Chapter-I

PURPOSE AND PERSPECTIVE

1.1 PURPOSE

Theme of this dissertation is ''Applied Geomorphological Study in a Controlled Tropical River: the Case of the Damodar between Panchet reservoir and Falta.''

The selection of a tropical alluvial river which has been controlled by multitudes of non-engineering and engineering structures in its low gradient sector, for applied geomorphological research has a definite multifaceted purpose behind.

The purpose has to be distinguished from research objectives. Objectives of any research emerge from a broader research theme; to be more specific, a well-defined objective is fed by a set of purposes. This set of purposes provides a frame and a canvas as well where pictures are to be drawn according to specific objectives with a specific perspective. Therefore, prior to spell the objectives of this research, purpose and perspective of this research endeavor need to be explained first.

All ancient civilizations are hydraulic civilizations and many river basins, though not necessarily with an optimum combination of atmospheric, hydrologic and geomorphic inputs were the containers of these civilizations. The Mesopotamian civilization flourished in the Tigris-Euphrates basin in South-west Asia and was in existence between 4000 BC and 600 BC. The Nilotic or the Egyptian civilization had an advance in the Lower Nile basin in between 3000 BC and 1750 BC. The earliest known civilization in China developed on the bank of the river Hwang Ho in northern China and the Hwang Ho valley itself has a continuous settlement history of 4000 years (Ward, 1978).

In the Indian sub-continent the oldest known agricultural settlement was in Mehrgarh on the Bolan river at the junction of the Baluchistan plateau and the Indus plain. The Mehrgarh settlement dates back to about 7000 BC. The Indus valley civilization or Harappan civilization flourished in the Indian plain around 3000 BC (Mishra, 1995).

The rivers of these river basins are perennial but with fluctuating river regime and floods are natural geomorphic phenomena for hydro-meteorological factors. Such flood-prone riverine environments, therefore, forced the erstwhile riverine communities to take flood disaster reduction measures on the one hand and flood management programme so as to transfer excess floodwater from surplus areas to deficit areas and from surplus seasons to deficit seasons on the other. Artificial levees, canals, dams and many other such artifacts associated with the above mentioned civilizations were nothing but river control structures and these structures were components of the geomorphic landscape from the dawn of these ancient civilizations.

These flood control measures necessitated observations on flood behavior, type and nature of silt accretion and collection and maintenance of hydro-geomorphic data for rational use of river water. In Egypt hydrologic data near Cairo dates back to 622 AD

(Mookerjee, 1989), and the basin irrigation which was first introduced in Egypt long ago is still socio-economically relevant in many parts of Tropical countries.

Dam building is thought to have begun on the Nile. Near Memphis there are remains of a masonry wall built across the river by King Menes in 4000 BC. The Roman built dams for water storage so well that some of the structures in Jordan are still usable today (Reifenberg, 1955; Pereira, 1973).

About 28.8 Kms south of Cairo in Egypt in Wadi-el-Garawi the ruins of Sadd-el-Kafara dam, which was built sometimes between 2950 BC and 2750 BC, are still to be observed (Costa, 1988). The height of this rock-fill dam was 11 meters and the length was 106 meters. The Egyptian engineers built another dam in Syria in between 1319 BC and 1304 BC when the first dam failed to serve its purpose (Biswas, 1970). At present the Nile between the Aswan and Cairo, a distance of 900 kms. and its two branches, Rosetta and Damietta are chained with a series of raised levees and embankments (Framji and Garg, 1976).

Contemporaneous with this, the Mesopotamian devised a canal system for twin purposes of irrigation and navigation. The canals they built were very often wide enough so as to reduce bank erosion from rushing water from the off take points of canals. The canal banks, therefore, became sites for industrial and commercial centers. Multiple uses of canals were thus one of the characteristics of agrarian civilization of Mesopotamia (Willcocks, 1930).

Some scholars are of the opinion that the oldest dam was constructed in the desert land of Jordan around 3000 BC. Most dams were built along Roman routes. Romans appear to have been the first to build arch dams (Reifenberg, 1955; Pereira, 1973).

In the Middle East, where evapo-transpiration is a severe problem and channels are lost in sand deposits, very special systems of irrigation referred to as ‘Quanat’ or ‘Kanat’ developed. In this system an artificial underground channel or a canal used to carry water over long distances either from a spring or water bearing strata. This system indicates that in the face of water scarcity the people were knowledgeable about water resource engineering (Biswas, 1970).

In China, emperor Yau constructed dams and dykes in 2280 BC. In central China there is an ancient Hongze reservoir. The Chinese subjects used to assess their emperors as good or bad on the basis of waterways maintenance measures adopted by the rulers (Biswas, 1970). Dykes and canals were in existence in upper reaches of the Hwang Ho River in 603 BC. It is a well-known fact that Hwang Ho was notorious for its flood disaster and the first recorded flood was in 2297 BC (Hyot and Langbein, 1955). In later years the concept of flood zoning also developed in China. In 8 BC J. Chia, the highest authority in-charge of the Hwang Ho River prepared a flood control plan. What he recommended was to abandon the densely populated foreshore and to resettle the people somewhere else. The primary purpose behind his plan was to keep enough space for flood flow.

Another purpose of course was to save people from flood disaster (Framji and Garg, 1976).

Reclamation of flood-prone areas for agriculture was in practice nearly 4000 years ago in the same Hwang Ho plain. In order to reduce vertical erosion rivers were confined within close lateral dykes. This system was known as 'Loute' and it was invented by some C.H. Pan in between 1521 and 1595. Together with these close or loute dykes 'Yaote' or distant dykes were prevalent to accommodate floodwaters (Framji and Garg, 1976). Floods in the Yangtze Kiang (present name Chang Ziang) are well documented in ancient inscriptions (Luo Chengzheng, 1985). These are some of the examples of attitudes of Chinese nobles and common people towards flood havoc in the basins of Hwang Ho and Yangtze Kiang and of measures taken so that they could live with floods.

The story of rise and fall of the Indus valley civilization in a semiarid bio-climatic environment is the story of man's struggle for conquering adversity of nature and building an integrated coherent society. In this struggle for existence the Harappans' response pattern to the challenge of nature, which mainly came from the river Indus, was a positive one. In the fertile Indus valley plain Harappans adopted measures to control annual and abnormal floods. For examples, in Sind, there are hundreds of kilometers of single and double lines of embankments (Framji and Garg, 1976).

India scriptures are also rich in examples of man's endeavor towards rational water harvest measures. The scriptures also refer to the significance of water bodies, natural or artificial during war. Among the scriptures the Vedas are the oldest one and the Vedic period extends between BC 2000 to BC 800 (Chattopadhyay, 1990). Rig-Veda, uses a term an 'Avata' which signifies a well. The dictionary of Nighanta mentions fourteen types of well. At the same time there are mentions about 'Kulya' an artificial river or canal. In another passage there is a reference of a dried up reservoir. The Yayur Veda also refers to canals and dams, which were known as 'Kulya' and 'Sarasi'. Sarasi in fact, denotes an artificial reservoir and a natural lake as well (Sarava, 1954). The Atharva Veda (III, 13) gives description of construction of canals from rivers. A canal is fed by a river or in other words a canal takes off from a river. To carry this sense, Atharva Veda describes a canal as a calf and the feeding river as a cow. (Sarava, 1954).

Manu, who is famous for his Manusanhita (2nd Century AD), writes in his work (VII, 196) that a king, wishing to conquer his enemy should first destroy all types of dam in his territory. Bishnugupta Kautilya (3rd Century BC) the prime minister of the King Chandragupta Mourya, in his Arthasastra or book on polity gives the same advice i.e., during war the land of the enemy should be flooded by breaking or breaching lakes, dams and embankments (Sarava, 1954). The purpose behind such practices was to disrupt the transport system so that enemies could not move through the flooded terrain. Similar steps used to be taken by the Chinese. During war enemy lands were flooded by forced breaching of dykes and dams (Schmitter, 1994). With a similar purpose, even now, river bridges are destroyed during war.

Ramayana our first epic (before 5th Century BC) describes in details some of the beautiful engineering works. Valmiki, the author of this epic gives an account of how King Bhagiratha and his group of engineers diverted the courses of the Ganges from the Himalayas towards the present Ganges delta. By cutting artificial canals Bhagiratha probably tried to improve the agricultural condition of the Lower Bengal. In his report Willcock, an Egyptian engineer writes that many of the distributaries of the Lower Ganges are nothing but artificial canals modified by natural riverine process (Willcock, 1930). The Lower Bengal was inhabited by a very advanced people known as Gangarides or Gangaridaes (Basu, 1989) and it was not unnatural for a civilized agrarian society to construct artificial canals for irrigation purposes.

Indian historical records and reports are full of description of such water management policies and programmes. An inscription of Rudraman 1 on the Girner rock in Kathiawar records the construction and repairs of an artificial lake Sudarsana by successive viceroys of the Maurya Chandragupta (320–290 BC) and was perfected under the Maurya Empire Asoke (260–222 BC), (Kotriah, 1959).In South India, the Chola rulers (1st Century AD) were the pioneers in the construction of reservoirs. The river Cauvery was a flood prone river and the king Karikola first introduced the concept of flood control measures by constructing dams and embankments (Sarava, 1954). The construction of a dam by Karikola is mentioned in an inscription of the Shaka year 1277 (1355 AD). During the periods of Chalukya, Hoyasala and Kakatiya rulers (12th Century AD) several tanks and a few anicuts were constructed. This policy continued during Viyaynagore period (Kotriah, 1959).

In the Lower Bengal the history of canal irrigation system predates British period (Willcock, 1930) and there were extensive embankment systems prior to the British rule. There are volumes or reports on the Bengal embankments published during British era containing papers from 1852 to1923. (Voorduin, 1947). In Bihar there were artificial cuts on river levees or canal banks. These cuts were known as Kanwas in Bhagalpur of Bihar. The word Kanwas is derived from the word ‘Kan’ an old Persian or Arabic word meaning ‘to dig’. These cuts were made for overflow irrigation, (Willcock, 1930).

In the adjacent Burma, present Mayanmer, the Irrawady shows extensive embankment systems, which are quite old in origin. In this system the alignment of the embankment was in a horseshoe pattern around the areas between the river distributaries so as to leave the downstream ends of the compartment open. In the event of extreme floods, the lower portion of the embankments acts as flood basin thus reducing, though slightly the flood peaks. The system of open embankments should be considered as a compromise in controversy between advocates and antagonists of flood protection by dyking in any deltaic area (Volkar, 1964).

Ceylon (present Sri Lanka) also has evidence of man’s effort to control water resources by control measures. For example, the Minneriya tank was constructed by the King Mahasena in the Third Century BC. The embankments date back to 370 BC. (Schmitter, 1994).

If we deviate our focus from the tropical countries to temperate countries we find that the history of reservoirs in Europe goes back to more than 200 years. But the use of dykes in the Po valley of Italy is quite ancient (Framji and Garg, 1976).

Unlike tropical Asia, the history of control structure in USA is relatively recent. In 1717 when the city of New Orleans was founded, the first levees, 1.2 meter high on the Lower Mississippi were constructed. The Mississippi and its major tributaries now show an extensive embankment system in the world.

These are the very few examples of drainage control structures, from all over the world. These few examples indicate that from the very beginning of civilization river water were put to human use and rivers had to be trained for the socio-economic benefit of the existing society. Antecedent to the river training programmes, observation on the behavior of the target river was imperative. Observation was followed by an analysis of river behavior and the final step was the construction of various artifacts to meet specific objectives. In a contemporary geomorphic language and sense as well this was the beginning of applied geomorphology that is application of geomorphic knowledge to solve socio-economic problems.

This is the cardinal factor behind selection of the research theme, which focuses on applied geomorphological issues connected with river control structures.

The present treatise as has been mentioned above is on applied geomorphological issue connected with a controlled river. What is to be mentioned now that the development of applied geomorphology is not severed from the development of other applied sciences. The need for applying scientific knowledge for economic and social benefits was strongly felt in the decolonized developing countries in Tropics since early forties. To feed the growing population the planning objectives in all these politically independent countries in Latin America, Africa and Asia were to explore the native resource potentials so as to lessen dependence on foreign assistance. The scientists were requested to use their theoretical knowledge to solve practical problems. As a consequence there was a flood in researches on applied issues in different fields. As a part of the planning policy, the resource which was developed first was the river water resource and almost all major rivers are now controlled, though in different phases in the decolonized Latin American, Asian and African countries. Thus, river water utilization and river control structures are now two of the major issues in developing countries in Tropics. India is one of such countries where harnessing of river water resources received top priority in planning programmes just after the independence in 1947.

The purpose is, therefore, to select a theme, which has national significance, and a theme, which is relevant at international level as decolonization is a continuous process, and river training policies and programmes are still crucial issues in all tropical countries (Petts, 1984).

Utilization of flood plains for agriculture and human habitation dates back to 3000 BC. The flood plains are the containers of ancient civilization as has been mentioned earlier.

But are we aware of the facts that the riverbed itself becomes site for settlement? In tropical Africa and Asia alluvial bars are used for agriculture in case of seasonal rivers when bars are exposed due to lowering of river level. This is a common practice throughout Indian sub-continent. Emergence and submergence of riverine bars particularly in the deltaic tract are common phenomena and there are often disputes over the occupation of this bar particularly in the border districts and states.

For reasons obvious, the riverine bars are preferred sites for agriculture, though the extent of agricultural season depends on the survival potentiality of these bars. These bars have also provided temporary shelter for war victims (Semple, 1911). These are used as campsite in the Colorado River (Schmidt and Grag, 1990). It has been noticed that throughout West Bengal the riverine alluvial bars provide shelters for millions, and these millions are Bengalee refugees, who came from the erstwhile East Pakistan (present Bangladesh) mostly after1947 and again during Bangladesh war in 1970. They are not only political economic victims but social victims also. Several government sponsored refugee colonies were set up where these refugees had to accept a dole-sustained existence. A sizeable number of these refugees coming from the farm sector rejected such an existence and preferred the riverine islands in the Ajay, Damodar and Hugli-Bhagirathi for self-sought settlements. These rivers are now dotted with such settlements and some of which look quite prosperous also (Basu, 1988; Bhattacharyya, 1995). The control structures on these rivers have brought several changes in the riverbed environment, and the refugees are constantly struggling with this changed environment for their survival in a foreign country.

Moreover, the refugee problem, which started almost 50 years ago, still plays a crucial role in Indian politics particularly in the eastern part of the country where constant infiltration of Bengalee refugees in the Border States creates political tension. The problem aggravates when the question of granting of ‘patta’ or land deeds in the self-sought settlements comes in forefront. The question has taken a different dimension in the Damodar Valley Corporation (DVC) command area where there are several self-sought refugee settlements in the riverine sandbars.

For selecting the research theme and the research area these questions and their magnitudes were pondered over. These are the distinctive facets of the purpose behind the research theme.

The 1990’s decade has been declared as the International Decade for Natural Disaster Reduction (IDNDR) and this IDNDR has forced to rethink the hazardous processes like floods, cyclone etc. It is sad to state that despite tremendous improvement in technology and revolution in information technology people all over the world not necessarily in the tropics are still affected by floods, droughts, cyclones, earthquakes etc. In spite of extensive flood control measures, flood is still a major issue in a tropical country be it developed, developing or under-developed. It may be China, India or Bangladesh; even highly developed USA cannot escape from the fury of floods. Flood is a universal topic, which is to be found in mythology of all religions, traditional anecdotes, and historical records. The evidence of deluge is found in the Biblical story of Noah. There are clear

parallel examples in Hebrew and Babylonian traditions (Lambert and Millard, 1969; ward, 1978). In India in Satapatha Brahmana (6th Century, BC) an important treatise on sacred rituals, reference has been made on a devastating flood and how Manu, a glorious sage saved mankind from that flood (Shastri, 1950).

Therefore, for a research theme, an issue like flood has been selected, which has of mythological, traditional and contemporary relevance as well. Moreover, flood is an issue, which stands at the interface between theoretical geomorphology and applied geomorphology.

Finally, while selecting the research theme a question was addressed whether river training programmes and river control structures ultimately solve social, economic problems for which these plans were executed and these structures were constructed. It has been observed and it has already been stated that highly developed countries are not immune from flood in spite of their technical supremacy. The great flood of 1993 in the Mississippi valley of U.S.A. challenged the 500 years design flood model. The damage was extreme, in some places due to extensive development of flood plain. St. Louis in the South of confluence of Mississippi and Missouri was worst affected. Downstream St. Louis protected by 15.8m concrete floodwall was severely damaged in 1993 flood. There was disruption in the transport and communication system and in supply of electricity. The problem continued more than one month (Adler, 1993; Coch, 1995). In 1996 half a million people has to be evacuated for repairing a breached dyke along the Yangtze River and its tributary due to unusual floods in the month of June 1996. By official count the rains and flooding have destroyed 3.2 million acres of crop and damaged property belonging to 20 million people (Telegraph, 1996).

After 1947, throughout India, several rivers have been trained to reduce flood risk. Several multipurpose projects have come up and dams have been constructed like the Maithon, Panchet, Tilaiya and Konar on the Damodar and its tributaries. The Bhakra Nangal on the Sutlej, the Hirakund on the Mahanadi, Tungabhadra, on a tributary of the Krishna, the Chambal reservoir on the Chambal, and the Kosi reservoir on the Kosi have been completed. Despite extensive river control measures floods still visit India. Some of the reservoirs have raised crucial political issues. S.L. Bahuguna, a social activist has long been agitating against the construction of Tehri dam in the Ganga-Jamuna Valley. He states that the construction of reservoirs in earthquake sensitive areas in the Himalayas will disbalance the natural system and ultimately the poor will have to suffer (Dogra, 1992). The Almati crisis on the river Cauvery continues to hit the newspaper headlines. The government of Karnataka is raising the height of the Almati dam, so, it is feared that after the completion of the said project Tamil Nadu will receive lesser amount of water and this will ultimately affect the interest of farmers in the state. Similar questions have been raised in case of some other reservoirs and barrages also. For example, boro cultivation in West Bengal to a great extent depends on the release of water from the Tenughat reservoir in Bihar. If there is a lack of understanding between these two States the boro cultivators have to suffer. Moreover, if there is a sudden release of water from the Tenughat, the lower reach of the Damodar gets flooded.

These political issues have taken very strong social nuances now. Ms. Medha Patkar, a well-known social activist, supports the movement, which was started by S.L. Bahuguna. These questions are socio-economically relevant, not only in India but in adjacent countries also. The most controversial international issue between India and Bangladesh is the issue of the Farakka barrage. The Farakka barrage was constructed in 1970 in order to divert part of the Ganges into the Bhagirathi-Hugli to save Calcutta port. It was presumed this barrage would reduce flood risk in the Lower Padma. But instead, the Bangladesh Government has a feeling that because of the Farakka Barrage, the Padma is not getting adequate water from upstream in lean period and flood propensity has increased due to shallowing of the river. Very recently in 1996 there was an agreement that more water will be given to Bangladesh but this agreement has antagonized some of the Indian politicians. River control structures have thus become social, economic and political issues.

Since 1969-70 the globally acclaimed concept of Environmental Impact Assessment or EIA is being applied for large engineering projects abroad (Morris and Therivel, 1995). Any research venture we believe should have some significance not only at local, regional or national level but also at international level.

This is the final purpose behind selecting the research theme which focuses on the engineering structures on a tropical river and their impacts on geomorphic and socio-economic environments.

1.2. Perspective

Floods, flood control measures and physical and socio-economic significance of such measures are examined by several disciplines like geography, sociology, economics, hydrology, engineering sciences etc. Each addresses flood related issues from a distinct disciplinary perspective. Geography is an observational or spatial science; therefore, geographic perspective is a spatial perspective. All phenomena, physical and socio-economic are registered on this space, which is complex but concrete, coherent and predictable as well (Beaujeu–Garnier, 1976). In other disciplines space comes tangentially or peripherally. In geography, space is the focusing center (Basu et al., 1995). The questions raised, discussed and answered in this dissertation are within geographic perspective.

Secondly, emphasis has been given on the exogenetic landforms, land forming process and materials. Perspective is, therefore, a geomorphic perspective. But the admission of anthropogenic forms, processes and materials in geomorphological enquiry has been acknowledged. Focus will be on issues, which relate geomorphology with other disciplines. This is the perspective of applied geomorphology. All applied geomorphological questions, however, in the present research are addressed within a wider geographical perspective.