Indus just below Kalabagh. The Jhelum joins Chenab at Trimmu; thence the two rivers flow under the name of Chenab till joined by the Sutlej at Panjnad. (The Sutlej receives the waters of the Beas at Harike). The Ravi falls into the Chenab about 45 miles below Trimmu. From Panjnad, the waters of the five tributaries from the east flow on, under the name of Panjnad, to join the Indus at Mithankot, about 600 miles above its month in the sea.

The Indus rises in Tibet (32° N and 81° E) behind the great mountain wall of the Himalaya at an elevation of 22,000 feat. Issuing from the softly mountains around Mansarovar it flows northwest, under the name of Singge-Khabab until it is joined, about 257 km. from its source by the ghat. A short distance lower down, it enters the south-eastern corner of Kashmir at an elevation of 4,206 metres and flows over a long flat of alluvium. It skirts Leh at 3,200 metres and is joined by the Zaskar river near the crossing of the great trade route into Central Asia via the Karakoram Pass. Still flowing north, but bearing west, the Indus passes near Skardu and reaches the Haramosh mountains. Here it takes a turn south wards at an acute angle and passing beneath the Hattu Pir enters Kohistan. After flowing through the wilds of Kohistan and at about 1,448 km from its source, the Indus is joined opposite Attock (Pakistan) by the Kabul river from

Afghanistan. The kabul river rises in Afganistan and enters Pakistan near Warsak. It then flows through the Peshawar valley where it receives the waters of the Swat).

At this point the Indus river has fallen to an elevation of about 610 metres. After leaving Attock, the Indus flows south wards, parallel to the Sulaiman range. Just above Mithankot, about 805 km from the sea and at an elevation of 79 metres, the Indus receives from the Panjnad, the accumulated waters of the five eastern tributaries. The river finally empties itself through the months into the Arabian sea, near Karachi. The total length of the Indus from its source to the sea is 2,880 km. out of which about 1,114 km. lies in India. Its principal tributaries, the Kabul and the Swat on its right and the Jhelum, the Chenab the Ravi, the Beas and the Sutlej, on its left have a total length of 5,600 km. Its catchment area up to the Indo-Pakistan border is about 168,335 sq. km.

The Jhelum in Kashmir is known as the Veth. It has its source in Verinag, a spring at the bottom of a high scrap of a mountain spur, at the upper end of the Kashmir valley. The river has several tributaries in the valley; many of these come from the everlasting snows of the Liddar Valley. Below Srinagar it receives the Sind and beyond the Wular lake which is in fact a delta of the river, the Pohru stream from the Lolab valley. Below Baramula, Jhelum leaves the fertile banks of the valley and rushes headlong down a deep gorge between lofty mountains. At Muzaffarabad, the Kishanganga joins the Jhelum from the right. Lower down, the river skirts the outlying spurs of the salt Range and finally debouches into the plains near the city of Jhelum in Pakistan About 322 km. lower down, it joins the Chenab at Trimmu. Upto the Indo-Pakistan border, its length is about 402 km. and the corresponding catchment area is 34,775 sq. km.

The Chenab rises in two streams the Chandra and the Bhaga in the Himalayan Canton of Lahul in the Himachal Pradesh. The United Stream known as the Chandrabhaga or Chenab, flows through the Pangi valley and enters Kashmir at an elevation of 1,828 metres. It flows for 290 km between steep cliffs and then for 40 km through the lower hills to Akhnur where it enters Pakistan near the Marala weir, below the junction of the Tawi. In Pakistan, the Chenab flows for more than 644 km. to Panjnad, where it joins the Sutlej, having received the waters of the Jhelum about halfway at Trimmu and of the Ravi a little lower down. From the confluence of rivers, the Chandra and the Bhaga, to the Indo-Pakistan border the river has a length of 378 km. Its total catchment area up to the Indo-Pak border is 261, 155 sq. km.

Of all the Punjab catchments the Ravi catchment of only about 14,442 sq. km. is the smallest. The river rises near the Rohtang Pass in the Kanga district and drains the southern slopes of the Dhauladhar. After crossing the sivaliks, it enters the Punjab plains at Madhopur. From its source to the Indo-Pakistan border, the river has a length of about 370km. The river passes into Pakistan about 26 km below Amritsar.

The Beas rises on the Southern face of the Rohtang Pass, 4,062 metres above sea level. Fairly steep in its upper portion (24 m per km.) it meanders lower down in a westerly course through hilly country. On meeting the Sivalik hills on Hoshiarpur, the river sweeps sharply north-ward, then bending round the base of the hills, it takes a southerly direction. In this portion of its course, through the uplands of the Punjab plains, a strip of low alluvial soil fringes its banks, subject in flood time to inundation from central streams. Lower down, the river shifts from year to year through the alluvial valley and finally joins the Sutlej at Marike after a total course of 460 km, wholly in India. It drains an area of 20,303 sq.km.

The Sutlej, rises in the distant highlands of Tibet at an elevation of about 4,570m. from the Mansarovar lake. It has a very long course through the mountain ranges, rising to 6,100 metres on either side. It passes through Himachal Pradesh and then enters the Punjab in the Hoshiarpur district. The Sutlej emerges from the Sivalik hills at the Bhakra gorge and flow as a narrow deep stream with low hills on either side for about 16 km before it widens into an alluvial river. It receives the Beas at Harike above Ferozepur, before joining the Chenab at Madwala in Pakistan. The slope of Sutlej, from its source to Bilaspur is steep and fairly uniform but lower down it gradually flattens to 1:5,000 or even less in the plains below Rupar. From Mansarovar lake to the Indo-Pak border, the river has a length of 1,078 km. and a catchment area, excluding that of Beas, of 204,058 Sq km. (including the head reach in Tibet).

The river Ghaggar has its source near Dagshai a small hill station at an elevation of 1,927 m. (77^{o} 3' east longitude 30^{o} 50' north latitude) in the Simla district of Himachal Pradesh. The river flows in a generally south-westerly direction practically throughout its length. It enters the state of Haryana near Kalka about 10km from its source. Continuing to flow in the same direction, the river criss-crosses the boundary line between Punjab and Haryana at a number of places. The Patielawali Nallah joins it at two different places on its right bank before it receives, through the Saraswati, the combined waters of its three important left bank tributaries viz. The Tangri, the Markanda and the Saraswati, near village Shatrana, about 148 km from its source. From here on, the direction of flow of the river is more westerly than southerly. From about 8km. downstream of this confluence the river crosses the Ghaggar branch of the Bhakra system. Continuing to flow for about 07 km. more in a generally south-westerly direction, the river is tapped at Ottu headworks (weir) where two canals, one northern and the other southern take off for irrigating the nearby areas. The canals go a little beyond Hanumangarh town in Rajasthan Thereafter the river, disappears in the sand dunes of the Rajasthan desert. The river has a total length of about 291 km. and its drainage area, though difficult to assess precisely, can roughly be placed around ,309 sq. km. up to the Ottu weir.

However most of these rivers have not stuck to their original courses. There is ample evidence to show that the Chenab, the Ravi, the Beas, and the Sutlej have changed their courses in historical times. The Chenab flowed east of Multan as late as 1245. The Beas then occupied its old bed i.e. the Hakra, while the Chenab and the Ravi met north-east of Multan and joined the Beas 28 miles south of Multan. At the time, the Sutlej found an independent outlet into the the Rann of Kutch. In the year 1000 it was a tributary of the Hakra and flowed into the eastern Nara.

By 1245 the river had taken a more northerly course, the Hakra had dried up and a great migration took place of the people of the desert-as it happened in the case of Indus valley civilization too. About 1593 the Sutlej changed its course once more though since 1796, there has been little further change.

5. THE RIVER FLOW

General :

The principal rivers of the Indus system are all perennial but the flow in each varies enormously during the year. It is a minimum during the winter and on the other hand floods occur during the rainy season extending from July to September; occasionally there are freshets during the winter also. The tributaries are more dependent on the monsoon rains than the main Indus.

Over the year, the Indus river (including the Kabul but excluding other tributary) brings into the plains a little more than one half of the total supply of the Indus system of rivers or about 90 M.A.F. (Million Acre Feet). The Jhelum and the Chenab each being about 23 M.A.F which makes it about one fourth of the supply of the Indus or taken together, carry a little less than 1/4th of the total supply of the system. The Ravi (6.4 MAF) the Beas (12.7 M.A.F.), and the Sutlej (13.5 M.A.F.) taken together carry a little less than 1/5th of the supply of the system. As these rivers enter the plains, their flow is gauged at points called rim stations These are located at Kalabagh on the Indus, Mangla on the Jhelum, Merala on the Chenab, Madhopur on the Ravi, Mandi plain on the Beas and Rupar on the Sutlej. Except Mandi plain all these stations were at the offtakes of the upper most canal from each river.

Flow characteristics :

In the main Indus river, the flow is lowest from mid-December to mid-February, the river then starts rising; slowly at first and more rapidly after mid-March. The rise from end of April to mid-July is very rapid-the peaks occurring between mid-July and mid-August.

The river then falls steadily till the end of September; the subsequent decline is slower. The Chenab river has a winter minimum during the same period as the Jhelum. The subsequent rise is, however, much slower and is not really significant till the beginning of May. The peak is rather flat and extends from May to early July. The river then falls steadily till end of September; the subsequent decline is slower.

The Chenab river has a winter minimum during the same period as the Jhelum. The subsequent rise is, however much slower and is not really significant till the beginning of May. From May to end of July the rate of rise is much higher than in the Jhelum. The post-monsoon fall is fairly sharp and somewhat similar to that on the Indus. The Ravi river behaves somewhat like the Chenab. The overall quantum of supplies is however small. The Beas and the Sutlej have a winter minimum from mid-November to mid-February. The subsequent rise is relatively slow until April on the Sutlej and end of June on the Beas. The peaks are reached between mid-July and mid-August the subsequent fall is relatively sharp. The flow in the Beas and the Sutlej, particularly in the Beas during early kharif (April-June) is very low as also the flow in the Sutlej from January to March. The flow in the Chenab from April to June is also somewhat low but that in the Jhelum during the same period, is relatively very high.

Unlike most other rivers, the rivers of the Indus system receive all their waters only in the parts of their mountainous catchments and have maximum flow when emerging from foothills; the surface flow into the rivers from the relatively large but arid plains is in significant.

Instead in the long lengths of the rivers, below the foothills, there are large losses from April to September, on account of percolation, evaporation etc. Apart from these losses, when the rivers rise from the dry weather or winter minimum to monsoon high, a significant quantity of water required to fill up their rivers up to their flood levels is held between the high banks of the rivers. These may vary from half a mile to eight or nine miles apart. The waters so held sometimes called valley storage, and the percolation and evaporation losses, mentioned above, are important factors in the development and use of the waters of the Indus rivers.

When the rivers begin to fall after each flood and at the end of the rainy season, the waters held or temporary stored, between high banks become available for use at lower points of withdrawal. In the Indus basin, this happens during a period when the irrigated crops need an unusually large quantity of water; this phenomenon is therefore of considerable interest to the irrigation engineer. In the post monsoon months there also are significant gains on account of regeneration namely seepage into the river beds from wet river margins and from irrigated fields. By regeneration we mean that part of the river supply diverted for irrigation which seeps into the soil during conveyance to the field or by seepage in the fields below the root zones and return to the river lower down. This regeneration water together with that temporarily held in the river channel during high river stage, becomes available for use lower down during winter. In the Indus basin this supply of water is called river gains and represents an important element in project planning.

6. SOILS

The basin covers fully ten districts of Jammu and Kashmir, six districts of Himachal Pradesh and ten districts of Punjab. Parts of Ladakh and Gilgit districts of Jammu and Kashmir and two districts of Rajasthan.

Most of the districts of Jammu and Kashmir have sub-montane and Brown hill soils. Gilgit district has Brown hill, sub montane and mountain meadow soils. Large areas of Ladakh are covered with mountains snows and glaciers. Gilgit district is covered by Brown hill, sub montane and mountain meadow soils.

In Himachal Pradesh the districts of Mahasn, Mandi Sirmur, Bilaspur and Simla are covered with Brown hill soils Chamba has sub-montane soils while Kangra and Kulu districts are covered with sub-montane podsolic soils. Lahur and Spiti districts have along with Sub-montane podsolic soils also glaciers and eternal snow.

(Table III Shows a detailed classification of predominant soil types found in the Indus Basin).

In Punjab the Sub-montane region has forest and hill soils. These range from slightly acidic to highly acidic in reaction and are in different stages of podzolisation. Though these soils are rich in humus, they contain very little soluble salts and are somewhat deficient in lime and phosphoric acid. The districts of Ferozepur and Bhatinda have desert soils which not only lack moisture, but are also deficient in organic matter, nitrogen and phosphorus.

The most predominant soil groups in the state belong to the class of Indo Gangetic alluvium and are found in the remaining area. The soil crust has an average depth of 25 cms. It contains 10 to 15 percent clay. The crust contains sodium salts and the control of their movement is a major problem. The soils are deficient in nitrogen and organic matter. The alkaline and saline soils are highly deficient in nitrogen, phosphorus and potassium. The problem of salivity and alkalinity is very acute in the districts of Amritsar, Ferozepur, and Sangrur and acute in Gurdaspur, Jullundhur, Kapurthala, Ludhina and Patiala districts.

In Haryana soils largely consists of alluvium containing sand, clay, silt and hard calcareous concentrations. In the southern region known as the Khadar, the alluvium consists of sand and silt that are deposited by rivers and small mountain streams.

Broadly, the state can be divided into five soil regions

(i) Desert soils - These are found in parts of the Hissar

rainfall is less than 300mm. These soils are deficient in nitrogen, phosphorus and potash.

(ii) Sierozem soils are found in parts of Rohtak, Hissar, Gurgaon and Mahendragarh districts where the annual rainfall varies from 300-500 mm. Salinity and alkalinity are serious problems, particularly in irrigated areas. Erosion by wind is common. Almost all these soils are deficient in nitrogen, phosphorus and potassium.

(iii) Arid brown soils : These are found in parts of the Gurgaon, Karnal, Rohtak and Jind districts. Salivity and alkalinity are serious problems. There are also problems of wind and water erosion. These soils are very deficient in nitrogen but contain phosphorus and potassium.

(iv) Tropical arid brown soils - These are found in parts of Karnal and Ambala district. These soils are again deficient in nitrogen, phosphorus and potassium.

(v) Reddish brown soils are found in parts of the Ambala district where the annual rainfall ranges between 1000-1500 mm. The soils are deficient in nitrogen and phosphorus but contain potash, zinc and iron.

In Rajasthan desert soils occupy the largest area Grey and brown desert soils occur in the districts of Barmer, Jhalawar, Jodhpur Sirohi, Pali, Nagaur, Sikar and Jhunjhunu. The fertility of the soil, which is saline and alkaline increases towards east and north east. Red and yellow soils occupy the parts of Udaipur, Ajmer, Bhilwara districts. Silty loams and silty clay loams are common. It has good moisture holding capacity. Feruginous red soils are found in Udaipur and Durgarpur districts. These are of lighter texture, porous and friable in structure and invariably free from °Kankar' nodules. Mixed red and black soils and alluvial soils are also found in parts of this state.

Table -III

SOILS OF INDUS BASIN

NAME OF THE STATE/DISTRICT 1.	PREDOMINANT TYPES OF SOILS 2.
JAMMU & KASHMIR	
ANANTNAG	Sub-montane
SRINAGAR	Sub-montane
BARAMULLA	Brown hill (on sand stones and shales)
DODA	Brown hill (on sand stones and shales) sub-montane
UDHAMPUR	Sub-montane, mountain meadow.
JAMMU	alluvial,brown hill (on sandstones and shales)
KATHUA	Brown hill (on sand stones and shaies), sub-montane
POONCH	Brown hill (on sand stones and shales),sub-montane.
LADAKH	Glaciers and eternal snow mountain meadow brown hill (on sand stones and shales).
GILGIT	Brown hill, sub-montane and mountain meadow.

i) Agency	Sub-montane, mountain meadow, saline and
ii) Leased Area	alkaline, peaty and peaty saline,
	glaciers and eternal snow.
MUZAFFARABAD	Brown hill and sub montane
MIRPUR	Alluvial and brown hill.

HIMACHAL PRADESH

MAHASU	Brown hill (on sandstones and shales)
KINNAUR	Sub-montane
MANDI	Brown hill (on sandstones and shales)
CHAMBA	Sub-montane
SIRMUR	Brown hill (on sandstones and shales alluvial)
BILASPUR	Brown hill (on sandstones and shales
SIMLA	Brown hill (on sandstones and shales
KANGRA	Brown hill (on sandstones and shales
KANGRA	Sub-montane (podsolic), brown hills (on sand stones and shales)
KULU	Sub-montane (podsolic), brown hills (on sand stones and shales)
LAHAUL & SPITI	Sub-montane (podsolic), glaciers and eternal snow

PUNJAB

HOSHIARPUR	Alluvial, brown hill (on sand stones and shales)

JULLUNDUR	Alluvial
LUDHIANA	Alluvial, chestnut bronw (alluvial).
FEROZEPUR	Chestnut brown (alluvial), desert
AMRITSAR	Alluvial, brown hill (on sand stones and shales)
GURDASPUR	Alluvial, brown hill (on sand stones and shales)
KAPURTHALA	Alluvial
BHATINDA	Chestnut brown (alluvial)
SANGRUR	Chestnut brown (alluvial) Alluvial
PATIALA	Chestnut, Chestnut brown (alluvial)
ROPAR	Alluvial

HARYANA

HISSAR	Chestnut brown (alluvial) desert,
JIND	Chestnut brown (alluvial) alluvial
KARNAL	Alluvial
AMBALA	Alluvial

RAJASTHAN

GANGANAGAR	Chestnut brown (alluvial) desert,
BIKANER	Desert

7. THE BASIN LAND USE

The land use details for the Indus Basin for the 1970's are as follows.

The culturable area in the basin is about 4.9% of the total culturable area of the Country. The total cropped area in the basin is about 6% roughly out of the total cropped area in the country. The area under irrigated crops is approximately 51% of the cropped area in the basin.

Jammu and Kashmir :

Of the gross irrigated area, 66% is under rice, roughly 7% under wheat and 7.1% under maize. Fruits of various types are grown extensively and produced specially for marketable surplus. Almost nine tenth of the land is under food crops.

Himachal Pradesh :

Out of the gross irrigated area more than one third is under rice another 32% under wheat, 10% and 4% under raize and barley respectively. Potatoes and apples are important crops. Food crops again account for 9/10th of the irrigated cropped area.

Punjab:

Of the gross irrigated area, two thirds is used up for food crops. Out of this maximum land is under wheat followed by rice and gram.

Rajasthan :

Food crops account for 60% of the gross irrigated area Gram and wheat are the principal crops. Amongst the non-food crops, cotton is the main crop occupying roughly 21% of the gross irrigated area.

Haryana :

Out of the total irrigated area, one third is under wheat followed by gram, paddy and sugarcane. Some area is also under miscellaneous crops like barley, oil seeds etc.

For the Indus basin as a whole there are two main crop seasons namely the Kharif and the Rabi. The important Kharif crops are rice and maize white Rabi crops wheat and gram. Wherever irrigation facilities exist, perennial and eight month crops are also cultivated.

Forests and Agriculture are the mainstay of the people. Nearly 21-22% of the total reporting area of the basin is covered with forests. The forests are of many varieties such as spruce, fir, deodar, pine and sal. The area annually cropped in the basin is approximately 9.5 million hectares, ou

out of which 4.75 million hectares are irrigated, growing mainly wheat, rice, cotton, gram and maize.

Minerals: The principal minerals found in the basin are-

Coal is found in Jammu province from Jangalgali in the east to Kalakot in the west and also in the Bikaner district of Rajasthan. Gypsum is found in Buniyar in Jammu and Kashmir Rajban in Himachal Pradesh and Bikaner in Rajasthan. Deposits of sandstone are also found in Bikaner.

Bauxite-In the Reasi and Poonch area of the Jammu province.

Limestone :

In the Kangea and Sirmur districts of Himachal Pradesh, the Ambala district of Haryana and over a great part of Jammu and Kashmir.

State :

In the Kangra and Mandi districts of Himachal Pradesh; it is locally utilised for roofing.

Salt :

Rock salt deposits are found in the Mandi district of Himachal Pradesh.

Hence a complete survey of water, soil and natural resources shows that the Indus basin is well endowed. In order to sustain the large population that it carries, an efficient utilisation of precious water resources seems indispensable. With reference to this the importance of the Indus Waters treaty cannot be overlooked.

TABLE IV

LAND USE DETAILS-INDU BASIN

(THOUSAND HECTARES)

NAME OF STATE/UNION TERRITORY

ITEM	PUNJAB	HARYANA	HIMACHAL PRADESH	RAJA-STHAN	JAMMU & KASHMIR	TOTAL
GROSS AREA	5,030	994	5,136	1,581	19,376	32,189
REPORTING AREA	4,989	983	4,296	1,575	2,418	14,375
AREA UNDER FOREST	66	41	2,291	2	661	3,061
AREA NOT AVAILABLE FOR CULTIVATION	634	114	198	68	548	1,562
CULTURABLE AREA	4,289	828	1,807	1,505	1,209	9,638
UNCULTIVATED CULTURABLE AREA	301	76	1,318	444	530	2,669
NET SOWN AREA	3,988	752	489	1,061	679	6,969
AREA SOWN MORE THAN ONCE	1,447	311	322	137	136	2,353

contd.

ITEM	PUNJAB	HARYANA	HIMACHAL PRADESH	RAJA-STHAN	JAMMU & KASHMIR	TOTAL
TOTAL CROPPED AREA	5,435	1,063	811	1,198	815	9,322
NET AREA IRRIGATED	2,331	252	84	352	284	3,302
GROSS AREA IRRIGATED	3,460	403	143	421	316	4,742
% OF NET AREA SHOWN TO CULTURABLE AREA	54.3	30.4	4.7	23.4	23.5	34.3
% OF NET AREA IRRIGATED TO CULTURABLE AREA	93.0	90.8	27.1	70.5	56.2	72.3
% OF NET AREA IRRIGATED TO	58.4	33.5	17.2	33.2	41.8	47.4

Source: The Irrigation Commission Report, Volume III, Chapter XVIII.

CHAPTER IV

ISSUES AND CONFLICTS

INTRODUCTION:

Even prior to the partition phase, irrigation issues in the indus basin led to many disputes amongst the various administrative units.

PRE-INDEPENDENCE DISPUTE OVER IRRIGATION SUPPLIES:

The irrigation from the indus river system covered a number of administrative units namely Punjab, Sind, N.W,F.P, Bhawalpur State, Bikaner etc. The waters available from the Indus system of rivers and canals was not always sufficient to meet with the combined demand. Hence disputes used to arise from time to time between these units for their shares of water at different times of the year and for different projects contemplated by them.

In 1935, the Government of India convened a committee of the Central Board of Irrigation to secure an agreement in regard to some of the outstanding issues. The recommendations of this committee were considered in detail and orders finally issued in 1937. However, in September 1941, a complaint was made by Government of Sind that the projected withdrawals upstream by the Punjab would seriously affect the Sind inundation canals during the summer months from May to October and also create a shortage of water at Sukkur during the winter season.

The Government of India then appointed a commission (Indus commission) with Mr. Justice B.N.Rau as Chairman and the Chief Engineers of U.P. and Madras as members, to investigate these complaints. The Indus Commission submitted its report in July 1942 and its general conclusion was that the Punjab withdrawals were likely to cause material injury to the Sind inundation canals, particularly in the month of September. The Commission also made some recommendations for the sharing of Indus waters during the winter season.

The government of Punjab and Sind did not accept any of these recommendations inspite of a series of discussions between Chief Engineers of the two provinces from 1943 to 1945. A draft agreement was actually prepared in September 1945, but could not be finalised and ultimately it was decided to refer the whole matter to His Majesty's Government. No final decision could, however, be reached till August 15, 1947, when India and Pakistan became two independent countries, with the eastern districts of Punjab coming to India and the Western districts and Sind going to Pakistan. Since the dispute was never resolved, the onus of settling the differences fell upon the new created states of India and Pakistan.

Before, the genesis of this dispute and resolving of matters is discussed in detail it would be worthwhile to discuss why such disputes arise and a broad framework under which such matters can be solved.

Though nothing can be stated as a rule but from experience of the past it has been noticed that it is the lower riparian states that develop first while the demand for water of the upper riparian states expands gradually. Once both develop a large population base along with considerable agricultural and industrial development, the tussle for larger shares of the river water begins. The earliest of civilizations came up by the banks of major rivers and hence man's emotional attachment to water is justified. Due to this there is bound to be a conflict in its use among individuals, groups of individuals, states of a country and between countries. As the main use of water is for irrigation the majority of disputes, therefore are in the field of irrigation. While there are other uses of water and some conflicts do arise in other areas also these are not so difficult to resolve. So for no clear- cut directions or conventions have emerged to deal with water disputes. Many organisation, including legal. Associations, have tried to lay down some principles. The best of these are the Helsinki Rules evolved by the International Law Association in 1966 at its 52nd conference at Helsinki.

THE HELSINKI RULES

According to these rules, the factors to be considered in allocation of water among the contending parties are:

a. The geography of the basin including, in particular, the extent of the drainage area in the territory of each basin state,.

b. The hydrology of the basin including in particular, the contribution of water by each basin state.

c. The climate affecting the basin.

d. The past utilization of the waters of the besin, including, in particular, existing utilisation,

e The economic and social needs of each basin state.

f. The population dependent on the waters of the basin of each state.

g. The comparative costs of alternative means of satisfying the economic and social needs of each basin state.

h. The availability of other resources,

i. The avoidance of unnecessary waste in the utilization of the waters of the basin,

j. The paracticability of compensation to one or more of the co-basin states as a means of adjusting conflicts among users; and

k. The degree to which the needs of a basin state may be satisfied without causing substantial injury to a co-basin state.

The above cited factors too are not exhaustive. For example, in fixing priority of use, there can be vital differences in the needs of different countries, and at different times. In the past, navigation was considered the most important use, however other uses are gaining more importance now. In a primarily agricultural economy like India irrigation needs are indispensable but for European countries the best use of water would be for generating hydropower.

Thus earlier agreements and the Helsinki rules serve as mere guidelines rather than a suitable framework for resolving disputes.

The inherent difficulties:

The difficulties arising while dealing with water distribution problems are:-

i. Fixing the quantity of water

ii. Allocation between conflicting states and

iii. Regulation or implementation of the decisions.

These may now be discussed in a little detail.

i. **Fixing the quantity of water:** For most of the rivers, there is no accurate data obtained by measurement by current meters and empirical formulae like those suggested by Inglis, Strange and Dr.Khosla are adopted for project' planning. These too are insufficient to give any precise idea of the quantity of water and in some cases, they may have given highly incongruous results. The problem becomes more complex when allocation between states is to be made since data on the water avaiabilities in the different subbasins would also be needed.

In the recent past, however, there have been some efforts to measure the total volume of water with help of current meters. These have not yet gained sufficient coverage and data has to be observed for 30-40 years before placing reliance on figures. In the absence of reliable estimates for the quantity of water in a river, it is not proper to assume a figure even by the consent of the parties. It is imperatives therefore, to think of a rational procedure in pricing the quantity of water to be shared.

If the total figure is placed at a very high value, the country will suffer on account of avoidable expenditure on projects which will be affected by inadequate supplies of water. On the other hand, if the figure assumed is too low, it will imply wasting the precious waters of the country. In order to adopt a rational approach the following guidelines may be referred to -.

Take into consideration only the average values of runoff, assuming 75 percent frequency figures is without any scientific basis. Yet the frequency of events cannot be predicted. The maximum discharge estimated to occur once in 100 years does not mean that after a flood of the magnitude, the next similar flood will occur only after hundred years. There can be a possibility that the next year itself there is a flood of greater intensity.

Similarly, while adopting the criterion of 75 per cent dependability, it does not mean that out of four years, the scarcity occurs only in one year and the following three years will be good ones. This generally does not happen.

A drought year may be followed by a succession of bad years with even worse flows. The economy of a country with one bad year of rainfall followed by three good rainfall years is entirely different from one with three successive bad years followed by a number of good years. The frequency method is, therefore, not applicable unless we have an accurate measured record of water flows for at least 30-40 years. In the absence of this, it is more rational to omit altogether the consideration of frequency criteria and adopt average values. The average values also do suffer from a defect. If the years under consideration are good years, the annual run off will be more than in the usual pattern of good and bad years following each other. Having no other choice and adopting the lesser evil, average run-off of the rivers may be considered as the quantity of water for allocation.

The difficulty still remains in estimating the average value in the absence of actual field measurements by correct method. It has been suggested that a committee should ascertain average values of run off for the various river systems. Such finalised figures may be printed and taken as the values to be adopted by all authorities including the Tribunals that may be set up for a period of 15 years. After this period, the average flow figures may again have to be reviewed taking into account the further observations available and revised to be used for the succeeding 15 years. At the end of 30 years and preferably after forty years, the final figures based on currentmeter observations may be arrived at, and may be adopted for final planning.

For allocating between the states, 70-75 percent of the average figures may be considered for allocation for the first and the second stages; complete quantity may be considered after the field observations are available.

The impact of reduced flow in the river systems on the coastal areas is another indeterminate factor. While salinity and other environmental aspects will be affected, the extent to which this happens is not known. It is therefore, important that a technical commission of experts continuously study this problem and make available adequate information at the time of total allocation of water

ii) **Allocation of Waters:** While allocating water between the states, application of legal principles valid for other resources may lead to highly misleading conclusions. Existing uses may be many years or many decades old.

In recent years farmers of the large un-irrigated tracts, specially in upper reaches of rivers, have become irrigation conscious and want to use the water.

The valid question that arises is that can the old users' rights be curtailed in favour of the newcomers whose demands are also genuine. In many river basins in India itself such as Cauvery, Krishna, Son etc, such issues have arisen where water use by lower riparians has been practiced for a century of more. Legal considerations are not of much help in problems of this nature as each case has to be judged more on political, social and economics consideration than on legal or technical ones. It is also important to ensure settlement in an amicable manner involving appreciation and accommodation of mutual needs and viewpoints

iii) Regulation : Even when the shares for each state are determined there may be considerable difficulty in securing its implementation to meet the irrigation requirements at the required time and from year to year. The discharges of a river are not predictable, and remain unknown till they are measured questions that may be asked. There are regarding the water sharing between lower riparian and how exactly should it be regulated. Any set of rules laid down for the purpose may prove unfavorable to one party or the other.

In the light of above said difficulties and regulation it would be logical and worthwhile to discuss the Indus waters dispute and the subsequent treaty.

THE INDUS WATERS TREATY

At the time of independence the boundary line between the two newly created independent countries i.e. Pakistan and India was drawn right across the Indus Basin, leaving Pakistan as the lower riparian. Moreover two important irrigation headworks, one at Madhopur on Ravi river and the other at Ferozenpur on Sutlej river, on which the irrigation canal supplies in Punjab (Pakistan) had been completely dependent, were left in the Indian territory. A dispute thus arose between the two countries regarding the utilization of irrigation water from existing facilities. Negotiations held under the good offices of International Bank for Reconstruction and Development (commonly known as World Bank) culminated in the signing of Indus waters Treaty in 1960.

The Treaty was signed at Karachi by General Muhammed Ayub Khan, the then President of Pakistan, Mr. Jawahar Lal Nehru, the Indian Prime Minister and Mr. W.A.B.Illif of the World Bank on 19th September 1960.

The Treaty fixes and delimits the rights and obligation of India and Pakistan in relation to each other concerning the use of the waters of the Indus system of rivers. As stated in the earlier chapter the Indus system of rivers comprise three Eastern rivers (The Sutlej,the Beas and the Ravi) and three Western rivers (The Indus, the Jhelum and the Chenab). The average annual flow of the rivers of the Indus system is as under

[1] EASTERN RIVERS	:	41 BCM (33 MAF)
WESTERN RIVERS	:	166 BCM (135 MAF)
		207 BCM 168 MAF

Under the treaty the waters of the eastern rivers stand allocated to India and those of western rivers largely to Pakistan. India is however, allowed to utilise some supplies of the Western rivers for specified agricultural use and for generation of hydro-electric power. India has also been permitted to build storage of specified capacities on the Western rivers for the above uses. There are no limits on the amount of waters of the Western rivers which India may use for domestic, municipal and industrial purposes. Such uses would, however, be relatively small.

Thus the water were divided roughly in the retro of 80% for Pakistan and 20% for India. Under the Treaty India had to pay 62.5 million pounds sterling (about Rs 100 crores) to Pakistan as India's fixed contribution towards the cost of replacement works in Pakistan required to transfer from the Western rivers, adequate supplies for irrigating about 4 Million acres which were dependent on the waters of Eastern rivers. (Since allocated to India Under the treaty).

1. The Indus Waters Treaty; Government of India Publication (1960).

The Gensis of the Dispute

The 2898 km long Indus river is at places almost fourteeen and a half km. wide and contains as much water as the nile or four times the annual flow of colorado river. Next to Indus, in terms of water supply, rank the three rivers nearest to it, the Kabual, the Jhelum and the Chenab each carrying about one and a half times the annual flow of the Colorado. The remaining three tributaries, the Ravi the Beas and the Sutlej, are comparatively poor in water supply and together carry about one fifth of the flow of the entire system.

The area at present irrigated in the plains of the Indus Basin comprises some 26 million acres. This irrigated area is by for the largest on any one river system in the world; in fact larger then than total irrigated area in any country outside the Indian sub-continent. The United States of America for example has only about 23 million irrigated acres. Some of the canals in the Indus basin carry more water than the river Thames in flood. These man- made waterways are as complicated as the streets and parkways around any big America city- only very much bigger. It has been made possible, through modern hydraulic engineering to take a canal off one river, run it across the path of another and irrigate an arid area on the distant side of a third river. Some of these waterways are as new as aviation, some were nurturing an ancient civilisation centuries before MarcoPolo left Venice to see the world.

More than 46 millions - live by the waters of these rivers in the Indus basin in India and Pakistan. Their holdings are small, water supply for agriculture is inadequate; the standard of using is Low. However a substantial improvement is possible. Although the Indus rivers support the worlds largest irrigation system, the unused waters of the rivers, which now go waste into the Arabian sea, have an equally large useful potential. These could reclaim from the desert an area equal to that already developed. Another 26 million acers could be turned in to lush fields of wheat rice and cotton, thereby providing food for the hungry mouths and work for the unemployed. The crux of the delicate situation created by geography and politics may be summed up in the following basic facts.

Most of the area developed for irrigation was given by the partition to Pakistan -21 million people in the Indus Basin in India received only 5 out of the 36 million acres until then reclaimed form the desert. Millions of acres of highly arid land in the Indian part of the Indus Basin were awaiting development, when the waters were put by an arbitrary line into another country. Large volumes of water were flowing unused in the western rivers in Pakistan while some of the canals in Pakistan were drawing on the limited supplies available to India from the eastern rivers. On the other hand the diverbion works for two of the Pakistan canals lay in India and one of these flowed for many miles in India before reaching the farms to be irrigated in Pakistan.

Before the advent of large scale irrigation in the Indus Basin large areas were barren and unoccupied. These areas were called **Crown Waste Lands** and were owned by the state. In the early part of the Twentieth cenlury , preference was given to the reclamation of theses waste lands in what was then British territory. Those areas at one time barren but now highly developed, generally lie in what is now Pakistan. It was perhaps logical though logical though not equitable for the government of the day to reclaim, in the first instance such lands from which government would derive large additional revenves by sale of state-owned lands and sacrifice, for the time being, the interests of private land owners in the area now in India. Their arid lands were equally in need of irrigation waters. Also cultural lands in the basin lying in some of the old Indian states, although within the each of the rivers were not developed by the Rulers who lacked the means to do so. Thus the developments of the past were lopsided in relation to population and natural resources. People in the Indian part of the region would obviously not accept the proposition that the mistakes of the past be perpetuated indefinitely.

No one, and certainly no one in India, would deny that it is natural for people in Pakistan to desire to have all the water they can get for their canals and for their areas in need of irrigation. But no one can deny that it is equally natural for the people in India where these rivers originate, to desire to develop irrigation land of their over no a scale suited to the needs. A large part of the Indus Basin in India is a well known "famine area",it was so even when the natural unity of the sub continent had not been cut arbitrarily.

Back of the basic situation is the political fact that when the new country of Pakistan was taken from the mother country of India, the boundary between the two was fixed not on any physical or economic basis but purdy on the basis of religious ties the people. On the other hand the rivers and the droughts Know no such artificial frontiers.

With the achievement of independence on August 15, 1947, the old Indian empire was simultaneously split into two countries and thus the present dispute indoubtedly has its beginnings in the pangs of separation.

Suddenly, as it were the two new governments of independent India and independent Pakistan found themselves confronted with innumerable economic and technical problems relating to communications, utlhties and other once common enterprises. Many of these technical problems were intricately interconnected and as it developed, tragically mixed up with political questions.

A partition committee was set up to negotiate vital and delicate issues between the two Punjabs. This committee was not able to solve the problems that were bound to follow from cutting of the rivers and canals in an arbitrary manner, "No one seems to know", as David E. Lihenthal remarked, why the flow of the valley's lifeblood was "so carelessly handled in the Partition". The question was refereed to a sub - committee of officials, was who agreed on a basis for the future maintenance and operation of the two canals, which were to be served by the new boundary. The Partition committee, representing the future states of India and Pakistan, however did not accept their proposals' but refereed the matter to two experts for further negotiations.

The result was a " Standstill Agreement", one similar to many such partition agreements in fields of once - common public utilities, which for a stated time, generally to run to the end of March 1948, determined that the status quo would be maintained in the new countries as it has been before partition. Such agreements were necessary to give to the new countries enough time to make such attentive arrangements as were necessary.

The standstill agreement on water supplies was signed on December 18, 1947, and was to maintain the same proportion of water supply from the rivers concerned as had been permitted to flow downstream in the past. The agreement was to expire on March 31st 1948. The agreement specified that the parties may execute a further agreement for any subsequent perid thenceforth.

An April 1, 1948 with no agreement in existence and none being negotiated the Indian authorities discountimied the delivery of water to Pakistan through two canals in the Indian territory. This action resulted in immediate meetings, first between engineers and then the representatives of both governments and led to the fundamental document, the Delhi Agreement which represents the basic position of India, and the basic position of Pakistan as agreed to between the two countries at that time. It was put into effect immediately.

For many months both, India and Pakistan followed this agreement in letter and spirit. After some time, Pakistan felt that certain payments were irksome to it . Later, instead of implementing the agreement, the demand was made that the matter be refereed to the International Court of Juctice at The Hague. Still later, it was agreed, without putting any facts in support, that the agreement had been Wrested from Pakistan under duress.'

India believed that settlement of such a complicated technical matter as this dispute, which fundamentally concerns the very existence of millions in two countries cannot be decided by a law court but only by constant and continuing negotiation and agreement between the parties concerned. It further believed that disputes over water rights- "ripaarian question" - between two countries have always been settled by agreement through Joint commissions. There is no record in history of third party judging such question. The unied states for examples, has a joint commission with Canada, which has been busy for the last forty year in resolving U.S.- Canada disputes regarding the use of the water crossing or forming 4000 miles boundary between the two countries. Similarly, for the eighty years, the United States has had various negotiations with Mexico over the waters of the Colorado and the Rio Grande. No third party intervened and thus India believed that such disputes about the use of natural resources can best be resolved by mutual negotiation.

The United State Supreme Court, giving its news on the Colorado Vs Kansas Case (320 Us 383-392) said :

> "The reason for judicial caution in adjudicating the relative rights of State in such cases is that, while we have jurisdiction for such disputs they involve the interests of quasi sovereigns, present complicated and delicate questions, and due to the possibility of future change of conditions, necessitates expert administration rather than judicial imposition of a hard and fast rule"[2].

> "Such controversies may apropriately be composed by negotiation and agreement pursuant to the compact clause of the Federal constitution. We say of this case, as the court has said of inter-state difference of like nature, that such mutual accommodation and agreement, should if possible be the medium of settlement instead of innovations of adjudicatory power".[3]

2&3: The Indus Waters Dispute, Facts and Figures. Published by Ministry of Irrigation and Power, Govt. of India.

THE WORLD BANK OFFERS HELP IN A SOLUTION OF THE DISPUTE

India urged as early as 1949 that plans be made for the Indus Basin by a Joint Commission of engineers from either side.

This is exactly what David E. Lihenthal, the distinguished former head of the Tennesse Valley Authority and of the Atomic Energy commission in the United States, proposed on August 4, 1951, in an article in Colliers. Here he suggested that thus unnecessary controversy can be solved by common sense and engineering, to the benefit of the people who live on either side of the Indus river.

The urgent problem, according to him was now to store up wasted waters so they can be fed down and distributed by engineering works and canals, and used by both countries, rather than permitted to flow to the sea unused. This is not a religious or political problem but a feasible engineering and business problems for which there is plenty of precedent and relevant experience. He further observed that this objective cannot be achieved by the countries working separately as the river pays no attention to partition. The whole Indus system must be developed as a unit - designed, built and operated too as a unit India endorsed this concept officially and otherwise on several occasions.

The Lilienthal proposal received wide comment and was called to the attention of the International Bank for Reconstruction and Development. Its president Mr. Eugene R. Black in September 1951, initiated action on the suggestions of Mr. Lilienthal that the World Bank might assemble a party of engineers to discuss the Indus water resources from a reasonable viewpoint with the objective of co- operative development. Mr. lack held the view that the problem of development and use of the Indus Basin water resources should be solved on a functional plane and not in a political climate without relation to past negotiations, past claims and independently of political issues.

The Prime Minister of india agreed that India and Pakistan would each designate a qualified engineer of high standing to prepare jointly with the designee of the other, a comprehensive long range plan for the most effective utilization of the water resources of the Indus Basin.

The working party met in Washington in May- June, 1952, and agreed on an outline of a programme. It included determination of total water supplies of the Indus Basin, water requirement of cultural irrigable areas, preparation of a comprehensive plan and preparation of cost estimates. The working party adjourned enable the designers to carry out these studies in their respective countries. The studies were exchanged the following winter. In 1953, September, the working party reassembled in Washington, the work out a comprehensive plan. Meanwhile during the 1952-53 time period, there was a pronounced drought all over the Indus Basin, which was most severe in its Eastern part. The Ravi and the Beas the month of September, 1952, had less than half of the average water supply these rivers had in the four years previously. This state of affairs continued upto December, and resulted in extreme hardship in a large part of the irrigated areas. India continued to give water in an amount proportionate to the reduction of total supply caused by the unfortunate drought, fulfilling the promise given to Mr. Black.

A few other facts that needed to be kept in mind before any long term agreement could be reached.

First and foremost if one takes the Indus Basin as a whole West Pakistan has a slightly larger population than that part of the basin which was within India.

According to the pre-partition census of 1941, Pakistan had 25 million people feed, from 39 million acres which are or could be developed in the plains of West Pakistan. India had to feed 21 million people from 26 million culturable acres already had 21 million irrigated acres- India on the other hand hard only 5 million.

Pakistan then used 66 million ache feet of irrigation water a year India used only 9 million. The total annual flow of the indus system of rivers ofter allowing for losses and gains in the rivers, is about 150 million acre feet. Thus about 75 million acre- feet flow unused in the Arabian Sea every year.

Both countries hard been disrupted by an influx of refugees, people who had to find land, food and a way of life. The refugees in India had migrated from a highly developed region now in Pakistan, which they had helped to build, into an undeveloped region where they would have had to build all over again. On the other hand, the refugees in Pakistan had gone to an area already highly developed. The refuges in India required to develop the desert like land where they had settled now.

The Indus and the Jhelum flows in India only in the mountainous regions of Kashmir where there can be no big irrigation development. The Kabul lies in its lower reaches entirely in Pakistan. From the Chenab, India gets little water at present, although she could easily use some of its supply through a tunnel to the Ravi from the upper reach of the Chenab in Punjab. The Ravi, the Beas, and the Sutlej, which flow through the plains of the Indus Basin in India, together carry only one fourth of the waters that flow in the Indus, Kabul Jhelum and Chenab. Almost half of the water of all these rivers is wasted April to September.

Most of these waters are wasted from the wastern rivers the main Indus, the Kabul, the Jhelum and the Chenab. The more limited supplies in the eastern rivers the Ravi, Beas and the Sutlej, have been carried to develop regions and accommodate populations which could have lived, and can live in the future, from the waters in the western rivers. India felt that she can not indefinitely deprive her scarcity areas of waters which flow by them and which would have been utilized theirin long ago, had a natural plan of development been followed.

If Pakistan would use Indus Kabul, Jhelum waters, which measure twice as much as these of the other four rivers combined, Pakistan could not only maintain its present irrigated areas without seeking to use water which India needs for her new development works, but could also develop large new areas. To India it appeared that Pakistan was developing new areas and colonizing new populations in line with a policy of hoping to hold on to old water supplies and develop new ones too.

Some of todays complications can be traced to the politics which led to over development of certain regions in the past while other areas remained underdeveloped.

Political factors sometimes reign supreme in resolving questions which ought to be decided according to natural or engineering factors. Any attempt to crystallize into the future the arbitrary apportionment of the past will only create more bitterness and acrimony.

A COMPREHENSIVE PLAN FOR THE ENTIRE INDUS BASIN AS SUGGESTED BY INDIA

In the Indus Basin working party Indian engineers proposed a plan for development of the entire Indus Basin, based on conservative estimates for water resources and the needs of the populations on both sides of the border.

This plan was built firmly on the experience of the past, on the findings of the engineers who have studied the rivers and canals, for many years. The plan treated the whole Indus valley as one unit making for considerable improvements in existing irrigation and co-accordinating with the existing canals a number of new canals, to be built by each country; as units of one over-all basin-wide plan. India had many engineers familiar with the details of the irrigation system in Pakistan; the same was true, vice versa of, Pakistan. The plan is based largely on knowledge gained when these men worked side by side before partition and thus hoped that in future too, the two countries could build together.

Such a plan would have benefitted in all about 18 million acres in India and 40 million acres in Pakistan. As already stated, the total irrigable area, fit for large scale irrigation development, is about 26 million acres in India and 39 million acres in Pakistan.

The Indian plan, presented to the Working Party in October 1953 was a plan in outline, as a basis for discussion by the working party and to be preferred by it. It was presented as a logical and far sighted effort to meet human needs in the Indus Basin, and to go forward from a precarious subsistence to a high standard of living in both countries.

This plan suggested that the irrigable areas dependent the Indus rivers be divided into suitable block to be supplied with water from specific dams. It was not a visionary concept, but one in many respects already started and in all aspects based on sound engineering practice.

The Indian plan would :

A) Continue the existing water supply to aheas already reclaimed in both India and Pakistan.

B) Provide assured irrigation supplies over a much longer period than at present to about 5 million acres in

Pakistan and half a million acres in India, which today receive only irregular supplies during the flood months, by what are called "inundation canals".

C) Improve supplies at present available to several existing canals which do not now receive enough water during critical agricultural periods. This would be beneficial to about five million acres in pakistan and three million acres in India.

D) Provide new irrigation facilities to 11 million acres in Pakistan and 12.4 million acres in India.

India outline plan for the first time viewed the entire Indus system as one unit, taking into account all existing developments in both countries - carried out by different provinces and states, over a period of many decades, as individual uncoordinated schemes.

It envisaged new storage reservoirs one or more on the Inuds and also on each of the major turbutaries. As mentioned earlier, the water available in the Western rivers is far more than in the eastern rivers. Accordingly, it has been the practise in the Punjab to transfer waters, where practicable, from the western to the eastern rivers.

The plan provided for three more links:-

i. From the Indus to Islam on the Sutlej.

ii. Another from the Jhelum to the Ravi

iii. From the Chenab to the Beas.

The Indian plan thus provided for all irrigable lands in Pakistan and only for 70 percent of the total irrigable lands in India's part of the Indus basin. Forty percent of the irrigable area in India would remain desert as there is not enough water in the eastern rivers from where it could economically get irrigation supplies. The plan thus gave India a share of total river supplies, which is less than a fair share in proportions to population and usable land. Only a part of the desert lands of Rajasthan would have been reclaimed while large stretches would have remained undeveloped. The need for development of the Rajasthan areas had been recognised for many years. For example in 1902, Mr.J.Wilson, a British settlement Commissioner in the Punjab had stated before the Indian Irrigation Commission that there are many millions of acres in the Rajputana desert which can be irrigated from the Punjab rivers. He thus recommended that the waters of the Punjab rivers should be carried as far to the East and South as possible.

In addition to reclamining large areas of land in both India and Pakistan, the Indian plan would be an effective flood control programme for the whole of west Pakistan, Large areas along the rivers in West Pakistan are ravaged by devastating floods during the monsoons and a programme of flood control measures, as provided by the Indian Plan is vital to the economy of West Pakistan.

THE PAKISTAN PLAN

The engineers from Pakistan too prepared a plan of development and proposed it to the Working Party. In this 'Preliminary Outline of Plan' put up to the Working Party in October, 1953, against an average annual available flow, in all the rivers of the Inuds system, of about 150 million acre feet, they worked out Pakistan's annual requirements from the Inuds waters as more than 506 million acre feet. Obviously this was not a very realistic approach. On the other hand they did not make any estimate of the irrigation requirements of the Indian part of the Indus basin. In this plan they reserved to Pakistan the use of the entire flow, whether already utilised or not, of the rivers Indus, Jhelum and Chenab and 70 percent of that in the rivers Ravi, Beas and Sutlej. The Pakistan engineers further proposed that India should get 7.6 percent of the total utilisable flow of the entire Indus system and Pakistan should have the other 92.4 per cent at its disposal.

THE WORKED BANK PROPOSAL AS THE BASIS OF SETTLEMENT

The proposal made by the engineers of the two countries were vary diffeernt, not only in concept but also in their approach towards a solution. When it became clear that there was little possibility of reconciling these differences and that so long as these differences persisted there was no prospect of further fruitful discussions, the bank representative on the Working Party put forward an independent proposal, for the consideration of both sides, as the basis of a comprehensive plan. The proposal had the full support of the management of the Bank. The Bank proposal claimed that it was based on concepts which produce a fair and economic result.

The bank proposal, stated briefly, is that as a basis for agreement between India and pakistan the water of the three 'Western' rivers Indus including Kabul, Jhelum and Chenab - except for such uses as are made of them in the State of Jammu and Kashmir, should be reserved exclusively for Pakistan, and the waters of the three 'eastern' rivers i.e. the Ravi, Beas and Sutlej - being a little less than one fourth of that of the three Western rivers (Indus, Jhelum, Chenab) go to India. If provides for certain regulations during a transition period and indicates principles for distributing, between the two countries the costs of new link canals necessary to give effect to this proposal. Thus under this proposal the Indus waters get shared between India and Pakistan in a 20:80 ratio.

The chief merit of the Bank proposal is this simplicity. Instead of elaborate regulations for distribution of the waters of each river, it adopts the whole river as a unit of division. It thus affords the greatest possible freedom of action by each country in the operation, maintenance and further development of its irrigation facilities. The bank believed that leaving each country free to develop its own water resources in the light of its own needs and resources and without having to obtain the agreement of the other at each point, will in the long run most effectively promote the efficient development of the whole system. The bank proposal had the essential elements which would reduce the chances of disputes and tensin and contribute to improved relations between the two countries.

The bank proposal required India to give up the use of a large part of the waters flowing through their own territory and thus to abandon for all time any hope of the development of a considerable portion of the extensive arid lands in India, which have no possible source of water supply other than the Indus system of rivers. Nevertheless India decided to accept the principles of the Bank proposal in the interest of a speedy and constructive settlement.

Though Pakistan was hesitant earlier but gradually it came around to signing the treaty in 1960.

The treaty thus allocated the waters of Sutlej, Beas and Ravi to India, for its unrestricted use, except for a transition period during which India continue supplies to Pakistan according to the detailed provisions set out in Annexure H to the treaty. The transition period commenced on April 1, 1960 and ender 10 years later on march 31, 1970. The transition period was intended to give Pakistan sufficient time to build engineering works for the replacement from alternative source of the supplies previously received by it from Sutlej, Beas and Ravi.

CONTENTS OF THE TREATY

The treaty provided for regular exchange of river and canal data and for future co-operation India and Pakistan also agreed to create a permanent post of Commissioners for Indus water on each side and to appoint a high ranking engineer competent in the field of hydrology and water use. The two commissioners together formed the "Permanent Indus Commission'.

The commission was required to meet regularly, alternatively in India and Pakistan and undertake tours of inspection in both countries for clearing up any points which might arise. The commission was also to make co-operative arrangements for

a) implementing the treaty.

b) Submit an annual report to the two governments, and

c) To resolve by agreement any differences concerning the interpration or application of the treaty.

The treaty also set out detailed provisions regarding the procedure to be followed, if the commision could not resolve any such problem, for a solution by reference to a Neutral Expert, or a Court of Arbitration.

So far 76 meetings of the permanent Indus commission ahve been held, the last meeting was held in May 1992.The table given below gives systematically the contents of the treaty.

ARTICLE	TITLE OF THE ARTICLE
1.	Definitions.
2.	Provision regarding eastern rivers.
3.	Provision regarding western rivers.
4.	Provision regarding eastern and western rivers.
5.	Financial provisions.
6.	Exchange of data.
7.	Future Co-operation.
8.	Permanent Indus commission.
9.	Settelment of differences and disputes.
10.	Emergency provision.
11.	General provision.
12.	Final provision.

ANNEXURE	TITLE OF THE ANNEXURE
A.	Exchange of notes between GOI and government of Pakistan.
B.	Agricultural use by Pakistan from certain tributries of Ravi.
C.	Agricultural use by India from Western rivers.
D.	Generation of hydroelectric power by India from western rivers.
E.	Storage of waters by India on the Western Rivers.
F.	Neutral Expert.
G.	Court of Arbitration.
H.	Transitional Arrangements.

During the implementation of the treaty for the last 32 years a number of issues cropped up between the two parties. Some issues took long before finally a solution could be found. The hurdles that have surfaced since then are discussed below in a chronological order. 1960 - 1980 : During the early 1970's dispute arose regarding the Salal project. This was a hydroelectric project being constructed in India on the Chenab river near Dyangarh in occupied Kashmir. The project aimed at constructing a 200 feet high dam for generating about 220 MW of hydro-electric power. The Indian side claimed that the Salal hydro-electric station would be a run-of-the-river plant and would not have any live storage. The project would have two dams on the Chenab river, one a rock filled one and another, a concrete one. There was also a provision for a diversion channel.

The Pakistan side objected to this project. In 1974 October, the Indian officials claimed that the project was quite in conformity with the Indus waters treaty and that the Government of India did not receive any formal protest from Pakistan.

" Moreover in confirmity with the treaty, India did not propose to use the Chenab waters for any consumptive purposes though it had allowed India some nominal use". Further the Indian side agreed to discuss Pakistan's objection to the design of the project at Salal, at the next meeting. By the 1975 round of Indus Waters Commissioner's talks, Pakistan had yet not specified it's objection to the project and thus no headway could be made.

1. The Times of India, New Delhi, 5th Oct. 1974

According to the Indian express dated 19th January 1975, it seemed that one of Pakistan's main objection was to the amount of "dead water" which will be stored behind the dam. The Indian sources claimed that it was going to be 230,000 acre feet, which at the normal Chenab discharge of 100,000 cusecs will take no more than 10-12 hours to fill.

" The dead water storage is a one time filling which will not as the Pak's are reported to fear, affect the water supply to the crops at Sialkot, Gujaranwala and Shekhupur which depend on the Chenab for irrigation"[1].

Finally in 1976, the Pakistan foreign secratary Mr. A. Shali arrived at New Delhi for talks.It was agreed that the conflict can be solved by subsequent round of talks. The Indian experts further allayed the fears,that Salal project posed a potential threat to the adjoining west Punjab districts. It was stated that the topography of the adjoining areas was such that it would be impossible to flood the lower Punjab area without causing much greater devastation to it's own territoy in the vicinity of the project.

In 1978, India and Pakistan signed the accord on the Salal project."It provides that India shall not make any alteration in the feature of the design of the plant"[2]. " The six article agreement provides for the location, full bondage, a dead storage level, discharge capacity, improvable crust level of the spillway and spillway gates and also the level of the inlet and outlet works"[3]. The Pakistan side also wished to ensure that India did not acquire the capacity to tap the flow of water in the Chenab or to release excess water, thereby flooding the lower

[1]: The Indian Express, New Delhi,19th January, 1975).
[2,3] :Dawn, Karachi, 15th April 1978)

riparian as and when it wished to. The accord also provided for the resolution of any dispute which might arise, by the appointment of a neutral expert.

During the 1970's, another project, the Thein dam on the river Ravi was shelved due to lack of funds. This however was not due to a dispute between India and Pakistan. India could not take up the project due to the paucity of funds. However foreign pressure was not ruled out because if the project was to be completed it would have deprived Pakistan of 2 million acre feet of Ravi's water flowing through eight and a half lakh acres of Pakistan's irrigable land Pakistan also needed the Ravi waters for it's diversion channels which includes the Ichogil canal which lines it's borders with India from Sialkot onwards.

The Indian side on the other hand maintained that it had gained exclusive rights over Ravi's waters by paying Pakistan 100 crores of rupees under the Indus water treaty which expired on March 31st, 1970.

"The period of the treaty was 10 years to provide Pakistan with an opportunity to make alterations in irrigation arrangements and also to enable India to raise the dam on the Ravi for diverting it's water to it's own areas"[4].

This project however, was taken up again and is now slated for completetion by the year 1995.

1980 onwards:

In 1986, Pakistan raised fresh objections as it felt that certain projects that were taken up by the Jammu and Kashmir Government were in violation with the Indus Waters Treaty. There was a call for virtual anullment of the treaty as there was a (4. Motherland, New Delhi. 24th October 1974). difficulty beingfaced in Kashmir in building the Wular barrage, designed to stabilise power generation in the lower Jhelum hydel project in Baramulla district.

There was a further controversy over the Tulbul project on river Jhelum, which the Pakistan side claimed, was in violation of the Indus waters treaty. Pakistan was subsequently told that it was it was only a navigation project and not a storage work. It was meant to be a control structure that would store natural storage in the Wular lake. This natural storage is available on Wular lake practically every year, even in the abscence of this work. The project will not contribute to raising the water level in the lake, but will only retard the natural depletion of the Wular lake and maintain the required draft to ensure the round - the - year navigability. Subsequently on Pakistan's request the commissioners visit was organised by India in

May 1986. Further data on was also provided .It was further communicated to Pakistan that they would benefit from this project as regulated flows will raise the lean season flows in Jhelum and would reduce the spills at Mangla dam. It would also increase firm generation at Mangla dam and also at other run-of-the river hydel plants proposed by Pakistan on the Jhelum upstream of the Mangla dam.

These matters have been taken up by the Permanent Indus Commission at the technical level. It was later decided that the issues would be taken up at the government level. However no major breakthrough has been achieved as yet. With continuous efforts from both sides a solution may be found out in the near future.

To conclude one can say that the signing of the Indus water treaty is more or less co-terminus with India's foreign policy. India believes that the whole of Asia, including India is awakening to a new era of development in human welfare. Also that development rests upon the will and resources of the Asian nations and their ability to act with maturity and foresight. Peace is a necessary condition to this development, and India has therefore worked for peace in the world and peace with her neighbours.

CHAPTER 5

DEVELOPMENT OF IRRIGATION AND AGRICULTURE SUBSEQUENT TO THE SIGNING OF THE TREATY

Undivided India used to irrigate every year near nearly 70 million acres of Land, the largest irrigated area in any country of the world. The area irrigated in undivided India was more than the combined total irrigated area of any other ten countries of the world. Due to partition of the country the best irrigatiion facilities were lost to pakistan which made agriculture on the Indian side poorer. While on one hand the concentration of irrigation facilitates in Pakistan meant assured and increased agricultural output while in India it only meant that there would be increased dependence on monsoons, thereby introducing elements of uncertainity in agricultural production from year to year.

The proportion of irrigated area to net sown area is larger in Pakistan than that in India. Excepting perhaps in U.P the irrigation works in India are largely of a protective character, that is, they are meant more to ward off famine conditions than it produce a significant increase in yield per acre. As contrasted with this, the Loyd barrage in Sind is one of the largest barrages in the world with canals and an aggregate capacity of over 40,000 cubic feet per second. Nearly the whole of the cultivated area of Sind and the state of Bhawalpur enjoy irrigatonal facilities. Of the total irrigated area of undivided Punjab, West Punjab has been blessed with 65 percent of the area.

> "Nearly 76 percent of the totat net sown area in wheat Pakistan enjoys irrigational facilities as contrasted with 22.5 percent in Indian provinces and 13.5 on an average in the Indian states. Because of irrigation facilities the yield per acre of various crops in Pakistan generally" remain higher than those in India"[1].

The cotton crops tells a similar story keeping this agricultural inbalance in mind many development works were taken up after the successful signing of the treaty in 1960. Many river valley projects and irrigation schemes were taken up some for the purpose of augmenting agricultural production while the rest were merely to ward off famine or near-famine conditions.

Some significant development works taken up in Pakistan area of the Indus basin have been mentioned below. These were :

1. C.N. Vakil and C.R.Rao: Economic Relations Between Indian and Pakistan. (Pg 38).

a. DAMS: Mangla dam was constructed on the river Jhelum, with a reservoir of a storage capacity of 4.75 million acre feet. The capacity could be raised later. The project could generate about one million kilomwatts of power. Besides the dam irrigates about 3 million acres or more of agricultural land.

TARBELA: Tarbela dam is a multipurpose project on the river Indus, though a part of the project is for replacement of waters. It has a reservoir capacity of 8.4 million acre feet gross, and 6.6 million acre feet effective, with a power potential of 1.5 million K.W. This dam is expected to provide irrigational facilities over an extensive area.

b) LINK CANALS: These are meant to replace the waters of the Sutlej the Beas and the Ravi with the waters of the Indus, the Jhelum and the Chenab. The southern-most link system comprises of Trimmu-Sidhanai, Sidhani-Mailsi, and Maishi-Bhawal link canals. The northernmost canal system comprises of the Rasul-Qadirabad Balloki and the Balloki-Sulemanki II link canals.

(c) BARRAGES: Qadirabad, Rasul and Chashma barrages have been constructed in the Indus basin. Marla and Balloki headworks have been remodelled since then. Pakistan faces some serious problems like waterlogging and salinity. The U.S.Agency for International Development has been financing some schemes for reclamination of land affected by water logging.

The development works that have been taken up in India are now discussed in a greater detail, taking up each state that forms a part of the Indus Basin.

1. JAMMU AND KASHMIR

The state of Jammu and Kashmir is a land locked region in the extreme western sector of the Himalayas. It is one of the most thinly populated states of the countay, with the population being mainly dependent on agriculture. The Indus, the Jhelum and the Chenab along with their tributaries drain the area. These principal rivers are perennial and snow-fed, but there are wide variations in their flows in the different periods of the year. Their flows are at the highest as the rivers emerge from the foothills into the plains. Thereafter little surface flow is added by the run off from the relatively large but arid part of their catchements. On the contrary, percolation and evaporation losses are heavy as the rivers flow through the plains.

Agriculture is the most important activity in the State. The percentage of gross irrigated area to gross cultivated area is roughly 40 percent. The important food crops that benefit from the irrigation are Rice, Wheat Maize and Barely. These together account for 80 percent of the total cereals grown. Oil seeds and fruits are grown for commercial sale.

The Kashmir Valley, geologically speaking, is a structural basin. More than half the area of the valley is composed of Karewas, which are low, flat plateaus consisting of the stratified deposits of fine silt, clays, sand and gravel. A serious handicap to agriculture here is the full utilisation of cultivable land. The area lies under snow for three to four months during winter. Rice is the main Kharif crop, which is harvested in October, thereby leaving no time for a rabi crop.

Through a series of experiments, it was found practicable to reap a short duration early paddy crop and have enough time to sow a dwarft variety of wheat. During the 1960's a second crop of wheat was raised. Gradually many local adaptations of Mexicern wheat, Sonalika and Safed Larma were sown over large areas. This system of double corpping was extended with help of irrigation facilities. The Kashmir valley is also reputed for growing temperate and sub-tropical zone fruits, apples, apricots, pears, peaches, plums, cherries, walnuts, almonds etc. Both the fruit bearing capacity and the area under fruit orchards have undergone great improvement, especially after the creation of the Department of Horiticulture. The climate and soil of the karewas is eminently situated for raising archards, provided arrangements for irrigation supplies are made. Indeed, the existence of the ruins of old irrigation works on some karewas go to show that those karewas were at one time put under crops as well as trees. As the water requirements of orchards are low and the cost of lifting water is high, it would be worthwhile to explore the possibility of raising fruit orchards on the karewas by lifting irrigation waters.

From some of the earliest time, one of the problems of the Kashmir valley has been to control the flood water of the Jhelum and to drain the valley after the floods. Since the river is an alluvial stream flowing through embankments, it frequently overtops these embankments when in flood. The flood waters carry considerable quantities of sand and silt and the bed of the river has been silting up for centuries. The measures so far adopted to control the Jhelum floods above Srinagar consisted largely of construction of bunds or embankments on both sides of the river. These bunds have, however, never been able to protect the velley against periodic inundations. Any measures to protect the valley above Srinagar would endanger the city itself, thereby requiring a combination of several flood control measures, instead of the single system of raising embankments.

Some measures that have been recommended are:

i. Strentheing and re-aligning the bunds without raising them;

ii. Improving the river channel by making cut offs etc.;

iii. The provision of a supplementary channel or flood way from Dogripur to Wular, and the improvement of the out fall channel by diverating the Ningle and the sediments of the Poharu river into the Wualr lake and

iv. Stabilising the torrents below Baramula and clearing debris from the bed of the outfall channel.

Most of the these suggestions have been implemented primarily as part of the flood control programmes.

Another important feature of the irrigation system here is the existence of high proportion of kuhls which take off from rivers, nallahs and srpings. These too have existed since very early times. At the beginning of the First Five Year Plan (1951), kuhls provided irrigation to an area of 0.16 million hectares compared to Government canals which provided irrigation to only 10,522 hectares. These kuhls were constructed, owned and maintained by the local zamindars. After landlordism was abolished in 1951, the maintenance of kuhls was neglected and they fell into disrepair. This led to a waste of water and to a loss of command. Furthermore, due to a lack of control on the off take points, the kuhls became a great menace to agricultural lands during floods. The State Government later drew up a programme under the minor irrigation scheme for arresting the deterioration and renovation of kuhls. The total number of kuhls involved in the programme were two thousand odd in number. The programme involved the taking over of all kuhls with a command of 1,012 hectares or more, for renovation and restoration. It included;

The state Government had also decided that it will not take over Zamindari kunls irrigating less than 200 hectares and the cultivator will be assisted in maintaining these kuhls. Once these are sufficiently repaired double cropping as well as horicultur would be given a sufficient boost.

LADAKH is the highest platean of India, is arid with steppe like conditions. It gets very little rain (8.28 cm per annum. Devoid of any forest cover, cultivation of crops there without irrigation is practically impossible. Barely, wheat and pulses are the principal crops grown. The soils are generally sandy and per hectare yields are very low. Recently the cultivation of fruits vegetables etc., primarily for supply to army units stationed in the area, has increased. Many seed research institutes have also come up in the area that strive to create better strains of seeds and plants. Since no cultivation is possible without irrigation the state has implemented a few schemes viz:-

1. The Abhichanothang Canal in Leh (486 hectares)

2. The Upstri canal in Leh (223 hectares);

3. The Gargarthan Irrigation Scheme in Kargi (121 hectares).

4. Kumbathang Irrigation Scheme in Kargil that irrigates roughly some 400 hectares.

In the JAMMU region, the first three plan periods, witnessed considerable activity in the irrigation sector, particularly in the extension of the area under Government canals. The State Government has already remodelled the Ranbir Canal System, which is the oldest canal in the State. It was built in 1905 and was initially designed to irrigate 52,000 hectares of land. The iremodelling of the system was done in order to stabilise the existing command area and also to provide additional irrigations facilities to roughly 2,500 hectares of land. The Ravi and Chenab flow through the Jammu region. The utilisation of the Chenab waters is controlled by the terms of the INDUS WATERS TREATY. The withdrawals of water for the RANBIR and PARTAP canals are prescribed under clause 3 of the annexure to the Treaty. Also, under the clasue 4 of Annexure C, not more than 40,468 hectares (100,000 acres) can be irrigated from the Chenab in Jammu province. The share of Jammu and Kashmir in the Ravi waters is limited to 1,048 m.cu m, the Ravi Tawi Lift Irrigation scheme has been formulated to irrigate a compact area between the Ravi, and the Tawi. The boundaries of this area are the lower siwaliks on the east and the Indo-Pakistan border on the west. With the scheme completed, all the supplies of the Tawi Ujh and Ravi are now available to the state. The government has also taken up a lift irrigation scheme from Manawar Tawi for irrigating areas in the Chamb Niabat, and on the Pargoal island which is situated in the Chenab river itself.

Once all these scheme are fully implemented/completed and the water utilised to the permissible extent, the possibilities of large scale irrigation in Jammu province would have been practically exhausted.

Some schemes have been capt incomplete for want of steel. By improving the position of power supplies in the valley, the irrigation through lift schemes could considerably be increased. The Karewas which have yet been left unirrigated, could be irrigated either by the benefit from the river Jhelum or from Tubewells. These Karewa lands are particularly suitable for growing cash crops like Kuth, fruits, flowers, seeds, vegetables, almonds, saffron etc. If lift irrigation schemes on the Karewas are properly designed, irrigaton could be done through sprinklers. This area holds out great importance in terms of commercial agriculture and thereby earning substantial revenue for the state.

2. HIMACHAL PRADESH

The Sutlej, the Beas, the Ravi and the Chenals flow through this state. The bulk of the rain falls during the months of July, August and september. The main ceral crops in Himachal Pradesh are rice, wheat, maize, and barely. The main commercial crops of the State are potatoes, ginger and sugarcane. Oilseeds such as sesamum, rape and mustard, linseed as well as cotton, tea tobacco are also grown. Himachal Pradesh has a great tradition of prosperous horticulture. The physical features and climate of the state facilitate the cultivation of a variety of fruits. Quality apples from Kotgarh in Mahasu district are famous. Efforts are also being made to popularise citrus fruits in other districts. Parwanoo for example has turned into one of the largest fruit 'mandis' of the country.

Cultivation in Himachal pradesh is generally done on terraced fields on hill slopes and in the valleys. For this reason, even when there are adequate perennial supplies of water, irrigation on a large scale is not possible. Famers construct small contour channels, which are fed from local streams or hill streams. Channels with a perennial supply of water are called 'kuhls' and those, which get only regional supplies are katuls. Kuhls and katuls have been the main source of irrigation in the territory from times commercial. However, these channels are usually imporary and are damaged by floods and land slides during the rains. They are an unreliable source of irrigation. No other type of irrigation is practiced on any appreciable scale, though small patches in a few places in the Poonta valley of the Sirmur district are irrigated by dug wells.

There are some canal systems that have been developed over the Five year Plans. These are described below:-

i. **CHANDPUR CANAL:** This canal is situated about 19 km west of Bilaspur. It was was constructed to benefit the villages of Jalhal and Deslin in the district of Bilaspur. The project irrigates roughly some 580 hectares of land.

ii) **THE BATA MAJRA CANAL:** The canal with a maximum discharge of 0.42 cumec runs in the Poonta valley to the north west of village Matak Majra in the district of Sirmur. It takes off from the Batar river whose, waters are first utilised for rotating gharats (grinding mills). The scheme commands a culturable area of some 500 hectares.

iii. **THE RAMPUR GIRI CANAL:** The canal runs through more or less flat country at a distance of about 8 kms to the north-east of Poonta Sahib in Siarmur district. It is 10 km in length and takes off from the right bank of the Giri river which froms the boundary between Himachal Pradesh and Uttar Pradesh. The diversion of bundh is formed of boulder crates, and is washed away during the monsoon. The bund has to be re-erected every year the scheme has a culturable command area of a little more than 1000 hectares.

With the support of the Indo-German Agriculture Project, in Mandi district, the vegetable growers lift water by electric pumps from the Suketi Khad Favourable conditions for this type of lift irrigation exist in many places in Himachal Pradesh, particularly in the valleys. The use of electric pumps for lifting water is being encouraged. With an adequate network of electric power lines, lift irrigation through pumps can be extended considerably. The experts attached to the Indo-German agricultural Project have also experimented with sprinkler irrigation, using mobile sprinklea sets. The scheme was first introduced in Mandi and Sirmur district and later extended to other districts. Other schemes that have been taken up are the Poonta valley irrigation scheme, Bahl valley being irrigated from the waters of the Beas and also the Bhakra and Nangal reservoirs.

In Himachal Pradesh the scope for future development of irrigation consists mainly of minor irrigatin works namely:-

i. Lift irrigation schemes in valley;

ii. Lift irrigation schemes using water from percolation wells in beds of Khads and Choes

iii. Tubewell schemes

iv. Flow irrigation by Kuhls; and

v. Installation of pumping sets on private wells.

The farmers in the state are not irrigation minded. They are not accustomed to taking water from canals according to the requirements of the crops and have a tendency to wait for the rains. Thus in order to relate the success of irrigation schemes with increase in agricultural yields, the farmers have to be made more aware of the advanced techniques of cultivation available to them. Special attention should also be given to soil conservation.

If due attention is not given to soil conservation works, the massive Bhakra and Beas reservoirs may silt up much earlier that what was envisaged at the stage of project formulation. There is urgent necessity that the critical areas which contribute heavy silt-load to these reservoirs should be identified soon.

3. PUNJAB

Through Punjab flow the three principal rivers the Sutlej, the Beas and the Ravi - are all snowfed and perennial. The soils are of forest and hill types and alluvial soils which can grow excellent food crops as well as cash crops.

Development of irrigation: One of the earliest irrigation works constructed in Punjab was the Bari Doab Canal, which was commissioned in 1876. On partition sizeable portions of the area irrigated by this canal and its channels, fell to the share of Pakistan. In India, irrigation under the canal is now restricted to Gurdaspur district. The Sirhind canal takes off from the Sultlej at Rupar, about 80.5 km. downstream of the Bhakara dam. In 1954, as a part of the Shakra-Nangal Project, the weir on the river was replaced by a berrage, providing complete control of the river supplies at all levels. Another canal known as the Bist Doab Canal was constructed to irrigate areas on the right bank of the river.

The Sirhind Canal, in its head reach, crosses two large hill torrents, the Budki and the Siswan, which are carried over the canal by means of viaducts. It irrigates an approximate area of 1 million hectares. The Sirhind Feeder was completed in 1960. It is 142 km long. It irrigates land in Ferozepur, Faridkot and Muktsar Tehsils (Punjab) besides some part in Rajasthan.

The Bhakra Canal was completed in 1964. It takes water from the Bhakra dam and irrigates about 15 lakh hectares land in the districts of Hissar and Rohtak in Haryana, while the Nangal canal irrigates, districts of Jullundheir, Feaozepur, Ludhaiana and Patila in Punjab. The Nangal canal takes off from the Nangal dam, is 64 km long and irrigates 26.4 lakh nectares.

The State has laid great stress on development of irrigation both from surface and ground water resources and that is why green revolution was particularly successful in this region.

Depending on the type of soil, it as been estimated that 25 to 70% of irrigation water is being wasted through seepage in conveyance channels. The seepage leads to waterlogging and salinity. By proper water management and land grading, it can be possible to irrigate an additional 25-70% of area with the same quantity of water.

Other projects that are in various ages of completion are Beas-Unit II. Beas Project Unit I and II together will be abel to utilize all the water available Ravi will be able to provide irrigation, power flood control and provisions of pisciculture. Thien is a thick-core gravel shell dam across Ravi in Thein village in Jammu and Kashmir State.

There is also a scheme to utilize the surplus Ravi - Beas waters. With the completion of Beas project, the stored water which will no longer need to go to Pakistan under the Indus Water Treaty, will be utilized for irrigation. It has two components (i) a link canal from Sutlej to Narwana in Haryana and ii) the extension and remodelling of the existing Bhakra and Sirhind systems.

To conclude one can say that Punjab is a typical example of how irrigation can transform areas that would otherwise be classified as drought affected. Large portions that should have been normally categorised as drought affected, have not been done so as the extensive network of canals have made these areas green and prosperous. Today not only agro-based industries but other industries too, have come up that are a direct result of agricultural prosperity and development.

4. HARYANA

The Haryana state lies between the basins of the Indus and the Ganga, and is formed almost entirely of aluminium. The soils of Haryana mostly grow foodgrains, thereby accounting for roughly 75 percent of the total cropped area. Wheat accounts for some 6 percent of the total cropped area. Other important foodgrains crops are bajra, barely and jowar while amongst non-food crops, cotton and sugarcane hold an important place.

Some important projects have been taken up since independence, the first and the foremost being the Nangal project on the Sutlej. This is one of the largest and outstanding multipurpose project in the world. It consists of two fully integrated units, the Nangal and the Bhakra dam.

The Bhakra Dam is a reinforced concrete structure of the straight gravity type across the river Sutlej at the foot of the Sivalik hills in Himachal Pradesh. Its maximum height is 226 metres and length is 518 metres. The dam was completed in 1963. About 13 km donwstream is the Nangal barrage which feeds the Nangal Hydel Canal that canal seaves as a feeder for the Bhakra canal system below Rupar, and for a generating power at the power stations at Gangnwal and

Kotla, which are 19.3 km and 28.9 km from the head of the channel respectively.

The Bhakra Canal system has been planned to serve the arid and scarcity tracts of Punjab and Haryana and a part of the Bikaner district of Rajasthan.

It comprises the following schemes:

i. The construction of the Bhakra canal, fed by a 354 cumecs hydel channel.

ii. The remodelling of the Rupar Headworks and the old Sirhind canal to give the canal an additional discharge capacity of 99 cumecs.

iii. Theconstruction of the Bist Doab canal, taking off on the right bank of the 'Sutlej at the Rupar Headworks, with a discharge of 39.6 cumecs.

The system utilises a discharge of about 509.7 cumecs and has a length of 1,110 km of main and branch canals and 3,379 km of distributary channels. The total area benefitting from the three schemes mentioned above, is nearly 4 million hectares out of which new areas cover about 2.4 million hectares. Work on the canal system was completed in 1954, though from 1952, a restricted supply was given for Kharif irrigation.

Beas Project: The waters of the Sutlej, Beas and Ravi weae alloted to India under the Indus water treaty. The project on the Beas has been undertaken for harnessing the water and power resources the river by means of storage and diversion works. The states of Punjab, Haryana and Rajasthan derive benefit unit No.1 - Sutlej-Beas link; and unit No.II the Pong Dam on the river Beas.

i. Unit no.1 (Sutlej - Beas Link) envisages a diversion dam at Pandoh in the Kulu valley, to transfer 4,589 m.cu.m. (3.72 MAF) of water of the Beas river to the Bhakra reservoir through tunnels and open conduits. This will obviate the danager of a fall in the level of the Bhakra reservoir and will provide canal irrigation to Gurgaon and other southern districts of the State. A natural fall of 305 m at Dehar is utilised for generation of power.

ii. Unit No. II (Pong Dam): envisages an earth-cum-gravel dam on the Beas in Kangra district. The dam will be 100.6m high and will release regulated supplies of water into the Rajasthan canal and the Punjab Canal System emanting from the Harike Headworks. The water will also be utilised for the generation of power in a power house situated downstream of the Pong dam.

Link works to transport Ravi-Beas water to the Western Yamuna Canal System: In the Inuds water treaty, water was supplied to Pakistan from the Ravi and Beas for a transitional period which expired after 10 years from date of signing the treaty. The Haryana State has a share in the water of these two rivers. On completion of Unit I of the Beas Project, water from the Beas will be carried to the 'Gobindsagar lake, and thence to the Bhakra Nangal and Western Yamuna Canal Systems. Once completed this link will provide more water to areas already commanded by the Bhakra Canal and the Western Yamuna canal. Its will also bring new areas under irrigation in the districts of Mahendragarh, Rohtak and Hissar.

Large areas of Haryana are level plains and do not present any problem of land levelling. Most of the level areas are, however, covered by the commands of the existing irrigation works. In some new areas to be irrigated, such as the commands of the Kenwari lift canal and the Gurgaon canal, the land is uneven and dotted with sand dunnes. These areas do present problems of land levelling. Another hurdle in the speedy utilisation of irrigation potential. Also the development of agriculture and proper maintenance of water courses and the excavation and maintenance of field channels.

With the increased tempo of agricultural development especially through intensive cultivation, high, yielding - variety seeds, featilizers and effective irrigation, many Farmer Training Centres have been established in the State Yet, information regarding technical knowhow and recent technology development does not filter down adequately due to loopholes in the agricultural information network.

So far, the broad approach in the development plans for chromically drought affected areas has been to -

i. increase in the supply of power and of drinking water;

ii. minor irrigation schemes.

iii. investigation of ground water resources,

iv. soil dry farming practices;

v. afforestation and conservation of natural pastures.

vi. investigation of mineral resources;

vii. diversification of agriculture; and

viii. spread of small scale industry.

Many lift irrigation schemes and tapping the ground water resources projects have been taken up. The Stage still has some great potential to develop irrigation works-roughly to the tune of 2 million hectares. This development will directly lead to greater agricultural production and a reduced dependence on rainfall.

5. RAJASTHAN

Rajasthan is the driest state of India. Out of these the desert soil occupies the largest area. The soil contains about 90-95 percent of sand a about 5 to 7 percent day. Phosphates together with nitrates make these desert soils potentially fertile for growing agricultural crops, and plants if water were available. But since water is scarce, the entire tract remains unproductive.

Keeping in mind the moisture adequacy and the sandy soil the best crops that can be sustained are the coarse grains that do not require to much of precipitation. Amongst the food crops, bajra is the major crop and occupies roughly a little more than 30 percent of the total cropped area. The State accounts for approximately 21 per cent of the total barely production in the country 15 percent of gram and 12 percent of the total maize production in the country.

Development of Irrigation: Before the construction of the Gang Canal during 1922-27, the only source of irrigation in the state were wells, tanks and rapats. The Gang canal takes off from the Sutlej on the left bank of the Ferozepur Barrage just upstream of the head regulator of the Eastern canal the main canal which is 135.1 km in length. The main canal runs through, Punjab and in this long reach, no irrigation is done.

Out of the Bhakra irrigation scheme Rajasthan is entitled to 15.22 percent of the total stored supplies of the Bhakra Dam. It irrigated roughly 0.23 million hectares in Ganganagar district. The Beas Project is an inter-State multipurpose scheme to harness the irrigation and power potential of the Beas. The Unit II consists of the Beams Dam at Pong and the Pong Power Station. The project is to give perenial water supply to the Rajasthan canal for irrigating an area of 1.10 million hectares annually. Rajasthan is also to get 150 MW of firm power from this project.

Out of all the projects that have been taken up in the State, and Indira Gandhi canal is the most gigantic and important of all. Indira Gandhi canal project is a human effort to transform that vast expanse of desert into a land of prosperity and plenty. It is one of the largest canal systems in the world. The command area of Indira Gandhi canal is located in the north-western part of Rajasthan i.e. the districts of Ganganagar, Bikaner, Jaislmer, Barmer, Jodhpur and Churu. It is stretched over an approximate area of 525x45 sq. km along the border of Pakistan. The main canal runs parallel to the Pakistan border for an approximate distance of 38 km from north-east to south-west. The upper part of the command area has extensive alluvial plain of Ghaggar river interrupted by small sand dunes. Here drought is a common climatic phenomenon. Severe drought occurs twice during a period of five years. Temporal variability of rainfall is very high. Variability of rainfall ranges between 50 percent near the head of the main canal and 80 percent near the tail.

Origin of the Canal: Work on the canal project begun in 1958. It originates from the Harike barrage, at the confluence of Beas and' Sutlej in Ferozepur district of Punjab Rajasthan has been allocated 8.6 million acre feet of Ravi-Beas surplus water.

The stage I of the project envisage intersive irrigation with an irrigation intensive irrigation with an "irrigation intensity[1] of 110 percent.

The Stage II of the project envisaged to provide extensive irrigation. This involves reducing the per acre allowance of water and providing irrigation to maximum cultivated area. Irrigation intensity of this regions is 80

1. IRRIGATION INTENSITY: Expressed as precentage ratio between gross irrigated area and culturable command area of the project.

percent that amonunts to provide irrigation to 80 per cent of cultural command area. Water allowance for stage II is 3.50 cuses which is less than that of Stage I. Basic objectives to design extensive irrigation for this region is to provide irrigation facility to maximium area in the desert, grow light irrigated crops and prevent water loggina dn soil salinity. Stage II also envisaged to develop irrigated pastures over an approximate of 3.66 lakh hectares. This would help in providing benefits of irrigation to aboriginal nomadic communities, help to develop animal husbandary and arrest desertification.

Agricultural Development: Deficiency in soil moisture has been a limiting factor for agricultural development in this part of Rajasthan. A large tract of cultivable land used to lie uncropped in the form of culturable waste land and follow land while farmers could grow crops only during the Kharif season due to lack of irrigation facilities. Now with the introduction of irrigation there has been an increase in net sown and double dropped areas. In this region before the advent of canal water drought resistant crops such as bajra, guar moon, moth and gram occupied almost 95 percent of the gross cropped area but now the cropping pattern has changed drastically. Now commercial crops such as cotton, groundnut, wheat and mustard have come up rapidly and occupy nearly 65 per cent of the gross cropped area in Stage I of the canal command area. Wheat occupied about one fourth of the gross corpped area in the canal command area during 1984-85, followed by cotton, mustard and guar. Groundnut is coming up as a major irrigated crop in Kharif season in the lower parts of the command area. Agricultural production as well as productivity per hectare has increased rapidly in command area of Indira Gandhi Canal. After full development of irrigation resource, the command area is expected to produce about 37 lakh tons of food grains. Two problems faced by this area now are of water logging and increasing soil salinity. Moreover, all the development projects originally envisaged have not brought about the expected level of change. hence almost, two years back a NAHAR YATRA' was conducted, a programme under which canal project officers moved from village to village along the canal to redress grievancas and to look into problems of soil salinity and water logging.

A discussion of development works in the five states that comprise the Indian Part of the Indus basin, show that there has been a positive correlation between the successful signing of the treaty and the successful utilisation of the Indus waters.

CONCLUSION

STRATEGY FOR CO-OPERATION AND CO-EXISTENCE

The Indus valley, as has been investigated in the previous chapters, shows that settlements existed in this region much before the Indus civilization came into existence. With a breakthrough in technology in agriculture, surplus was generated in terms of foodgrains and that is how the first Harappan cities came into exestence. Specilization of skills and craft made the cities develop further. However the end of the civilization cannot be accounted for by any one specific reason. It was a combination of natural and socio-political factors. The most important feature of most of those settlements was that, they were located by the banks of of the river Indus - that served as the lifeline of this civilization.

The life giving waters of the Indus are enough to provide food and sustainenance to the entire basin. Each of the rivers i.e. the Sutlej, Beas, Jhelum, Chenab, Ravi, Swat, Kabul-form fertile doabs. The precipitation is found in summer as well as in winter season but most of these streams have a distinct lean season, when scaracity is felt by one and all. It is at such instances that sharing of waters on an equitable basis becomes a problem.

Thus in 1947, when the country was partitioned, the

Thus in 1947, when the country was partitioned, the Indus basin that had always been a unified basin, got divided by an arbitrary line that had no conformity to geography or to the socio-economic patterns of the region. Such a carelessly drawn boundary brought problems along with it. Most of the irrigation channels and the irrigated area went to Pakistan while the river waters of the upper reaches came to India, due to its position of being the upper riparian state. India however could not use up all the water of the Indus rivers as it went against all canons of justice. Problem arose when the question of sharing the waters came up. With no solution in sight the World Bank offered to mediate and finally came up with a practical solution so that the two countries could operate their own river development works, without any hinderance from the other party. There was a transition period from 1960-70 when Pakistan was allowed to build its alternate networks for canals while India also doled out some money as compensation to Pakistan. Subsequent to the signing of the treaty a great deal of development has occurred on either side of the divided Indus basin. Needless to say most of these projects have augmented food production and also facilitated the generation of hydroelectric power.

It must not be forgotten though that through more than three quarters of the world's land surface is suited for integrated basin development. The remaining areas lack the combination of water and land that would make such integrated development technically feasible. However, regions where such projects are possible , only a few have been developed due to political and economic constraints. In most cases differences crop up as each of the riparian states demand greater than their due share of water.

In the above light, the Indus Waters Treaty can definitely be termed as one of the more successful attempts at resolving water disputes.

In an ideal solution to the problem, Indus Basin could have been treated as a unified whole and then proceed towards integrated basin development. In fact the initial plan proposed by India was one such plan. The various complexities and political differences prevented from such a solution being arrived at. Thus the eastern and the western rivers of the Indus were seperately earmarked for use of Indian and Pakistan needs. Though the basin could not be developed on an integrated basis, yet the accord reached was substantial involving a great deal of technical expertise.

In the long term, a far-sighted strategy on water management will essentially require that river basins be adopted as units of development. With the burgeoning seem to be any other solution to this problem. If the teeming millions are to be fed and if the precious top soil layer is to be protected, a multi- functional and multi-country participation will be required on water resource development. The southern part of Asia is endowed with ample water resources. The region has almost 20% of world's population and only 3.3% of the land area. A paucity of land resources can only be compensated to a great extent by the rich water resources of the region." For example the water resources of India, Bangladesh, Nepal and Pakistan have almost 2,8222 MAF of water resources in terms of their rivers. Yet these countries have not been able to harness this tremendous potential"[1].

These countries for most years shuttle between subsistence existence and disaster. They exist in a fragile eco-system which is threatened by the growing pressure of the people on land without irrigation, water management and continuous menace of droughts, floods, soil erosion and ever creeping desertification. These together account for a vastly fluctuating food production. A proper conservation

1 R.C.Sharma: "Readings in General Geography and Geography of India", Jawahar Pub. and Distributers, Delhi, 1992.

and management of the region's rich water resources can mitigate the problem of food insufficiency and deficiencies in waters required for irrigation.

Interdependence as the key for " Integrated Development " for the future

To solve the negative balance that exists between food and population, there has to be a focus on optimised development of the Ganga-Brahmaputra-Barah-Meghna basin on a multi-level, multi- displinary and multi-functional basis within a framework of South Asian Regional Cooperation for development. The underlying fact here is that optimum exploitation of the water resources of most of these Himalayan rivers cannot be done on a single country basis. Most of the Himalayan rivers meander through the various countries binding them in natural bonds of " hydrological interrelatedness ". Thus upper and lower riparian states need to be in some sort of a mutual agreement regarding the usage of waters.

While the Indus accord could be signed successfully on the western flank, India has yet not been able to resolve the Farakka dispute with its eastern neighbour i.e. Bangladesh. The genesis of the problem lies in the wide seasonal fluctuations of the river flow. During the lean period i.e. April and May the water is not enough to meet the requirement of both the countries. For India, during the lean season, navigation at the Calcutta port used to be a problem. In order to make up for the water requirements during the lean period the Farakka project was conceived that diverted 40,000 cusecs of water from the Padma river into the Hoogly. This however, affected thr lower reparian i.e. Bangladesh's water needs. Thus since 1971, efforts are being made by the way of Joint River Commission to resolve differences that have arisen regarding the sharing of Ganga waters. Here the signing of the Indus accord can definitely serve as an example of a feasible solution, inspite of large scale political differences.

If the Ganga-Brahmaputra-Barak River system could be developed along the eastern flank, it would transform this region of poverty and natural calamities, into a basin that has integrated constructive development. The project can go a long way for effective flood controlling, water conservation and irrigation. Also, the fragile eco-system can be stabilised as most of the menace in this region is caused by deforestation, siltation and floods. As yet this idea is placed very low on the priority list of the countries concerned.

To conclude it can be suggested that if co-ordinated management of water and land resources is to be achieved, the scope of a holistic approach must be carefully thought through. It is recommended here that a two stage strategy be used. At a STRATEGIC LEVEL a comprehensive viewpoint is desieable which implies the widest possible range of issues and variables. At an operational level, however, a more focused approach should be utilised. At this level the approach can be called an "integrated approach". In developing this bounded and a holistic perspective a set of common goals and objectives should be defined by the various participating countries.

Boundary problems will always exist in such a natural resource management. No matter how much care is taken in allocating specific objectives and responsibilities, some overlap and conflict will emerge since society has multiple values, not all of which are compatible. Thus the objective should be to devise institutional arrangements that will minimise the associated problems and iron out most of the possible differences regarding resources and cost sharings. Lastly, it should not be forgotten that a strengthened regional co-operational unit can yield tremendous bargaining power vis - a - vis the more developed world.

Water management and coexistence seem to be the call of the hour.

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