HARNESSING THE BRAHMAPUTRA AND DISASTER MANAGEMENT

Dissertation submitted to the Jawaharlal Nehru University
in partial fulfilment of the requirements
for the award of the degree of

MASTER OF PHILOSOPHY

BISWAJEET SAIKIA

Centre for South, Central, Southeast Asia
and Southwest Pacific Studies
School of International Studies
Jawaharlal Nehru University
New Delhi-110067
INDIA
2000

जवाहरलाल नेहरू विश्वविद्यालय
JAWAHARLAL NEHRU UNIVERSITY
NEW DELHI - 110 067

Centre for South, Central,
South East Asia and
South West Pacific Studies

20 July, 2000

CERTIFICATE

This is to certify that the dissertation entitled **HARNESSING THE BRAHMAPUTRA AND DISASTER MANAGEMENT**, submitted by **BISWAJEET SAIKIA**, in partial fulfilment of the award of the degree of Master of Philosophy, of this University, is her own work and may be placed before the examiner for evaluation. This dissertation has not been previously submitted for the award of any other degree of this or any other university.

Prof. NANCY JETLY
(Chairperson)

Dr. S.R. CHAKRABARTY
(Supervisor)

GRAM : JAYENU TEL. : 6107676, 6167557 TELEX : 031-73167 JNU IN FAX : 91-011-6865886

Dedicated to my
Late Father,
Whom I Miss Every Moment

ACKNOWLEDGEMENT

I begin the series of acknowledgements, foremost, by expressing my gratitude, for the guidance I received from my centre and my supervisor.

The tremendous help, that I received from the various libraries in Delhi and Guwahati, without which, I would have been unable to collect the data for my research. I would like to thank the librarians of Brahmaputra Board, Gauhati; Oxfarm (India) Trust, Central Water Commission Library, Centre for Policy research, Indian Statistical Institute, Centre for science and environment, International Commission for Irrigation and drainage in New Delhi. Last but not the least, our very own, Jawaharlal Nehru University library.

I would like to express my gratitude to Sanjay Hazarika, for providing useful suggestions for my framework and also providing me with various books.

Ashok and Vikram, are two persons, without whom this dissertation would never have acquired its present form, without them patiently typing the various drafts.

The cartography of the river, which is rather complex, would have not acquired, a professional form, without the help of budding Cartographers, Amit and Atul from C.S.R.D.

To Sohaib, I need not say thanks for not only his proof reading of my rather incoherent chapters, but moreover for his friendship

To Ma, for her constant care and for always listening patiently, to my endless plans and for always encouraging and nurturing them.

To Aloka, for always being by my side whenever I needed her and for her companionship in the umpteen number of journeys that we undertook from various libraries in Delhi to the origin of the River Brahmaputra at Sadiya.

Biswajeet

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CHAPTER - I

INTRODUCTION

Civilizations have **grown** up along rivers, lakes and oceans. The great rivers of the world influence the lives of million not only through their very existence but also their politics, art, religion and science. River basin are precious natural resources Properly developed they can substantially augment food and water supply, improve transport, provide energy and develop industries. With population growth threatening to outrun food supplies, food and cheaper source of energy is in urgent demand. Therefore harnessing natural water resource for human needs is very essential.

History of river basin development in world

River basin planning in its narrower and more technocratic form of water resource management has been practiced in many parts of Asia and Africa for at least nine thousand years. The oldest recorded practice of irrigated agriculture has been traced in Jericho in 7000 BC (Hirch 1959). There are also recorded histories of scientific water management including quite sophisticated engineering works for water regulation in China, Egypt and Iraq, which go back to several thousand years and indicate the remarkably sound knowledge about hydrological cycle, ecological balance between surface and ground water and engineering and social aspect of irrigation. In Egypt, for instance, an intricate system of basin irrigation involving

longitudinal dykes parallel to the main channel of the Nile to regulate flood water; a network of cross dykes and canal to conduct the flood water into pre designed basin and a diversion channel to the naturally formed Faiyum depression for creating a storage reservation for excess. By the seventh century A.D the Chinese had developed a highly sophisticated network of engineering structure for irrigation making, a balanced use of ground and surface water resources, organised a tightly knit system of administrative authority to ensure a state of maintenance of these structure and perfected a land use pattern, that maximised the use of available irrigation facilities. .

In India

In India the genesis of the use of irrigation water date back to ancient times. The Arthasastra of kautilya (3rd century BC) gives refers to "Ahar" which is the name of mode of irrigation from the river. It also finds reference in the certain early literatures viz. Jataka and sangam texts.

Diverging the river stream in the hill region and plain were the most suitable way of harnessing the river water. The people of hill region often throw a few stones to block the course of small drainage streams to divert the water to cultivate fields. In some parts of the Himalayas extensive arrangement of channeling is used to carry such diversion. Locally these channels are called *kuties, katula* and *guhls.*

We also get inferences from an inscription of *Rudravarman* in A.D 150 which mentioned that he repaired the *Sudrasana* lake which was built during the time of *Chadragupta Maurya* in Gujarat. Western Yamnna canal is reported to have been dug out by *Firozeshah Tughluq* about 600 year ago (*Habib* 1982, 49).

During Colonial period

There has been a very zigzag progress of irrigation from the river during the early phase of colonial rule. During the second half of 19th century, the colonial masters began to show considerable interest in the development of irrigation, thus lying down the foundation of modern irrigation. Technical knowledge and expertise of the colonial official rather than their interest helped far more in understanding the nature of irrigation development in India under colonial rule.

The first major success in irrigation through harnessing the river in 2nd half of 19th century was Eastern Yamuna canal in UP which covered 1.91 million hectares for irrigation. Since then British government started a progressive irrigation policy through harnessing the river by canal diversion. Till independence British government had constructed about 25 irrigation projects through canal diversion (Appendix I). Among them upper Ganga canal was the biggest irrigation project in pre independence India having 6.99 million hectare irrigated area capacity. Although all these projects were

constructed only for irrigation purpose, neither were multipurpose projects. Only some of these laid emphasis on drinking water and navigational facility.

Hydel power were produced since pre independence but not through the above mentioned irrigation projects. It started with the 130 kw hydro electric plant near Darjeeling in 1897 and *Sivasumudram* installation of 4500 kw. Since 1902 water power has been used for generation of power. The next major hydro electric project was by Tatas in Kopoli (Maharashtra) in 1914 with an installed capacity of 5000 kw. By 1939 hydro power capacity rose to 442000 kw and by 1950 to 560,000 kw.

Post colonial period

After partition in 1947 India was left with 83% of the population of undivided India and 84% of net land area. But there was only 19% of irrigated area. Amounting to 19.4 million hectares. Over half of the area irrigated by government canals in undivided India was now located in Pakistan[1].

After independence irrigation was made a entirely a state subject. As a result the state governments have immense power over the control and use of water resources. Pointing at the post Independence period development, the seventh plan states the area under irrigation increased at the rate of 8.7 million

[1] Putta Swamiah K. 1994 irrigation project in India, p. 23.

hectare per year. It was 1.6 million hectares and 2.2 million hectares per year during the fifth and sixth plan year respectively[2].

In post independent India various river valley projects have come uptill. 1985 India was having 1578 major dams (such commanding CCA above 10,000 ha Appendix II) costing Rs 15026 crore[3]. Because of such dams the area under irrigation increased substantially, hydel power generation has voluminously increased, for instance Narmada project; perhaps the largest in the world is expected to generate employment for about four Lakhs during the implementation stage and for six Lakhs people after completion. It will irrigate 19 Lakhs hectares of land benefiting about one crore of people. As a result food production is expected to go up to 80 Lakhs tones annually, besides increasing the production of other commercial crops and vegetable and several other allied benefits such as industry, infrastructure like road railway, navigation, fisheries, tourism will be possible[4].

It is evident that both in colonial and post-colonial periods, State as well as private initiative did not show any concern to harness the vast water potential in the Eastern region of the sub-continent. It may be due to the fact that the entire eastern India gets the highest precipitation at the rate of 250-

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2 Ibid, p 25.

3 Swaminathan ms 1990 agricultural productivity in independent India, Journal of applied Economics.

4 Pathak, MT. 1991: Sardar Srovar Project. P 37.

300 inch per annum in respect to the Indian sub-continent. Therefore there was no extra water required for agriculture. Secondly the entire Eastern India especially North Eastern India has the lowest percentage of population in comparison to their habitational land. So it is an obvious fact that there is no need for cultivating a crop for two to three times in year. Due to this reason the people of the region cultivate during the kharif season only. Regarding the soil climate and food habits, of the people in the Brahmaputra valley, rice is the staple food, which is cultivated only during the summer season. During the winter season except in a few pockets, people do not cultivate any crop, even rice because of unavailability of irrigation water. During the colonial period, the British government tried to increase the food grain production, for they brought farmers from Eastern Bengal (*Sylheth, Maymansingh* and *Rangpur* district of present Bangladesh) to cultivate rice and other crops. Rice was extensively needed to feed the tea garden labourers whom the British brought from Bihar, Bengal Orissa and Madhya Pradesh to work in the Tea gardens.

At the end of this millenium the population of Assam is roughly about 250 million (222 million in 1991) which requires high production of food grain in order to become self sufficient. Although the total water wealth of the Brahmaputra basin is 30% in comparison to the total water wealth of India but production of fish to feed the population, who are traditionally fish

consumer, is quite less. It is supplied from states like Andhra Pradesh, West Bengal and even Delhi.

In the post-independent planned period the central as well as state government tried to locate the area in Assam for the higher production of food grain. For that medium and minor irrigation projects were implemented. Some of them still are working and some of them were destroyed due to the flood, poor maintenance and economic unfeasibility.

In the case of the generation of hydel electricity, emphasis has been laid since the 70s. Till today however, not a single watt of electricity has been generated from any hydel projects which is undergoing construction, e.g *Kopili, Karbi Langpi, Ranganadi* hydel power project. An estimating 700 mw electricity is expected by the end of the year 2000. Till today Assam is borrowing electricity from the neighbouring state of Meghalaya and sometimes from West Bengal[5], although hydro electrical potential of the Brahmaputra and its tributaries as assessed by central water commission till the year 1999 is as follow[6].

Potential assessed	**harnessed**	**under developing**	
34920 mw	1.30%	1.05	Total 2.35%

[5] Assam state electricity broad, annual report 1999.

[6] Central water commission, annual report 1999.

There fore it is evident that water resources of this part of the country is not properly utilised. The proper and timely utilization may provide future benefit to a vast number of people. For that a multipurpose project is essential. Even in the literature that is available on water wealth as well as water related issues like irrigation, hydel electricity, navigation drinking water and production of fish in India, isolating the regions water wealth and its potential area of harnessing for future benefit. Although as it is already told that the Brahmaputra basin carries 30% of India's total water wealth, having that, even planning commission's five year plan it is isolating due to varied region like cost efficient, economic feasibility, poor infrastructure, problem on transmission of electricity and long distance channel diversion.

Review of literature

The book *Converting Water into Wealth Regional Cooperation in Harnessing the Eastern Himalayan River* (Verghese, et. al (ed.) Konark 1994) is mainly about the harnessing the Eastern Himalayan river for the equitable benefit of co-riparian countries. It brings out the points that Regional cooperation can be possible through the harnessing of these Eastern Himalayan rivers. Eastern Himalayan countries are the home to the largest concentration of the world's poorest, having lowest per capita income. The book basically highlights the main issue that the planner should think before planning to convert water into wealth. Entire scholarship is based on primary

investigation of waterways resources in the Eastern Himalayan regions. It also included possibilities of area of harnessing in the field of energy, inland waterways, environment and natural disaster. On the modalities of cooperation where all the scholars have discussed on forms and mechanism, guiding principle for financing and inter regional data for better understanding and co-operation.

Water of hope from vision to reality (Oxford and IBH 1999) is an exhaustive work of B G Verghese on of harnessing the water resources in India especially the Ganga Brahmaputra Meghna basin. He investigated possible potential of hydro-electricity, irrigation potential, area under irrigation, total cultivable area, total ground water navigation potential, evaluation of fish, flora and fauna on each river separately. On the aspect of disaster, which has been created by the river due to changes of river courses is given elusively by the author. Covering flood, soil degradation soil erosion, displacement of human and animal life. Last but not the least, on water of hope, the author tries to locate future benefit from the harnessing the GBM rivers, by constructing large dams. Also he discuses about the safety of dam irrespective of seismic hazard, man and animal displacement due to construction of huge reservoir water law and possible cooperation with neighbouring countries. In his second edition, the author incorporates one more sections "from vision to reality". Here he has given a detailed account that took place in last eight years when it was a vision. The book is a result of

extensive investigation and in detailed analysis on the part of the author to transform a vision into reality.

Harnessing the Eastern Himalayan River Regional Cooperation in South Asia (CPR 1992) by Verghese and Iyar is an investigation for the possible outlet for regional cooperation in South Asia through harnessing the Eastern Himalayan rivers. The work is almost same as Verghese's later edited edition *Converting Water into wealth* (Konark 1994) which is already mentioned in this review. This work is slightly different because of its objective of regional cooperation through optimal basin development. Through this, the author suggested a kind of approach for water resource planning. For that it requires a multilevel and holistic planning for the integrated development of Ganga Brahmaputra and Meghna basins. The author ends the work by saying that "if the nations that shares the Ganga Brahmaputra Meghna basins are to roll back poverty ignorance and disease and ensure a better quality of life to large part of human kind they cannot turn their back on the wealth that they have only to reach out to grasp.

India's water wealth (Orient Longman 1979) is the study conducted by Prof. K L Rao in late 80s to assess the India's water wealth. His entire works gives us a detail description on the water wealth in India. The first three chapters deal with river system of India. The river systems in India are divided into three groups. The first group comprises fourteen rivers whose

catchment area is more man 20,000 sq km. The next group having 44 rivers with catchment area in between 20,000 to 2000 sq km and last group covering minor river comprising less than 2000 sq km.

Also the author discussed India's ground water resources, where he says that a new approach has been used to access the utilizable ground water which is estimated to be about 255 thousand million cu m. Thus the total water available in India from all sources is about 1900 thousand million cu m.

Water Resources Development Nepalese Perspective (Konark 1995) of Bhekh B Thapa and Bharat B Pradhan lays emphasis that no other factor is perhaps as important for the survival and prosperity of the people who live along the Eastern part of South Asia as the water that originate in the Himalayan foot hills and flow through Nepal India and Bangladesh. The resources that is linked with the very life of the million is also a source of occasional disaster that affect many who live within the Ganga Brahmaputra Meghana basin. The broad objective of this regional studies is to assess the need prospect and modalities for cooperative development of the water resources of the GBM river basin. This study is divided into two sections. Each if the three participating country prepared a national country report which assessed the role of water resources development in the specific context. Each country reviewed past effort for cooperative development. In

the second section it synthesized regional report which identifies and appraise. The various sector where cooperative effort can be fruit-ful and suggest modalities for cooperative activities.

Four hundred million people make their lives in the basin of the Ganges and the Brahmaputra. Lives constrained by poverty and inextricably linked to vagaries and limited development of these great rivers. *Ben Crow, Alan Lindquist* and *David Wilson* through emphasising the socio-economical aspect of sharing the Ganges is discussed in their book *Sharing the Ganges Technology of River Development* (sage 1995). The book discusses a major factor which contributed to much unexpected poverty. The regional conflict which has prevented an effective responses to the flood, drought and poverty which affect the plains surrounding these two rivers. It incisively analyses the central question underlying more than decades of dispute about sharing the water between India, Pakistan (before 1971) Nepal and Bhutan.

The book starts with an exploration of the processes that led up to the construction of the Farraka Barrage the initial-cause of dispute and rebuts the widely held view that its construction was intended to undermine the economy of Bangladesh. It end by giving a detailed outlook for the dynamics of regional cooperation between India and Bangladesh.

Sardar Sarobar project in state of Gujarat is one of the largest multipurpose river valley project that has generated world wide public interest

on social and environmental issues,. Sardar Sarobar project (Oxford and IBH 1991) by Mahesh T Pathak on analyzing the policies and prospect on Sardar Sarobar project has bought into focus that project has made on incorrect information for various developmental aspect of the project. Different views are expressed on environmental impact social of crafts and distribution, rehabilitation and resettlement plan, benefit and cost estimate. Some of the criticism is because of the assumption by the critics that the project is planned in a traditional way without adequate and systematic data base. The author has covered the importance of planning and issues and incorporated adequate details so that the reader can better understand the Sardar Sarobar project plan.

In *Winning the Future* (Konark 1994) B. G. Verghese, has hgihlighted post independent dam construction controversies. He points out that over whelming population, high dependence on agriculture, relentless urbanization and the pressing requirement of water for domestic and industrial use, health and a better quality of life leads to make necessary for harnessing of India's water wealth. Distress migration to the cities from an impoverished countryside. An increasingly degraded environment and lack of opportunities for employment generation force people to migrate. Displacement is obviously a traumatic experience for any community more so for tribal people whose lives are closely interwoven with their natural surrounding. Resettlement and rehabilitation are being undertaken so that at the end of the

day those displaced are better off than previously. The author shows the enormous benefit likely to be conferred by these projects. This book is basically a debate on the issue of huge dam, resettlement of tribal people and environmental controversies in particular related to the Bhakra Narmada and Tehri dam projects.

Taming the Water the Political Economy of Large Dam in India (OUP 1997) by Satyajit Singh is a study of irrigation development in the context of the politics of state and classes in India. It examines the nature and of the planning and state interventions in irrigation development, particularly through large dams in the light of its critique by the emergent ecological movement. Significantly this book is much about the politics of environment as it is about control of water. The author makes a critique of large dams on the basis of their economic performance, ecological impact, displacement caused by dam construction and the unequal distribution of their cost and benefit in society. The book argues that public resources spent on irrigation are not only uneconomical and unsustainable but has been monopolised by the privileged few. Proprietary right in land determines rights over the use of water. The author sets the agenda for reforms based on the concept of property rights in land. It is also demonstrated that small decentralized and participatory irrigation and hydropower technologies are not only important alternatives but can be empowering agenda.

A conclusion can be drawn from the investigation of the existing scholarship on the water resource development, specially in post-independence period, particularly on the Eastern Indian rivers, that it totally concentrates on the development of Ganges water. Not a single work especially emphasizing on the harnessing of Brahmaputra water has been done till now. Only BG Verghese deals partially in his *water of hope* (Oxford and IBH 1999) incorporating Ganges Brahmaputra and Meghna as an integrated whole. The methodology, which he has applied to discuss the entire Eastern Indian rivers, is debatable. Instead of basin wise development he had taken entire north and eastern Indian river as a whole. But basin wise planning has been the process preferred by most bodies in regard to water development. The national water policy of India (NWP 1999) also embodies this concept. The rationale is based on the concept of the basin being a hydrological unit and the concept of being both a "unified entity" and a whole. The concept of unified entity is based on the premise affect possible action at another place. Because of these converging nature of the flow of water in the river basin, water related action any where in the basin would have a consequence elsewhere.

Secondly instead of having the problem of high population growth (2.67, 1991) shortage of electricity for shortcoming industrialization, insufficient water in the production of food grain and fish, poor facility of rail

and road communication, not even a single academic interest has been shown to harness the vast potential of water of the Brahmaputra basin.

Thirdly instead of getting the gift of its vast wealth, population of the Brahmaputra basin area has been facing perennial disaster. The river causes disaster to the population through its frequently changes of its courses, soil erosion and soil degradation etc.

Objective

The present work therefore will lay emphases on tracing the river from Tibet to the Bay of Bengal, incorporating the entire geography of the river and its tributaries and its characteristic of geomorphology. Secondly it will be emphasized how much the Brahmaputra have potential for the development of irrigation, hydel-electricity, navigation, fisheries and tourism. Thirdly it will be emphasized to trace the disaster that has been created by the river since the 1950s and fourthly propose a solution to the harnessing of the Brahmaputra for both managing the disaster and getting the maximum benefit.

Importance of water resource development in the Brahmaputra basin

An adequate food supply plays an important role in stabilising the social and economic system of all developing countries. Regardless of the high annual rainfall crop production in the Brahmaputra basin region suffers. An adequate supply of irrigation water at critical periods of plant growth and the protection fo cultivation from natural hazards (such as floods, drought and

drainage congestion) are therefore to ensuring agricultural development and production. The only way to make the region self sufficient in food is to increase production through irrigation. The existing available flow in the rivers, including the amount during the dry season is of great importance for this purpose. The flow has also to be allocated to other important uses such as maintaining the ecology of the region, water supply system, navigation, fisheries and forestry.

A solution to the agricultural development problem will not of itself solve the other problems of regional economic growth. Water resource development is only one aspect of overall regional development and must take its place along side the problem of transplantation, industrialization, communication, health and population. Given the Economic problem of this region, however one should begin with the development of water resources. There are two basic reason for this choice. Firstly the water resource problem is critical to overall development. Agricultural, development is inextricably linked with decisions about irrigation and flood control. Transportation is largely a matter of river management. The river basin contains tremendous opportunities for the development of electric power. Secondly water resource planning is an obvious starting point for international cooperation. It is only the sector where the inter-dependence among the neighbouring countries closely emerge.

Flood and flood control are of great importance in Brahmaputra river basin. Flood in Brahmaputra and its tributaries assume colossal proportions in

bom India and Bangladesh. The area affected in Brahmaputra river basin in Assam is 7 million hectare.

Planning a development strategy from the water resource potential of a region is essential to consider the rivers in a drainage basin as an unified entity and integrated whole. The purpose of river basin development in its hydraulic aspect is to improve the distribution and utilization of surface water. The fundamental elements of such regulation is the dam, where water is stored in its natural movements towards the sea. The dam is provided with gates other control devices to regulate the flow according to necessity. Canals control the distribution of water in space.

River development programme takes a long time plan and implementation but once completed these endure for decades even centuries. The future of millions of people living in the valley of the Brahmaputra rests on this effort. Adequate food and safe drinking water and cheapest form of energy hopefully will be provided to ensure a better standard of living.

APPENDIX – I

PRE-INDEPENDENT MULTIPURPOSE DAMS

NAME OF THE PROJECT AND STATE	YEAR OF CONSTRUCTION	AREA IRRIGATED m hectare.
Upper Ganga Canal (UP)	1854	6.99
Eastern Yamuna Canal (UP)	1854	1.91
Agra Canal (UP)	1873	1.38
Mahanadi Canal (Orissa)	1875-76	1.12
Lower Ganga Canal (Bihar)	1878	5.28
Sone Canal (Bihar)	1879	3.47
Upper mani Doah Canal (Punjab)	1879	3.35
Sirhind Canal (Punjab)	1887	6.00
Cauvery Delta system (Tamilnadu)	1889	4.29
Midnapur Delta (W. Bengal)	1889	0.50
Godavari Delta (Andhra Pradesh)	1890	5.58
Western Yamuna Canal (reconstruct) UP	1892	4.81
Periyar system (Tamilnadu)	1897	0.62
Krishna Delta (AP)	1898	4.42
Ranjbir Canal (J & K)	1904	0.54
Nira Left Bank Canal (Maharastra)	1906	0.48
Tribeni Canal (Bihar)	1914	0.48
Godavari Canal (Darna Dam)	1916	0.32
Tundula reservoir (MP)	1921	0.67
Sarda Canal (UP)	1926	6.12
Mahanadi Canal (Orissa)	1927	0.85
Ganga Canal (Rajasthan)	1928	3.03
Krishna raj Sangam Dam	1930	0.51
Damodar Canal (W.B)	1935	0.73
Right bank Canal (Maharastra)	1938	0.35

Source: Verma, NMP, irrigation in India M D Publication 1993.

APPENDIX – II

STATE WISE NUMBERS OF MULTIPURPOSE DAMS

Names of State	No.
Andhra Pradesh	74
Assam	-
Bihar	31
Gujarat	276
Himachal Pradesh	3
Jammu & Kashmir	7
Karnataka	63
Kerala	44
Madhya Pradesh	131
Maharastra	631
Meghalaya	6
Orissa	39
Punjab	-
Rajasthan	67
Tamilnadu	77
Uttar Pradesh	84
West Bengal	17
Goa, Daman and Diu	2

Source: *Swaminathan, Ms, Agricultural Productivity in independent India, Journal of Applied Economic, 1990.*

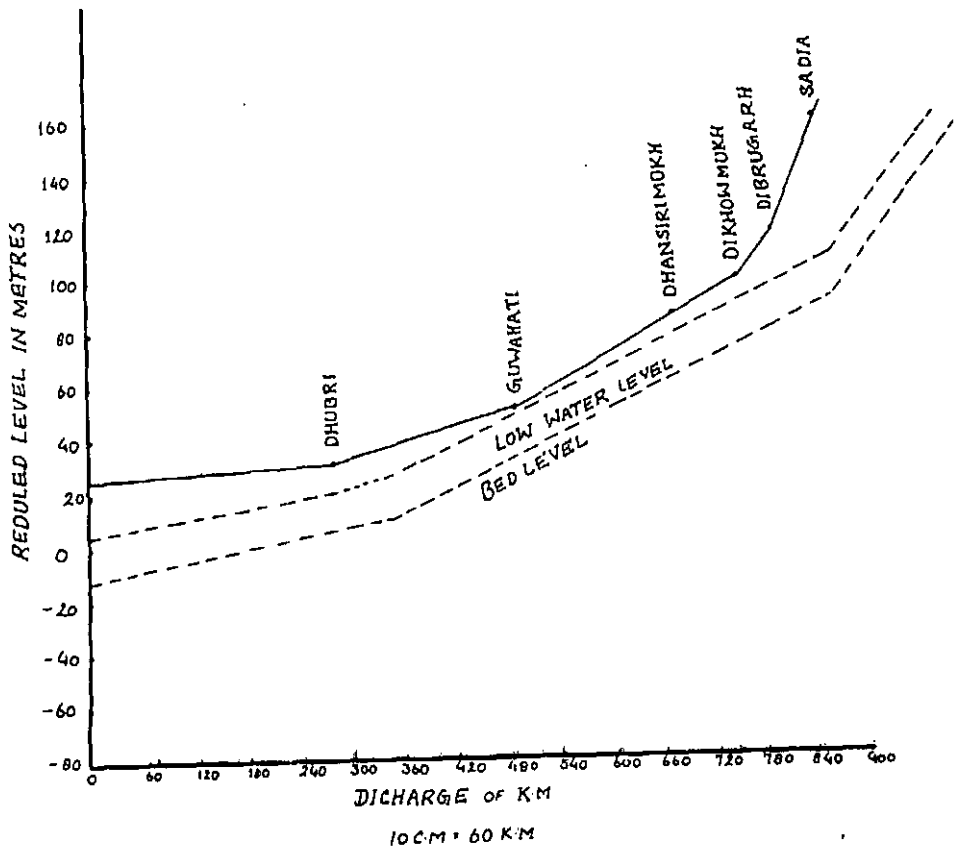
CHAPTER - II

GEOGRAPHY OF THE RIVER BRAHMAPUTRA

The Brahmaputra is one of the largest river with a length of about 2906 km (1800 miles), flowing through China (Tibet), India, and Bangladesh. It is orginates at an altitude of 5300 m about 63 km south of the Mansarovar lake in South West of Tibet. The source of the river lies (according to Tibetans) Kanglung Kang glacier (longitude 82^0 10′ E and Latitude 30^0 30′ N) near kanggyu Tso lake (4877m) of Kailash range of Himalayas. Mayym la (5150 m) and Manyak La (5303 m) separates Brahmaputra basin from mansrovar lake where two great rivers originate, namely Indus and the Gangas. The river touches the political boundary of China (Tibet) India and Bangladesh covering the country wise distance shown as

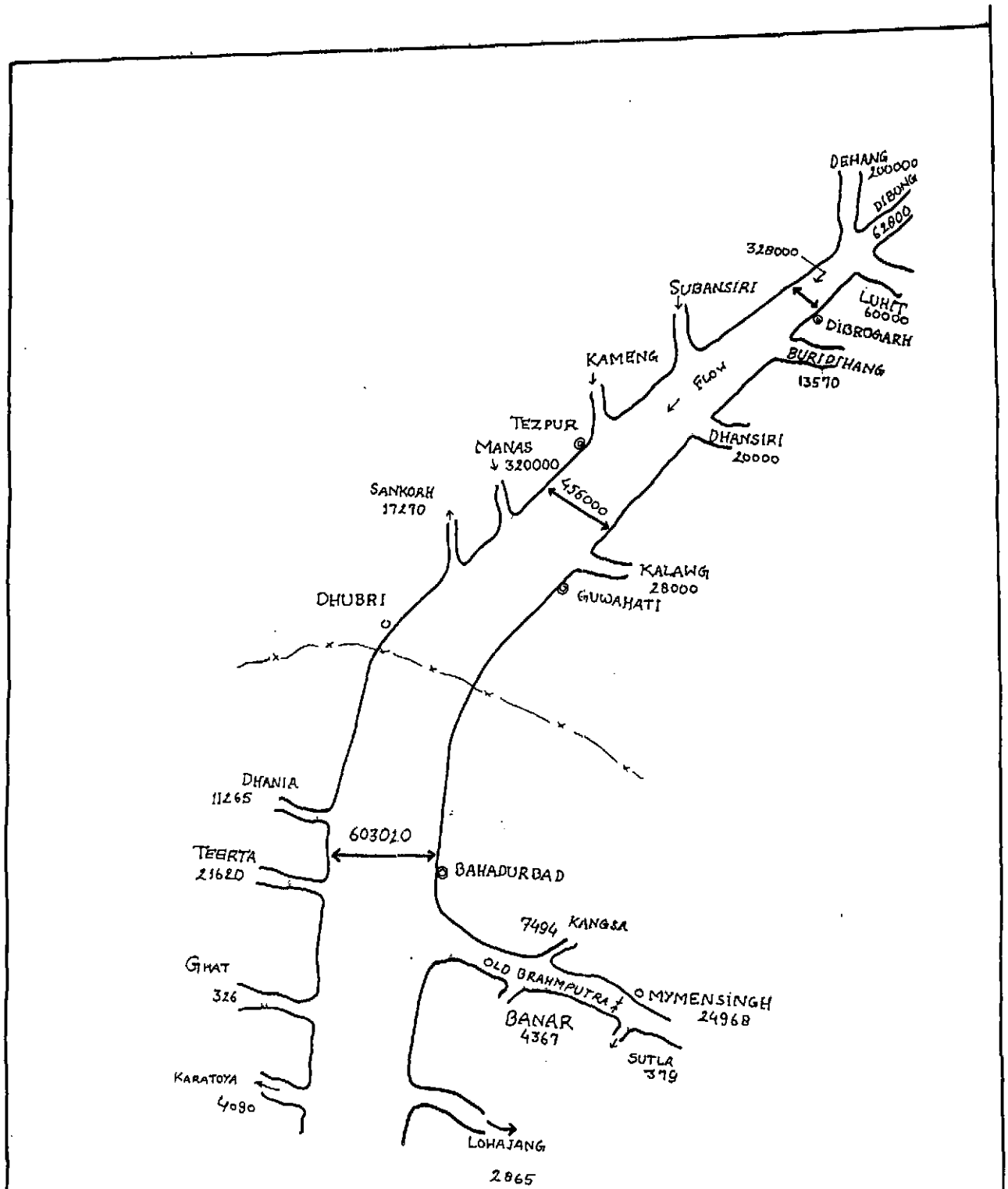
Tibet	1625 km
India	918 km
Bangladesh	365 km
Total	2906 km.

The river known as Tsangpo in Tibet, till its entry point in Arunachal Pradesh. In Arunchal Pradesh it is known as Dihang till thepoitn where it enters in Assam. In Assam it is known as Brahmaputra. In Bangladesh till it meets Ganga at Goalundo it is known as Jamuna. After meeting the Ganga it is known as Padma till it meet Meghna. After that it is known as Meghna until it reaches the Bay of Bengal.



BED SLOPE OF THE BRAHMAPUTRA RIVER

FIG. 1



Fig·2· FLOW DIAGRAM OF BRAHMAPUTRA RIVER IN INDIA & BANGLADESH SHOWING AVERAGE ANNUAL VOLUME IN M·C·U·METRES

At Sadiya the river has an elevation of about 130 m while in Kobo (near the junction of Dihang and Dibang) its 120.7 m . At Dibrugarh (95 km downstream of Sadiya) it is 105 m, Dikhoumukh 94 m, Dhansiremukh 74 m, Guwahati (480 km down stream of Sadiya) 50 m and Dhubri about 28 m. The gradient of the Brahamputra bed is thus very low with about 14 cm per km. (Map shown)

Its drainage basin has a total catchment area of 580,000 sq km (234000 square miles) and falls within the territory of China, Bhutan, India and Bangladesh. There for country wise total catchment area lies as shown

Tibet	293000 sq km
India	195000 sq. km
Bhutan	45000 sq. km
Bangladesh	2,7000 sq. km
Total	580000 sq. km

The state wise distribution of drainage area in India is as shown

Arunachal Pradesh	81,424 Sq. km.
Assam	70,000 Sq. km.
Nagaland	70,634 Sq. km.
Meghalaya	11,667 Sq. km.
Sikkim	73,00 Sq. km.
West Bengal	12,585 Sq. km.

The Brahmaputra basin in India is bounded on north by the Himalayas, on the east by the Patkai range of hills running along the Indo-Burma borders, on the, south by the Assam range of hills and on the west by the ridge separating it from the Ganga basin. The basin has a maximum east-west length of about 1540 km and a maximum norm south width of about 682 km along 93^0 E. of latitude.

The upper portion of the basin lying in Tibet comprises mostly mountain ranges and numerous valleys. The portion lying in Bhutan is also hilly. Similar in the case with the Sikkim, Arunachal Pradesh, Nagaland and the Meghalaya. In Assam the basin consist of hills, forest, tea gardens and fertile valleys. In W. Bengal the basin consists of hills, forest, tea garden and fertile plains. In Bangladesh the basin consists of fertile plains only.

A considerable part of the Tsangpo Dihang Brahmaputra basin lies in Tibet and the remaining part lies in Arunachal Pradesh, Nagaland, Meghalaya, Assam, Sikkim, West Bengal, Bhutan and Bangladesh. Meteorologically the catchment area are divided into two division. The catchment in Tibet lies in climatic zone III comprising the plateaue of Chumdo, Shanghi and Tibt and Southern part of Singkiang. The part of the basin in India falls in climate zone I comprising growth and North-east India adjoining part of Nepal, Bhutan, Bangladesh and North Burma[1].

[1] Brahmaputra Master Plan vol I 1986. P 70

The characteristic feature of the isolation of high latitude zone is the large summer day of oblique sunshine through a dense atmosphere. On the other hand isolation is intense at high levels on account of the transparency of the atmosphere. These differences have great bearing on the vegetation and habitations of the zones. Due to variation of temperature and rainfall, vegetation changes rapidly with elevation from one type to another. The zone of maximum precipitation is generally covered by deciduous forest with coniferous trees higher up. It is generally covered with alpine trees with grassland becoming drier towards the top.

The south-west monsoon which enters Assam and the adjoining areas around the end of may and beginning of June establishes firmly over the entire north East India by the end of June. When it moves towards the foothills of Himalayas the rainfall over Assam increases and though it is one of the primary causes of flood in the Brahmaputra valley. Some times a minor east-west oriented through over Assam and west Bengal can also give rise to increase in precipitation over the Brahmaputra catchment.

The other feature that normally causes increased precipitation over the Brahmaputra valley is passage of upper air through in the monsoon westerlies and sometimes by the appearance of the remnants of mid latitude western disturbance over extreme north Arunachal in conjunction with other precipitation causing feature.

Monsoon sets in Assam in the first week of June and withdraws in the second week of October. From an estimation of the attendant meteorological situation responsible for causing heavy spells of rain and consequent flood in Brahmaputra valley, it has been found that the following form of meteorological situation are mainly responsible[2].

(i) Break monsoon situation or when the axis of the season through shifts to the north from its normal position and lies close to the foothills of the Himalayas.

(ii) North- Westerly to northerly movement of monsoon depression storms from the head of Bay of Bengal into the interior of the country.

(iii) Formation and movement of land depression over north over north east India.

(iv) Upper air cyolonic circulation over north east India and its neighbourhood.

The average annual rainfall distribution over the basin is maximum on the southern slope of foothills of the Himalayas roughly along Bhutan, Assam and Arunachal Pradesh borders. One axis passes through Gerukamukh, likebari, Deing, Passighat, Roing, and Lohitpur and another cell with axis through Jamdura Hatisar and Raimona. Rainfall is between these two cells falls sharply to less than 2500 mm. Being in the rain shadow area of the Mikis

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2 Ibid, p 72.

hills and other hills of the south, rainfalls decrease abruptly towards north to south in the foothills of the Himalayas. The Eastern part of the Lohit district is a rain shadow area with an annual rainfall less man 1000mm. Rainfall in Western part of the Arunachal Pradesh and adjacent part of Bhutan as appear less man 1000 m^3.

To study the river, it is divided into five segments.

1. From origin to bordering Arunachal Pradesh, known as Tsangpo.
2. From Arunachal Pradesh to bondering Assam known as Dihang.
3. In entire Assam from Sadiya to Dhubri known as the Brahmaputra.
4. From Dhubri to Goalundo known as Jamuna.
5. From Goalanndo to Bay of Bengal. Known as Padma and Meghna.

The first tributary Raga Tsangpo joins the mainstream from the north near Lhatse Dronge. From Lhatse Dronge, the Tsangpo flows in a wide navigable channel for about 400 miles (644 km), forming an important east west route, at an altitude of 9842 ft (3000 m), beyond Pe, the river turns to the north and after flowing through a series of deep narrow gorges turns to the south and south-west entering India in the extreme north of the Siange district of Arunachal Pradesh where it is called the Siang or the Dihang.

The tributaries joining *Tsangpo* are the *Nau chhu*, the *Tsa chhu*, the *Shang chhu*, the *Ghychhu*, the *Giamadachch*, the *Po Tsangpo* and the *Chin dhu chhu* on its north bank. *Jubi*, the *Kyang, Sakya, Tranchhu*, the *Rhe, chhu*, the

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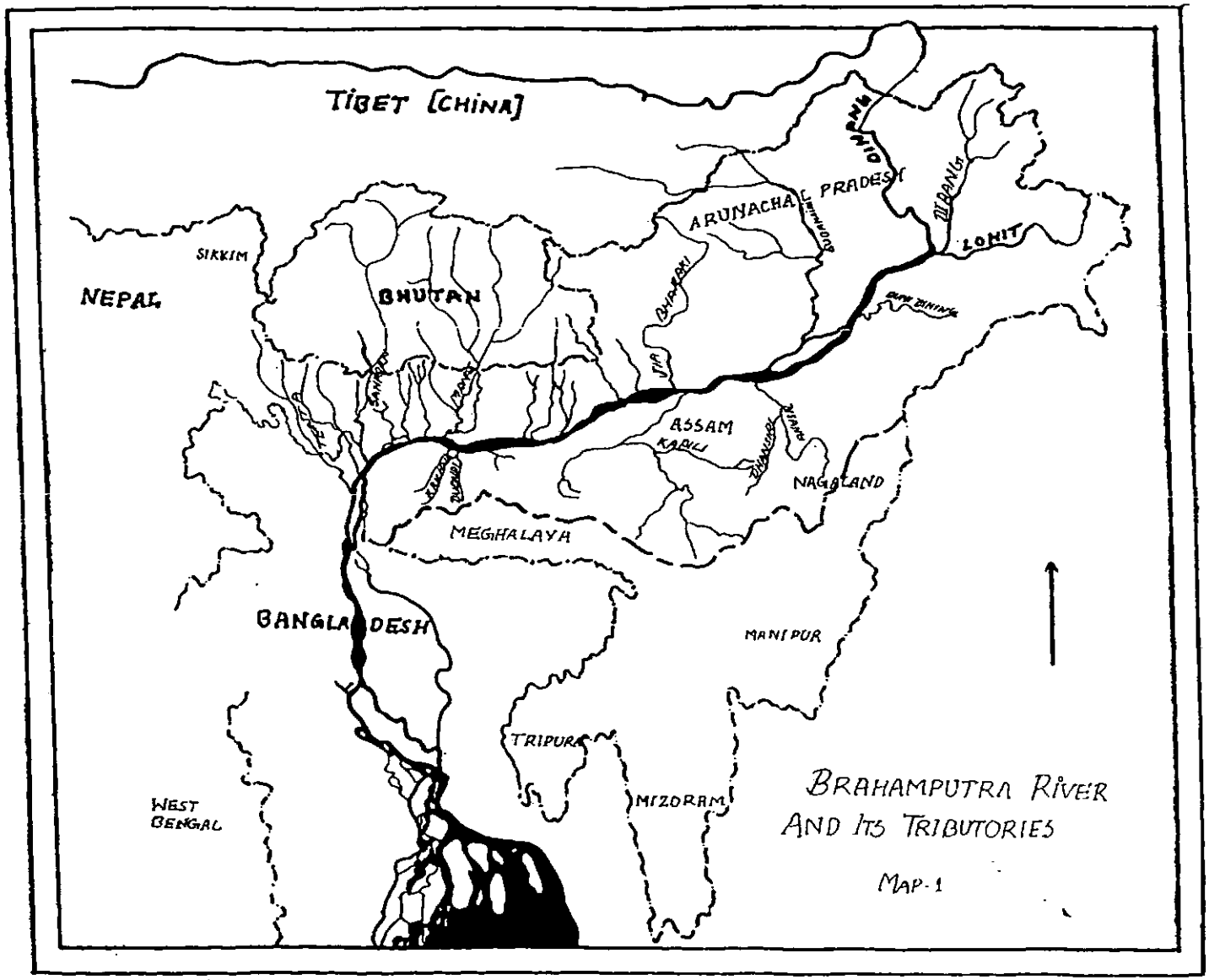
[3] Ibid, p. 73.


TIBET (CHINA)
SIKKIM
NEPAL
BHUTAN
ARUNACHAL PRADESH
DIBANG
LOHIT
ASSAM
KAMLI
NAGALAND
MEGHALAYA
BANGLADESH
MANIPUR
TRIPURA
MIZORAM
WEST BENGAL
BRAHAMPUTRA RIVER
AND ITS TRIBUTORIES
MAP-1

Rang chhu the *Nayang chhu*, the *Yarlang chhu* and the *Trulung chhu* on its southern side.

The Brahmaputra (as the Dihang) then enters Assam at the north-west of old town where it is joined by two more trans-Himalayan tributaries, Dibang and Luhit. The combined flow of these three streams is known the Brahmaputra throughout its courses in Assam with a length of about 450 miles (725 km). The major north bank and south bank tributaries of the Brahmaputra with the catchment area is shown below, in table 2.1 (Map)

Table 2.1

North Bank	Sq km	South Bank	Sq km
1. Jiya Dhol	1346	1. Dibru	8730
2. Subansiri	28200	2. Buri Dihing	8950
3. Burai	791	3. Disang	31950
4. Bargang	550	4. Dikhu	10022
5. Jia Bhanali	14738	5. Jhanzi	1349
6. Gabharu	296	6. Dhansiri	
7. Belsiri	751	7. Kopili	20068
8. Dhansiri (n)	956	8. Kulsi-Deosila	3770
9.Noa nadi	366	Dudhnal-Krishna	1615
10.Nanai	860		
11. Bar nadi	739		
12. Puthimari	1787		
13. Pag ladiya	1674		
14. Beki-Manas	41350		
15. Champamati	1038		
16. Gurange	1023		
17. Sankosh	10345		
18. Ranganadi	2941		

Among them the principle north bank tributaries are the Jiadhol, Ranga nadi, Pagladia, Manas Sonkosh and the south bank tributaries are Noa Dihing, Buri Dihang, Dhansiri, Kopili, etc.

After traversing the broad ferlite Assam valley the river sweeps round the western end of the Assam range (the Garo hills) and enter the allievial plains of Bangladesh near Dhubri.

Known as the Jamuna in Bangladesh the river continues to flow south of for a distance of 170 miles (274 km) and joins the Ganges at Goalundo. The major tributaries joining the reverie from the north are the Dud kumar, Dharka, Teesta and Karotoya-Baral below the confluence of the Teesta. The old channel of the Brahmaputra and the Ganges flow towards south east under a new name the Padma. At Chandpur 65 miles (105 km below Goalundo the Padma is again joined on the left bank by another large river the Meghna. From this confluence to southwards direction river is known as the Meghna until it reaches the Bay of Bengal.

The major tributaries of both side of the Brahmaputra basin contributed largely as shown in table 2.2 in percentage wise contributions of water to the mainstream.

Table 2.2

Name of Tributaries	Average annual yield (m cum)	Percentage
Dihang (main river in Arunachal Pradesh)	1,85,102	37.45%
Subansiri	52,705	10.56%
Lohit	46964	9.50%
Debang	37818	7.65%
Jiabharali	28844	5.84%
Burhi Dihing	11906	2.41%
Kopili	9023	1.83%
Dhansiri (s)	6785	1.37%
Other tributaries above pandu (Guwahati)		23.29%

Source: Brahamputra Master plan vol. I 1986.

The tributaries of Brahmaputra have differences on both side of the bank. The main characteristic of north bank tributaries are.

1. The north bank tributaries have a very steep slop stoop and shallow braided channel for a considerable distance from the foothills and in some cases right up to the out fall. 2. have boulder pebble and coarse sandy bed and carry a heavy silt charge. 3. generally have flash flood. The south bank tributaries have a different character.. These are 1. they have comparatively grades and deep meandering channels almost from the foothills, II. have bed and banks composed of fine alluvial soils III. have comparatively low silt charge.

Thus south bank tributaries have gentle gradient, change their course less frequently and cause lesser flood havoc. That their meandering is essentially

the result of hydraulic action rather than topography can be testified from the following qualification of sinuosity of some important tributaries. and the altogether average annual yield of Brahmaputra at Pandu (Guwahati). Which is 499300 mcum.

All these tributaries contributes largely to the level of water in the valley. It is known from the data available to the Brahmaputra Board Observation office at various places as shown in table 2.3.

Table 2.3

Maximum and minimum water level of the Brahmaputra at Different sites.

Places	Maximum water level (M_1)	Minimum water level (M_2)
Dibrugarh	105 95	97.24
Bechamara	87.28	80.02
Bhurbandha	69.46	59.01
Tezpur	68.33	57.02
Pandu	49.66	40.20
Jogighopa	36.62	-
Dhubri	29.97	28.06

Source Brahmaputra master Plan Vol. I 1986 p984

The Brahmaputra valley receives run off flows from the resounding hills of Arunachal Pradesh, Nagaland and Mehalaya through above tributaries, with the rainfall as high as in Arunachal Pradesh, is 2.800 mm.

Nagaland and Manipur as 2000 mm of rainfall during the rainy season the tributaries brings substantial quality of silt. Most of which is carried to the Brahmaputra. When the silt laden water in the tributaries overspill on the bank, the heavier fraction in the silt are dropped near the bank, thus progressively raising the banks around the country side.

The drainage problem of the Brahmaputra valley are partly due to natural causes and partly are man made. Among the natural causes, are high rainfall in the basin exceeding 2000 mm in most of the catchment area and precipitation of 85% of it during may to October. It is figured out in 1995 that total precipitation occur a as follows in Assam.

Table 2.4

Months	Actual Rainfall	Normal Rainfall
January	19.9	27.3
February	35.4	30.4
March	1729	89.6
April	135.1	194.3
May	535.2	355.2
June	250.2	464.5
July	422.8	444.8
August	323.0	378.1
September	236.8	217.0
October	168.0	131.0
November	18.5	24.8
December	0.1	11.4

Source: Indian statistical year book 1998.

From Above data it is evident that precipitation started rising from the month of May till the mid of October. Man has contributed to the problem of drainage by creating obstruction in the natural flow of water by several actions like constriction of railway and roads, building, embankments etc.

Thus it is saying that the total water potential are carrying generally come from the precipitation in the summer season.

As the Brahmaputra is one of the longest river in world, geographically it is much important in its courses. It creates fertile plateau and navigation facility in above 4000 m in Tibet. It creates fertile valley in Assam. Although it is narrow measuring about 80-90 km. breath it makes the valley rich houses of food grain production. It creates fertile valley and delta in Bangladesh, where it makes natural houses of fish production. Thus through along its courses, the river makes his presence in the life of surrounding inhabitant.

CHAPTER III

POTENTIALITIES AND UTILIZATION

Jalasinchan- **Life line of farming**

The Brahmaputra is the lifeline of Assam where it influences the society, economy, politics, art and religion since ancient times. The river reaches the Bay of Bengal after crossing barrier of cultural differences international boundaries irrespective of nation states and language of people inhabiting along the states of China (Tibet) India and Bangladesh. It is a cultural highway, which is the nature's gift for communication of the people across the traditional boundaries of these nations.

The population inhabiting along the main river and its tributaries in Brahmaputra basin area is as follows (Table 3.1)

Population of the Basin area (in million)

Table 3.1

State	Total for the State			For the Brahmaputra Basin area		
	1971	1981	1991	1971	1981	1991
Arunachal Pradesh	0.467	0.628	0.864	0.467	0.628	0.864
Nagaland	0.516	0.773	1.209	0.33	0.49	0.897
Assam	14.625	19903	22.414	12.91	17.56	19.383
Meghalaya	1.012	1.328	1.774	0.52	0.68	0.846

Source: Brahmaputra broad, Brahmaputra master plan vol. I 1986

The population of Assam is entirely dependent on the river economy through irrigation on agricultural field, navigation along the main river and its tributaries, breeding of fish and exchange of trade etc. Out of total population more or less than 80% population living along the Brahmaputra basin in Assam. Table 3.1 shows that total population of the Brahmaputra basin area since 1971, which highlighted that except the population in the district Karbi Anlong, North Cachar, hill district, Cachar, Karimgang, Hylakandi in South Assam entire population of state of Assam is in Brahmaputra basin.

Table 3.2

Year	Total Population	Decadel increase	Percentage increase
1901	3239680		
1911	3848617	+558937	+16.99
1921	4636980	+788363	+2048
1931	5560371	+923391	+19.91
1941	6694790	+1134066	+2040
1951	80288526	+1334066	+19.93
1961	10837329	+2808473	+34.98
1971	14624152	+3787823	+3493
1981	19902826	+5277674	+36.09
1991	22414322	+2511496	+24.25

Source: Census 1991, Registrar Genera of India.

Out of total population of the Brahmaputra basin state, density of Assam in per sq. km is 285, which in much more higher than the all India figure (all India 267, 1991)[1]. The density is scatterdly distributed in Assam. Density is much higher along the river valley only. In NC hills, Karbi Anlong, it is just 56 per sq. km. In three district of South Assam, it is much more than the overall density of Assam, which is because of the Surma valley.

The Decadel growth rate of Assam is also higher than the all India decadal growth rate in 1991. (Assam 24.25, All India 23.85, 1991). Assam is the 13th state among the Indian state in population wise and 14th state in land wise, covering 2.63% and 2.39% of population and land respectively. It shows that population is growing overwhelmingly in recent times by giving a pressure on land, natural resources, and food.

Land utilisation in the basin area:

Land in the Brahmaputra Valley is utilise in many ways. In cultivation, in forest, in pasture and in grazing, wet land, waste land and land for habitation and industrial purpose. Survey has conducted by Registrar General of India in 1993-94 on land utilization in Assam which is given in table 3.3.

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[1] Census 1991, RGI.

Table 3.3

1993-94 (000 hectare),

Reporting area of land utilization	Forest	Net available for cultivation	Permanent Pasture and grazing	Land under miscellaneous	Cultivable waste land
7852	1984	3987	184	247	104

Out of total cultivable land, land utilized in 1993-94 is as follows

Table 3.4

(000 hectare)

Net sown area	Area sown more than once	Fellow land	Total area for cropping
2706	1111	172	3989

<u>Crops and cropping pattern</u>:

In these cultivable land –various crops are cultivated in the Brahmaputra valley. Rice is the staple food in the valley. Which is moist suitable for cultivation in the valley in respect to valley's climatic condition like, high intensity of precipitation (250-300 cm per annum) alluvial soil, water storage drainage capacity of the valley. Pulses are also cultivated in the valley. Specially, Pea, Lentil, Ahar etc. are the main variety of pulses, which generally needs moderate amount of rain and irrigation for dry

season. Mustered is generally cultivated because population of the valley use mustered oil for fry fish and cooking other food items. Sugarcane is also more or less cultivated for the domestic use as well as production of sugar form valley's single sugar mill. Jute is produced extensively, which is the country's second in rank in total production in the valley, needs shallow water for deposition and fermentation. For cultivation of jute needs rainfall about 200-250 cm.

Most extensively cultivated crop in the valley is the tea. It was started during the British period. Since then it has been cultivating more extensively with a potential to export. Now valley becomes the world largest producer of Tea estimating about 425 million tones, which cover about 52% of total India's production.

Area of cultivation and production:

Entire cultivable land is used for cultivation of various crops. In 1995-96 use of cultivable land for various crops is given table 3.5.

Table 3.5

	Crops	Land utilized for cropping (000 hectare)	Total production (000 tones)
1. Cereals	Rice	2502	3390
	Maize	19	13
	Small millet	12	6
	Wheat	86	95
	Total	2620	3505
2. Pulses	Gram	3	2
	Tur	6	4
	Other pulses	98	51
	Total	305	212
(1+2)	Total food grain)	2925	3716
Oil seed	Seasmum	16	8
	Repseed/Mustard	279	144
	Linseed	10	5
	Castor	2	1
		306	158
4. Fibre	Cotton	2	1 (Balls)
	Jute	89	844 (Balls)
	Rubber	1	05
5. Fruits	Banana	41	1490
	Sugarcane	36	50
	Potato	173	505
	Chilies	8	9
	Ginger	1	-
	Turmeric	9	1
	Coconut		
6. Beverages	Tea	233	425
	Tobacco	134	-

Source: Statistical hand book of India RGI, 1997

Reason of necessity for development of irrigation:

From the above table 3.5, it is found that production with respect to utilization of land is comparatively low in their per hectare yield. Although the valley has most fertile alluvial soil, crisis crosses by various tributaries and high precipitation. Agriculture Commission of India arguing it that because of Lean season less rainfall, and summer high rainfall, lack of irrigation facility (canal, well, pond etc.), not use of high quality seeds and capital farming, production is very law as compared to the rest of India. Production of the various crops in the valley is given Table 3.5.

In a comparative agricultural survey of the production in the Brahmaputra valley with the rest of India's production, it is found that in the state like Punjab, Haryana, Andhra Pradesh and Tamil Nadu, production is much more higher than the production in the Brahmaputra valley. Comparative figures are given in Table 3.6 shows that agricultural production in Assam needs much more concentration to develop, to feed the growing population of Assam, which is 24.25% decade wise.

Table 3.6

Average yield of principle crop (quintal to per hectare (1995-96)

	Rice	Pulses	Tea	Potato	Mustered
India	18.6	5.5	18		8.5
Assam	13.5	2.1	18.2	68.1	10.6
Andhra Pradesh	25.6	4.2		169.3	
Bihar				90.8	
Haryana	22.2	6.8		134.6	12.8
Gujarat				200.4	
Karnataka			22.2		
Kerala			16.8		
Punjab	31.3	8.2		204	12.0
Tamil Nadu	33.9	3.7	23.2	270.0	14.7
West Bengal				244.6	

Source: SHI, RGI 1997.

If we look total food grain production in Assam with respect to other state and all India out put, we found that in respect to potential cultivable land, production in Assam is much more less compared to other state like Punjab, Haryana, Andhra Pradesh, Tamilnadu etc. Table 3.5 shows that Food grain production in 1995-96 in Assam was 3716 thousand tones while in Punjab, Haryana which has less cultivable land in comparison to Assam, production was much more, which was 19289.7 thousand tones in Punjab and 9099.2 thousand in Haryana. From the above data we can also find that average per capita, production of food grain in Assam was 145.3kg/yr

(1995-96) while in All India 202.6 kg/yr. Other states have average per capita production as follows: AP (18517) Haryana (533.0) Punjab (951.1) UP (251.4) West Bengal (175.2) etc.

A food deficit in the case of an individual state need not be worrying if sufficient means are available to pay for imports from the other states. But states like Assam, imports of food grain from the other states have become a perennial drain, which may lead future impoverishment of the population. Planning Commission reports listed Assam to be self sufficient in food grain production in the coming decade. A report says that a huge outflow of money has been occurring of the Population of Assam whose has already limited purchasing power. An annual estimated Rs. 700 crore flown out of the state by way of procurement of food grain, fish, edible oils etc from the other states. If the present pattern of dependence on procurement of these commodities continues unabated then it is estimated that at the end of 9th plan period as much as Rs. 55000 crore worth of cash will be flowing out of the hands of the people of Assam. If this flow can be restrained fully or even partially by incremental local production, it will lead to enormous accretion of resources in the hands of the people of

Assam at large. We find there is substantial scope for augmenting local production.[2]

From above analysis it is clear that agriculture in Assam is not developed in comparison with the other state in India. For the higher growth rate of agriculture production, irrigation water is necessary for the dry season cultivation for multiple cropping. Irrigation in Assam is scatardly developed. People generally cultivate one crop during the summer season depending on rainwater. Some of the parts of the state multiple cropping has been taking taken place. Assam is witnessing average annual rainfall about 2477 mm and 1624 mm in season rainfall during the month of June-Sept. which signify that dry season rainfall in very limited amount. (Table 1.1) Therefore people of the valley have to depend on artificial irrigation to cultivate crop like rice, mustered, tea potato and other vegetables. Irrigation water has been classified as surface water and ground water. Surface irrigation water has been classified as major, medium and minor irrigation water.

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[2] Planning Commission, Report on Agriculture in Assam, 1998.

Potential of Irrigation development in the Basin area:

Brahmaputra is the biggest source of water supply for valley's population. Instead of that, people use tanks, Tube-well and other means to extract ground water for cultivation. Brahmaputra has total 766 thousand-hectare irrigated capacity in both surface and groundwater irrigation. (KL Rao 1979). 1991 census reveals that net sown and irrigated area in North East ago climatic zone is as follows: [3]

Table 3.7

(000 hectare)

Climatic zone	Net sown area	Irrigated area	Percentage of irrigated area
NE Transition	570	42.20	7.41
NE Dry	1320	94.68	7.17

Estimating total sown area as 1890 thousand hectare: Out of that total irrigated area, it is 7.29% only.

It is estimated by the central water commission (Govt. of India) that the Brahmaputra has average potential about 537.3222 cubic km. Out of that 24.000 cubic km water is estimated utilizable.

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[3] Statistical hand of India 1997 RGI, p.57.

The Brahmaputra has a storage capacity to facilitate irrigation for winter (dry) season cropping and other purposes at about 141.5 million cum in Assam. Which is not store till today for any purpose. Till 1993-94 the net area under irrigation by source in Assam was 572 thousand-hectare.[4] Where total net sown area was 2706 thousand hectare (Table 3.4) out of total 3989 thousand hectare cultivable land. In comparison to the other state Irrigation in Assam is in embryonic stage. Out of net irrigated area 71000 hectare by private canal. Rest is by other means of irrigation. Therefore, it is evident that state initiative of irrigation development for agricultural development is almost pathetic.

Development of Irrigation Projects in the Basin area:

Till 1980 government was started constructing irrigation project in Brahmaputra valley. Among them Bordikarai (1974) integrated Kollong (1974) Dhansiri (1975) Kaladiya (1974) Pahumara Dekadong (1979) Champamati (1980) which are major irrigation project. Kollong (1970) Buradihing (1980) Berolla (1980) Hawaipur lift (1981) are medium irrigation project. Till 1992-93 Assam has two major five medium and 1278 minor irrigation projects.[5] Among them the Champamati in still in

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[4] Ibid., p.59.

[5] Hand book on Assam, 1998, Economic and Statistical dept., p.29.

construction stage since 1981 having the estimated expenditure about 10 times more,

GROUND WATER RESOURCES :

Ground water resources are neither in exhaustible nor uniformly distributed. The government of India in 1982 constituted a ground water estimates committee. According to this, estimated ground water potential of the Brahmaputra basin area is as follow:

Table 3.8

States	Replenisible G.W. in cum /yr	Domestic uses	Irrigational uses	Net	G.W.
Assam	26550.00	3372.00	22560.00	0.76	21800.00
Meghalaya	424.52	63.67	360.85	0.24	
Nagaland	52.00	7.80	44.20	0.00	
W.Bengal	3462.41	519.3	2943.10	46.58	

The Brahmaputra basin area has a rainy season from June to Sept. The remaining eight months are generally dry. On the whole with large variations from west to East and from north to south, the Basin experiences quick ground water fluctuations with the onset of the monsoon. The greater part of the Basin witness a rise of the water table in response to rainfall. This tends to peak about mid august under normal rainfall conditions All

rainfall if superfluous to the ground water system and runs off as rejected recharge. This aspects have to be considered while planning the development of the ground water resources of the Basin. Similar observation on the confined acquitter system would contribute greatly to the planning of intensive and extensive ground water development through deep tube wells. Exploration of ground water through tube wells in the state in as follows. Dug well (1387) shallow Tube well (451540) and Deep Tube well (293) (Annual report CWC 1997). Through this is indicate that the true extent of ground water exploration for optimal resource utilization. The project under construction for ground water exploration in the state of Assam is estimating about 1054.32 in cum (CWC 1997). Which is 3.37% of the level of ground water development in the state.

Before plan development irrigation potential was 0.23 m ha. Under plan development about 20 major and medium irrigation project and a large number of minor irrigation projects were undertaken resulting creation of 0.85 m hectare irrigation potential. Which is one third of the ultimate irrigation potential of 2.67m ha for the state. A net area of 0.57 m ha has been thought under irrigation through these projects.

Irrigation is needed as a supplement to rain water for Rabi crop production. The available of irrigation would make a big differences to

both the yield of crops and the cropping pattern replacing the present Rotation by a far more productive one in terms of both physical out put and the value of crop grown. Irrigation makes possible the use of complementary inputs, like high yielding seeds, fertilizers and pesticides which together constitute a combined leading input package; that can trigger a green revolution and optimize land productivity.

JALABIDYUT – VEHICLE FOR MODERNIZATION:

Hydro power is a renewable source of energy and exhibits operation and Economic superiority over the other mode of power generation. Particularly in catering the peaking power requirement. It is a clean and non polluting resource of energy with high conservation efficiency. Earth is covered by 2/3 water through sea, river, lake, glacier and other small stream. Generation of electricity from this water potential of earth is cheapest and most durable form of electricity production. Although it has taken long gestation period to produce, but once setup it give us an uninterrupted flow of energy 50 to 100 years and m ore.

Only 28% of the economically potentially and 18% of the technically possible hydro-potential have been developed throughout the world. It is highest in France (97%) followed by Switzerland (85%) North

America (75%) Europe (70%) S. America (33%) Asia (excluding Russia and Turkey) 20% and Africa 6%.

India's Total Potential:

Compare to other countries of the world development of hydel electricity from India's water resources in very negligible. It is estimated that total potential of 84000 mw can be produced from various rivers in India. Among them Brahmaputra having the largest amount of potential of electricity generation. Table shown the total generation in India.[6]

Table 3.9

Total hydel electricity potential in India's river

Indus (India)	20000mw
Brahmaputra	35000 mw
Ganges	11000 mw
Central Indian Rivers	3000 mw
W. Flowing River	6000 mw
E. Flowing River	9000
	84000 mw

[6] CWC Annual Report, 1998.

Past Development:

In the year 1902 the first water power house was set up on the River Kaveri at Sivasamudram in Karnataka. It was then followed by the Tata hydroelectric scheme in the western Ghats of Maharastra to supply power to the city of Bombay. In Tamil Nadu, Pykara was the first water power station. In the north Mandi power house was the first to be developed in the Himalayan region. The Rihand Project is the largest man made lake in India on the borders of M.P. and UP. Its capacity is 300 mw every year. The Koyna Project in Maharastra is on the East of flowing tributary of the Krishna. A dam on the Koyna has been built which to takes water through a tunnel to the western slopes of the Ghats. It has capacity to generate 880 mw. It supplies power to Bombay- Pune industrial region. The Sharavatry project in Karnataka is located at the Jog Falls which is the highest waterfall in India. Its total capacity is 891 mw. It feeds Bangalore industrial region and is also taken to the state of Goa and Tamilnadu. Kalinadi Project in Karnataka has 270 mw capacity. The Kundoh project in Tamil Nadu has initially 425 mw capacity which has been expand lately to 535 mw. The Sabarighiri project in Kerala has an installed capacity of 300 mw while the Idukki Project has capacity of 390 mw. The Balimela Project in Orissa has an capacity of 300 mw. In J&K Salal Hydel Power Project has been completed and waiting for operationalisation. India is constructing a

very big hydel power project chukha in Bhutan. It is financing by India on the basis of Built, Operate and Transfer (BOT)

At the time of independence hydel electricity generated from different private and public project was 508 mw where it was 1367 mw installed capacity. Since than it has raised to about 13000 mw. In addition to that 9000 mw will be available from project under construction having the total harness/under harness would be about 22000 mw which is nearly one fourth of the estimated potential. This has been producing from 201 projects in various parts of India.

Necessity and importance of hydropower:

During the 1970's hydropower development in many countries become more favourable compared to other forms of electricity generation.

1. *Firstly,* it is because major increases in oil prices since October 1973 changed the economics of oil fired power plants.

2. *Secondly,* many countries are not self sufficient in oil and natural gas and constantly increasing balance of payment deficits due to importing of oil and natural gas, forced many countries to seriously re-examine their hydel resource development.

3. *Thirdly*, hydropower in the only renewable form of energy that can be used extensively in many countries extensively for large scale generation of electricity. It is not necessary to wait for further technical development. While the initial capital costs for hydro development are high, operational and running costs are minimal.

4. *Fourthly*, hydropower does not raise the same type of environment, ethical and safety problem as are currently associated with nuclear energy.

5. *Fifthly*, especially for many developing countries, much of the planning and technology necessary to develop hydropower development available locally and thus no need to be imported at high costs from other countries.

6. *Sixthly*, the potential for future hydropower development is very good in many countries. Many good dam sites are still available and this is especially relevant for developing countries.

7. *Finally*, hydropower in unique since the main development process, provides other significant benefits. Dams are seldom constructed only for a single purpose like electricity generation, they can also simultaneously provide irrigation, flood control, better navigation, recreation, wild life protection and low flow augmentation. Thus for

developing countries water resources development could successfully contribute to the solution of two major crises, energy and food.[7]

Energy Planning:

At the present rule of energy consumption through oil and natural gas will be exhausted within the next half century. The amount of uranium in the world is limited and cannot provide us with the fuel required by present day nuclear power station for long. The development of breeder reactor would stretch the life span of nuclear fuel. Considerably but not in definitely. Coal although in abundance, will also eventually vanish. The ultimate solution of the world energy crisis will be through the discovery of method of harnessing the energy from the sun and water.

Reason of slow development hydropower generation:

Despite hydroelectric projects being recognized as the most economic and preferred source of electricity in worldwide, share of hydro electricity generation in India has been declined since 1963. Coming down from 44% in 1970 to 25% in 1998 in respect to average development of electricity. Reasons for slow development of hydropower are:

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[7] Biswas A. K. et al., (ed.) 1983, New and Renewable Source of Energy, pp.55-56

(1) Shortage of funds.

(2) Resettlement and Rehabilitational Problem.

(3) Dearth of Good construction.

(4) Interstate conflict.

(5) Delays in Environmental and Forest Clearance.

(6) Slow development in NE Indian region having largest hydro potential.

(7) Law and order problem in the remote area.

(8) Land acquisition problem basically in tribal areas.

(9) Geological landscape likes seismic hazards, soil content, gradient etc.

The significant feature of India's hydro electric potential is that 41.5% of its potential concentrated in the North Eastern region in the Brahmaputra basin which in virtually untapped. This is mainly due to low levels of demand for power within the region and gas and oil option available to meet short term objective with much lower capital investment. It is interesting to note that the Eastern Region have a share of only 12.7% in all India electricity consumption and the NE Region a meager of 1.3%.

Energy resources are more plentiful and diverse in North Eastern India, which lies in Brahmaputra basin. The hydro resources in the region

estimated at 35000mw at 60% load factor. State wise it is divided as follows.[8]

Table 3.10

State wise hydel electricity generation potential

Arunachal Pradesh	26756.00 mw at 60% load factor
Assam	351.00 mw at 60% load factor
Meghalaya	1070.00 mw at 60% load factor
Nagaland	1040.00 mw at 60% load factor
Manpur	2100.00 mw at 60% load factor
Mizoram	1800.00 mw at 60% load factor
Tripura	--

Out of the total potential it has potential to developed in the state of Arunachal Pradesh (96.50% at 60% LF) Meghalaya (81-67% at 60% LF) Nagaland (71.67 at 60% LF) and Assam (90.83% at 60%LF) in the Brahmaputra valley in both economic and technically feasible condition.[9] These north-eastern states of the Brahmaputra valley not getting any sign of possible harnessing for power generation.

Central electrical authority and central water commission has selected several rivers for the construction of mini multipurpose project for harnessing the power and development of irrigation water in the

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[8] Brahmaputra Board, Brahmaputra Master Plan, Vol.I, 1986.

[9] I CWC annual report 1997.

Brahmaputra basin. Among them Dihang, Subansiri, Ranganadi in Arunachal Pradesh; Kopili, Karbi Lungpi, Pagladiya in Assam; Buri Dihing, Dansiri in Nagaland. Dihing, Subansiri and Pagladiya are among the largest having the installation capacity about 20000 mw, 4800 mw and 550 mw respectively. For all that construction site for Dam lies in the upper reaches of the rivers to get facilitate do sharp gradient and huge reservation.

The north Eastern India is hilly and mountainous. These area are sparely populated and accessible to remote corner is difficult. Infrastructure like road, railways are totally underdeveloped. Urbanization and industrialization is in poor stage. But these area are fortunate in having numerous water resources as mentioned in earlier chapter, which is contributing 30% of total Indian's water resources. But these resources are not adequately developed for the population of the North Eastern India simultaneously for rest of the people of India. Although energy demand especially from water resources is not such a dire necessity but energy planning should be given emphasis to look for alternative sources from non renewable to renewable source of energy for the future of the growing population in India, which has crossed already 1 billion.

The future demand of energy is estimated through the analysis of various variables like (1) growing population (2) scarcity of exiting energy

sources. (3) Economically and Technologically feasible (4) cost of generation of electricity and duration of the plants (5) management and maintenance efficiency of the plant for long term.

Central electrical authority has identified various river valley project in the Brahmaputra Basin. Instead of constructing huge multipurpose river valley project, Central electrical authority with central water commission and Brahmaputra Broad has emphasized numerous small and mini hydel projects in the Brahmaputra basin. The small hydel plants are divided into three classes.

(a) Small hydel plants – Those which are less than 15 mw installed capacity with individual limit ranging between 1 mw and 5 mw,

(b) Mini hydro plants – which are less than 2 mw installed capacity with individual unit capacity ranging between 100 kw to 1 mw.

(c) Micro hydro plants – Those which are less than 100 kw installed capacity having individual units capacity of a few kw to 100 kw.

The emphasis of small hydro electrical plants in North East India by these institution has several reason. These are (1) these plants less costly. (2) period of construction will be minimum which reduced the cost of the generation also. (3) lack of infrastructure will not permit to set up huge

plant, (4) huge plant submerged thousand of hectare area which will effect the environment, displace people and animal, destroy flora and fauna (5) less production consume locally otherwise long distance transmission will be big problem because of transmission loss and problem of huge investment to set up long distance grid and searching of market in outside region, (6) non availability of industrial market, which would be consume huge share of the production, (7) electricity is needed to run the entire 900 odd Tea garden in the Assam, domestic use for entire population (400 million in northeast India), irrigational facility for higher production, faster growth of industries and expansion of commercial uses.

JALAPARIBAHAN **– READYMADE HIGHWAY OF COMMUNICATION:**

Navigation is one of the oldest means of communication since the people started to move in early historical period in the world. It is a readymade highway which is used for communication across boundaries for trading various goods. Through this highway people discovered a lot of things on their way and set up big urban settlements on its courses. It helps to communicate and facilitates understanding among people across natural boundaries.

Waterways in the river Brahmaputra is the oldest occupation since people began to live across the river. Since then river ways has been used

for the trading activities, to communicate with other parts of the world to understand and develop this part of the subcontinent. This river has been used by people from various parts of the world vis-a-vis through present day Bangladesh and Myanmar to come and settle in its valley.

This river was extensively used by the Britishers to trade in this part of the world and they also used it for conquering the entire areas. Through this highway they brought huge machinery for exploration of oil and coal to set up huge factories for tea production in this parts of the world. Even recently for the construction of the Numaligarh refinery, huge machinery was carried through this river. It was his readymade highway through which American missionaries had come to propagate Christianity and ultimately these missionaries brought Assamese languages to the world's door step.

The people to go from one place to another since time has used this river. It has been the prime means of communication for both sides of the population. Even in the post independent India, people have been using it because (i) it is the cheapest form of communication (ii) Rail and Road are not properly developed in this part (ii) At some points Rail and road ways are totally impossible. For this reason, river ways is the only means to reach the destination. Sadiya and parts of Arunachal Pradesh are the

regions where river ways is the only way of communication (iv) It provides pollution free and traffic free communication. (v) River Communication has become a tradition for the inhabitants living along the river.

Use of various kinds of boats, is the product of the indigenous development of boat technology. It is dependent on the availability of Raw material along the river. In Tibet, Yak skin boats which are much lighter than general wood boats are used for upstream navigation. In Assam, small country boats made of a special type of wood are generally used for navigation. After the coming of the British, along with the country boat, steamer began to be used. Since then indigenous boat technology upgraded with foreign technology. With respect to the depth of the river steamers, feeder boats, ferries, and huge hovercrafts have been used for travelling, as goods carrier and for other such purpose. Statistics shows that Assam has the largest number of inland water boat compared with the other states of India. These boats are the life line of goods carriers across the river. It is extensively used in the places like Guwahati, Dubri, Goalpara, Tezpur Nimati (Jorhat), Dibrugarh and Sadiya to supply daily consumable essential goods like milk and vegetables. Also these country boats are used to reach office on time by passing long Journey of rail and road. It is the main communication line to reach Majuli, which is the world's biggest river island and Sadiya, which is in eastern most part of the India. This country

boat also extremely essential and useful to catch the fish in the river Brahmaputra.

Brahmaputra waterways declared as National waterways II in 1990 by the government of India. Since then government has been trying to develop the waterways as an alternate means of communication. The Brahmaputra is navigable has about 650 km in India out of 1000 km while rest is in the Bangladesh. To sum extent river is navigable in Tibet also. Its tributaries also navigable about 50-70 km from the confluence with he Brahmaputra to the upper reaches. Estimating altogether about 15000 km in the state of Assam, and West Bengal is navigable. Although river is navigable throughout the year, it is tedious to cross the river during the wintertime because of huge deposition of silt, which makes river shallow. Also in summer times it looks like a moving lake measuring about 4-7 km width in some places.

Navigation is very much necessary for the economic development in a state like Assam. It is because, it is cheapest form of communication, no maintenance expenditure, pollution free and traffic free. Also it consume less time, in comparison to the other mode of communication. In Assam only three Bridges are on the river Brahmaputra to cross from north to

south and vice-versa. People have to depend on these three bridges only. But it is very easy to cross by boat if it is properly developed.

On the other hand for the export and import of goods from the state, people are dependent on the highways and railways communication which is more time consuming, is costlier and risky. From Dibrugarh to Calcutta by rail and road it takes about 7-10 days for any kind of good carrier, which generally carry maximum 300 tons and 20 tons respectively at one time. But through this river navigation it is be possible to carry more than 1000 tones at a time. It makes goods less costlier which is generally costlier than the existing prices in other Indian states, because of the distance transportation cost.

Carrying huge machinery through Rail and Road is very difficult because of the soil content and rainy climate for the newly emerging industrial sites. For this reason it is only dependent on the waterways which can carry a huge load measuring to about maximum 1000 tones.

Although the river has potential to bear the huge load, in some places it is difficult for navigation due to deposition of silt, which makes the river shallow. For better navigational facility river should have a minimum depth of 10-15 metre. There is a need to be developed better kind of water-crafts, which have a maximum speed with respect to a particular

East and west flowing rivers of the country have a total catchment area of 3.12 million km and supports highly diverse fish fauna. The total length of the rivers and canals has been estimate 0.17 million ha are considered an important source of fish and prawn seeds. Chain of man made multi-purpose reservoirs estimated to be 3.15 million ha. According to FAO there are 2331 small reservation (<<1000 ha). And 16803 irrigation tanks covering an area of 1.49 million ha. There are 180 medium (1000-5000) and 56 large (>5000 ha) reservoirs covering an area of 0.53 and 1.14 million ha respectively.[12]

Catching fishes from the river, Beels, Lakes and Ponds are the very traditional practice since time in Assam. Natural environment helps in fish production in Assam. Brahmaputra and its tributaries are the big sources of fish production covering an area of 15038 sq. km. Above them more than 40 beels covering 100,000 ha area are providing breeding houses for fish . Inland fishes landing in Assam during the period of 1998 and 1999 was 2,217,12 and 242,156 kg respectively.[13] Out of the total inland fishes landing in the state more than 60% has generally came from other status like Andhra Pradesh, Bihar and even Delhi.

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[12] Ibid., p.39.

[13] Ibid., p.46.

India is bestowed with vast and varied type of inland water indigenous fish fauna. Due to diversity of natural resources, topographical and agro-climatical differences varying types of indigenous fish fauna are existing. In the Brahmaputra basin area indigenous *Rahu, Barali, Bahu, Cital, Ari, Pithia* and hundreds of small varieties fish fauna are available. These fishes are highly proteneous and testy due to availability of pathogen in higher amount in the Brahmaputra and its tributaries.

India is referred to as crap country because craps constitute the single most dominant group of fishes in the domestic market accounting for almost 70% of total inland fish production. The polyculture (composite culture) - system with three species of Indian major craps (*catla, rohu* and *mrigal*) and three of exotic carps (*Silver Carp, Grass Crap*, and *Common crap*). Helped in increasing the yield rates of coup ponds from 600 kg/ha/year under traditional practice to the present range of 3000 to 10000 kg/ha/year. In Assam, in 23 FFPA ponds produces average 1850 kg/ha/year fishes.

From the above discussion it is cleared that Assam is importing fishes from outside in major amount instead of having potential to produce in surplus amount.

Secondly whatever the fishes are produces in the state of Assam, major amount are produces in the Government FFDA ponds, various government leased beels, individuals captive small and medium ponds. A least amount of fishes are landed from the 15028 km long rivers in the state calculating all total fish production in the state about 80000 kg. which is 40% of total fishes landed in the state.

Thirdly state in spending hundreds of crore rupees for importing rests of 60% fishes consumed in the state, loosing a good amount of state revenue.

Fourthly neither government nor people non-other interested agency has attempt to utilise the vast resources of the Brahmaputra and its tributaries for the fish production.

Fifthly although fish is the one of the staple diet in the valley's population, neither government nor any other sources has attempt to modernise the fish breeding, hatching, rearing, catching method in the state of Assam. Sixthly although entire Assam has readymade market for fish, but it is not an integrated and modernise market. There is no provision for preserving the surplus fish for more than one day. Surplus production in a particular area and scarcity in another area is a regular phenomenon in the

state. Production centres are always do not get information facility to sell in appropriate price in the market place.

Considering the urgent need to enhance Inland fish production in the country, emphasis need be laid on a management of small irrigation reservoirs based on optimum stocking of suitable species and effective capture. Reservoir fisheries develop is must for a quantum jump in inland fish production in future as well as improving the socio economic condition of fishers of the country. Through this only Inland fishery resource whose hectarage is bound to go up with the increase in population and resultant development. This resource alone has the potential to yield 0.24 million ton of fish with modest target of average production of 100 kg, 75 kg. and 50 kg per hectare in large, medium and small reservoirs respectively, if managed on scientific lines.

On the other hand the flood plain also by virtue of their productive potential as well as magnitude, constitute one of the frontline areas capable of contributing substantially to country's fish production. Lack of proper management measures have reduced fish yield to 300 kg/ha/yr against a production potential of 1000-1800 kg/ha/yr, leaving a significantly wide gap between the actual yield and the nearest potential.

TOURISM - RECREATION IN WATER:

Development of Tourism in India and the world is a phenomena of second half of the 20th century. It was developed in the developed countries after the World War II. It was because of the rise of 'marketism' in the era of capitalism, higher per capita purchasing power in the developed countries, development of technology, communication through air, road and rail and the emergence of Hotel business etc.

In India it was started in 70's, particularly through historical monumental centric tourism. Like in Agra for Tajmahal and other Mughal architecture, Khajaraho for ancient erotic siva temple, Konark, in Bhubaneswar for sun temple, Jaipur and Udipur for Rajput fort and various places in South India for ancient and medieval temples. In later stage it was shifted to Natural vegetation like National parks, mountain hills, confluence of river and deep grudges etc. Tourism in Assam was started after the declaration of Kazirangha as a national park due to the presence of one horned Rhinoceros, only living Rhinoceros species in Asia. Later it was shifted to Ahom dynastic monumental structure after it was taken over by the archeological survey of India.

India is getting third highest amount of foreign exchange from Tourism, after Germs and Jewellerry and Readymade garments. In comparison to the whole of India, Assam is visited by a negligible number

of Tourists. This is due to the fact that Tourism is not properly and scientifically developed.

1. Road, rail and airways is almost in poor condition due to a lack of maintenance.
2. It is not scientifically studied yet.
3. Although Assam possesses scenic beauty, Natural vegetation, natural course of river and beautiful mountain ranges, yet it is not developed for tourism purpose.

Why Brahmaputra for Tourism:

The Brahmaputra has a potential to develop as a Tourist resort palace, water sports hub, natural swimming pool, riverine picnic spot etc. in along its courses and also in proposed dam site.

Particularly in the up stream reservoirs which is to become a huge lake, Tourism centre can develop. In that tourist centre water sports like Boating, water skiing, Rafting, boat race, can be developed. On the other hand to keep the Tourist is that particular place the hotel industry can be developed with proper ethnic and modern marketing system.

Along the river, particularly in riverine ports, Tourists centres can be developed in Dibrugarh, Sadiya, Nimati, Tezpur, Guwahati Goalpara etc. Particular Nimati is important because it links Majuli, which is the biggest

riverine island in the world. Secondly it is the cultural centre of Assam Where Vaisnavite culture is being performed in the various satras.

Along the river these places have significance in Tourism and marketing wise. Kaziranga National park, which is along the river has great importance for tourism purpose. Manas Tiger reserve forest (river name itself) is one of the habitation of the Asian Tiger and Golden Langoor. Like these other attraction for tourism are situated along the river. If tourism is developed considering the river as centric, then it would be a great benefit for the state of Assam and the whole India. River is the only nodal point to develop the Economy through Tourism in Assam.

It can be concluded from the above discussion that the Brahmaputra has vast potentialities to develop the Economy of Assam. If proper and timely investment money, energy and brain is done, the people of the state of Assam and neighbouring state as well as India would be benefited. The utilization of resources should be substantial and the effect would be sustainable through the harnessing of the Brahmaputra.

river. Carrying potential should be high, the docks should be built scientifically made for loading-unloading facility and other shipping activities.

Properly developed navigational facility can change the close economy in the state of Assam to a substantially larger open economy in a global context. If it is properly develop it may be become the life-line of the population.

FISHERIES: NATURAL HUB FOR POOR MAN'S FOOD:

Fisheries provides the fifth largest agricultural resource accounting for 7.5% global food production and is the chief source of food protein for common people besides providing economic livelihood for many. FAO projections in the document *Agriculture toward 2010* (FAO 1993) indicate that 91 million tons of food fish will be required in 2010 to maintain per capita fish consumption level of 13 kg per year. This would require an increase of 19 million tons of food fish over the 1993 level of 72.3 million tons.[10] In India since the launching of first five-year plan, the development of fisheries in the country has witness tremendous transformation from a highly traditional activity to a sunrise industry. Motorisation and

[10] FAO 1993 Agriculture towards 2010, p.320.

mechanisation of traditional crafts, introduction of modern fishing crafts and gears in marine fisheries led to a significant increase in marine fish landings from 0.53 million tons in 1950-51 to 2.3 million tons in 1990-91 Inland fisheries witness, introduction of composite fish culture.

Culture, change from natural collection of seeds to hatchery bred seed production, improved package of cultural practices, which led to significant increase in Inland fish production from 0.22 million tons in 1950-51 to 1.54 million tons in 1990-91. Thus the total fish production which was 0.75 million tons from both marine and Inland sector in 1950-51 rose to 3.84 million tons in 1990-91. Presently country produces 5.1 million tons of fish annually with 57 per cent of it coming from marine fisheries.[11]

India has vast and varied marine and inland fishery resources. The country has a long coastline of 8041 sq. km with continental shift of 504000 km. The marine resources are spread in the Indian Ocean, Arabian Sea and Bay of Bengal. The exclusive Economic zones of the country encompasses an area of 2.02 million km comprising 0.86 million km on the west coast, 0.56 million km on east coast and 0.60 million km around the Andaman and Nicobar Island.

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[11] Biradan R S and Thakur N.K. Fish Production prospects in India by 2020, in Abidi SAH et al., (ed.), Fisheries Vision in 21st Century, p.26.

CHAPTER – IV

DISASTER

The Webster's Dictionary defines a disaster as "a grave occurrence having ruinous result." The world health organization (WHO) defines disaster as any occurrence that causes damage, economic destruction, loss of human life and deterioration in health and health services on a scale sufficient to the wants of an extraordinary response from outside the affected community or area.

Definition and categorization of disaster vary according to geosectors the geographical and social things where they are located. Every new disaster adds a different dimension to human suffering. The realities that confront disaster affect communities in developing countries and often challenge conventional western academic definition.

In absence of official definition, observations from the field suggest that Disaster can be classified under three broad categories. Among these there are major disasters and minor disasters. It is not just the damage or destruction potential that defines a disaster as major or minor, but it also depends on its being reported by the media. For a large number of people in several states of India, more or less every disaster is major and occur almost constantly in every year.

Classification of Disaster

A. Natural Disaster

Major	Minor
Earthquake	Heatwave
Flood	Cold wave
Drought	Landslide
Cyclone	Avalanche
	Tornadoes.
	Hailstorm

B. Man Made Disaster

- Communal riots
- Ethnic conflict
- Refugee situation

C. Other Disasters

Major	Minor
• Epidemics	• Transport – Road, Air Railways and Water
• Industrial disaster	• Food poisoning
• Fire	• Festival and Pilgrimage related disaster
• Policy induced disaster	• Alcohol /liquor tragedies

India is one of the world's major threats of Disaster; both natural and human made. Flood, Drought, Cyclone and Earthquake occurred almost in every year. Communal riots, ethnic conflict, fire, epidemics and other Disaster compound the country into a chronic trouble.

In decade 1988-97 Disaster in India affected on an average over 24 million people and killed 5116 each year.[1] In 1998 Disaster affected 34,11,2,566 people in India and killed 9846. Between 1985 and 1995 Disaster caused an annual Economic loss of about US$ 1883.93 million.[2] No. of Disaster occurred in India during 1997 in various categories are flood/landslide 69; wind related – 30; Epidemics – 11, Earthquake – 6, Drought – 3 and others-13.[3]

Inundation by the Brahmaputra and its tributaries have been becoming a perennial disaster since a long time. It was recorded by the colonial administrators in 1769 about the inundation in the Assam valley, although in 1769 Assam was not a part of British empire. In 1786 there was re-occurrence of inundation in the Assam valley. Later it occurred in 1927, 1937, 1943 and 1950. But the enormous flood of 1953 in independent India saw a remarkable change in the policy and target of flood control began to be pursued with great earnestness. The first national policy in this regard was formulated in 1954.

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1 The World Disaster report 1999.

2 India Disaster report, 2000, p.5.

3 Ibid., p.6.

The Disaster cycle can be differentiated into five main phases.

- The warning phase - indicating the possibilities of a catastrophe and the threat period.
- The impact phase -when devastation occur.
- The emergency phase - when rescue treatment, salvage activities take place.
- The rehabilitation phase - when essential services are provided temporarily.
- The reconstruction phase, when return to normalcy is achieved.[4]

Flood-Chronic disease of the Brahmaputra Valley:

According to the International Commission on irrigation and drainage (ICID) Multilingual Technical dictionary on Irrigation and drainage define "flood" as

"A relatively high flow or stage in a river markedly higher than the usual. Also the inundation of low land which may result from there. A body of water rising, swelling and over flowing on land".

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[4] Ibid. p.7.

Causes of flood:

Floods occur due to a variety of causes in almost all river basins. The term floods as dealt with the following situation.

(1) Streams carrying flow in excess of the transporting capacity within their banks thus over flowing adjoining lands.

(2) Backing up of waters in tributaries at their out falls into the main river with or without synchronization of peak flood in them.

(3) Heavy rainfall synchronizing with river spills.

(4) Ice Jams on lands slides blocking stream courses resulting in a backwater overflowing river banks.

(5) Synchronization of upland floods with high tides.

(6) Heavy local Rainfall.

(7) Typhoons and cyclones.

(8) Inadequate drainage to carry away surface water with the desired quickness.

It would be observed that areas are also flooded when water due to rainfall or river spell is not able to drain off as quickly as considered desirable. This is consider drainage congestion and termed drainage problem.

Stagnation of water behind embankments due to insufficient capacity of drainage sluices falls in the same category. Excess water on the land surface could be the result of water logging or stagnation in the depressions and low areas. This can also be a result as seepage from canals, tanks and subsoil's from the higher ground. Floods are caused by excessive rainfall in river catchment area. Their magnitude depends upon the nature and extent of rainfall and characteristics of the catchment. It may be that a sporadic fall of even heavy rain may not produce flood in the plain. On the other hand this could cause flash floods in a hilly catchment.

The heavy spells of rainfall occur in India in association with the formation and movement of depression on cyclonic storms, which originate in the bay of Bengal and some times in Arabian sea, is the cause of flood in many areas. Most of the floods in India occur during the monsoon and are generally associated with the following weather situations.

(1) Tropical storms and depression

(2) Active monsoon condition

(3) Break monsoon retraction.

The tropical disturbances (storms and depression) often form in the Bay of Bengal and move across the country generally in west-north Westerly direction. They cause rainfall along their tracks which can be locally heavy

varying from 10 to 20 cm in 24 hours and may extends over thousands of square kilometer. If the disturbances are slow moving or stationary for a couple of days at any location, the total accumulation of rainwater may occur over a number of days and be enough to cause floods.

During the break monsoon period there is a general decrease in rainfall over the country. In such a situation, however rainfall increase over sub Himalayan Bengal and upper Assam, thus causing floods in the Brahmaputra and its tributaries lying in the North Eastern part of the country. Such break monsoon conditions sometimes last a couple of weeks resulting in heavy rains over the north eastern part of the country.

The important rain producing system of summer season are one the cyclonic storms, which forms in the Bay of Bengal. In the earlier part of the season the storms travel north or North East wards causing widespread and heavy rainfall in North Bengal and Assam.

Rivers rising in the Himalayas derive their flow from both rainfall and snow melt while snowmelt contributes a significant amount of the total annual flow. It has not so far been possible to assess its contribution to floods. Coming down the slopes of the Himalayas, which is a young geological formation and consists of friable soil mantle. These rivers carry a lot of sediment which affect river regime and damage land. When the rivers bring

down sand and result in silt accumulation in river beds causing high intensity flood.

In majority of cases flooding is caused by a river due to over spilling in its banks. This can be due to excessive precipitation combined with a inadequate channel capacity.

Over spilling can also occur due to obstruction in river courses or aggravation of the riverbed. The former situation arose in the Brahmaputra river after the earthquake of 1950 which caused extensive landslides and upheavals of land. Similarly the beds of a number of streams in Assam have also aggraded resulting the river courses being higher than the general valley which causes spreading of excessive from the river to its banks..

Flooding also accrue at confluence of streams when the main river is in high stage and backs up into the tributaries and areas inundated there about. Floods originate in the watersheds of rivers in the mountains and the plain. The rainfall on hill sides flow down along the slopes at great speed unless retarded as the sheet. As flow gathers momentum erosion sets in and soil is washed down resulting loss of productivity of land and increase the sediment content in the streams. Vegetation in the form of forest or plantation acts as a retardant of the sheet flow. Forest also provide leaf cover, which break the impact of the falling rain and reduce erosion. Roots of trees create condition in the soil texture which are conducive to percolation. Thus in areas under

vegetal cover, soil erosion is reduced and low floods are moderated. Deforestation and lack of soil conservation and watershed management are the causes, which contribute to flash flood and Soil Erosion. Earthquake Landslides, Shifting Cultivation, Road, Building Construction and such other phenomena and human activities are also the reason to erosion and sediment load in the river courses.

As a result of the 1950 earthquake the bed of the Brahmaputra river silted up by about three metre up stream of Dibrugarh. The Dihang the main river in Arunachal Pradesh silted up to as much as 6 metres. Extensive sedimentation in rivers has also led to large-scale bank erosion. The region is inter-spread with a large number of streams, which inundate the intervening narrow valleys. The riverbeds in some cases were higher than the surrounding valley land and any breach or spilling causes deep flooding in the valleys. Drainage also is a problem because the river levels are usually higher than the levels in the valley.

Thus the problem inundation in the Brahmaputra basin area are overspills, drainage congestion, bank erosion, landslides aggravation and changes in the river courses.

In the analysis of damage data statistics Assam ranks sixth in order of flood damage magnitude. According to the report of the state govt. all the (17) seventeen district of Brahmaputra Valley are inundated almost every year.

According to the Rashtriya Barh Ayog (1980) Assam has a total flood prone area of 31.15 Lakhs hectares which account for 9.4% of the country's total. The acuteness of the flood hazard in the state can very well be gauged from the fact that in the fiercest ever that occurred year 1988, a total of 46.50 lakh hectares of land including 13.35 lakh hectares of cropped land were damaged affecting 12.7 million people. In 8770 villages covering 17 district of the state. Besides, loss of cattle head was in the order of lakhs and that of people in hundreds.[5] (See Appendix I)

The Brahmaputra is ranked fourth among the large rivers of the world in terms of discharge at the month viz. 1983 m^3 per second.[6] It has a basin 580000 sq. km. in area of which Assam occupied 70000 sq.km. The Assam section of the river with an average width of 8 km, flows through a valley 720 km. and 80-90 km. width. Surrounded by an almost continuous chain of high hills and plateaus on the north, east and south. The Brahmaputra valley with the belts of active flood plains on either side of the river represents an area that is environmentally very sensitive and extremely hazard prone. Besides this valley and its adjoining area constitutes a highly active seismic region.[7]

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5 Goswami D.C., 1989, 'Flood and their impact on the agriculture of Assam in Goswami P.G. (Ed.) Agriculture in Assam, p.192.

6 Ibid., p.192, other rivers are Amazan 99.15, Congo 39.66 Yangtze 21.80 $10^3 m^3 sec^{-1}$

7 Ibid., p.192.

A significant feature of the flooding rivers in Assam especially those of Himalayan origin is the excessive loads of sediment carried by them. In fact among the large rivers of the world the Brahmaputra is second only to the Yellow river in China in the amount of sediment transported per unit of drainage area. At pandu, the Brahmaputra carries an average annual sediment load of about 400 million metric tones. During the rainy season (may through Oct), the river transports more than 95 per cent of the annual sediment load at an average daily rate of about 2 million metric tons.[8] The rate of soil erosion from the river basin in Assam is also exceedingly high. (Appendix II). The factors responsible for the phenomenal rate of soil erosion in the Brahmaputra basin include high intensity monsoonal thunderstorms, caxading flash floods and devastating landslides coupled with high susceptibility of basin nocks to erosion, steps slopes, high scismiciti and improper land use practices including deforestation and shifting cultivation.

One of the major factor responsible for the underdeveloped nature of the state's agriculture is the damaging impact of disastrous floods that recur almost every year. The extent of flood damage in agriculture since 1954 is shown in Table 4.1. It clearly indicate that the losses due to flood have increased manifold over the years in the state. As against an average annual flood damaged crop area of 1.1 lakh hectares during 1954-58, the corresponding figure for the period 1984-88 is 6.3 lakh hectares. During these

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[8] Ibid., p.194.

two periods the sizes of population affected by flood were 4.9 and 59.8 lakh and total values of crop damaged 3.83 and 234.1 crores of rupees respectively.[9]

As much as 75 per cent of the flood loss in Assam is accounted for crop damage. The extent of crop damage depends on the time of occurrence and frequency of the flood. Crop damage in 1996 and 1998 in Assam in respect to area was 200 lakh hectares and 2.89 lakh hectares respectively. It is signify that in just two years it was increased about 89 thousand hectare area. Out of 23 district in Assam 17 were affected by the flood in 1980 (RBA) but later it has increased to 21 district affecting about 5292 villages covering about 4.699 million population and 0.972 million hectare are in 1998.[10]

Managing the Disaster:

The magnitude of the natural process operating in the region makes it imperative that the methods to tame the rivers are to be bold and scientific in concept, comprehensive in nature and suitable for rapid implementation. The solution must unavoidably be costly. Total elimination of floods is not desirable because they make the land fertile. Further more, the supply of surface water in these innumerable perennial rivers is a great asset which should be utilised as fully as possible.

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[9] Ibid., p.176.

[10] Roy, Dunu, 2000, Flood, *A small mater of history*, India Disaster Report, p.,150.

Table 4.1

Flood Damage in Assam

Year	Area affected (Lakh hectares)	Cropped area damaged (Lakh hectares)	Value of crops damaged (Lakh rupees)	Population affected (Lakh).
1954	29.00	3.05	1175.14	13.00
1955	13.50	0.73	238.43	1.77
1956	5.13	0.69	254.55	2.71
1957	3.95	0.25	100.71	3.16
1958	12.29	0.59	144.33	4.04
1959	7.58	1.44	486.59	11.72
1960	4.68	2.21	762.92	13.22
1961	1.69	0.13	29.90	2.21
1962	15.95	3.61	1848.57	39.08
1963	5.67	0.74	197.40	8.80
1964	6.02	1.23	238.07	7.65
1965	3.22	0.24	88.56	2.58
1966	15.11	3.69	2149.04	36.24
1967	2.45	0.88	133.44	4.50
1968	3.76	1.25	801.40	8.35
1969	10.63	0.69	335.73	8.90
1970	7.58	2.26	1042.52	18.51
1971	3.48	1.12	469.88	6.59
1972	9.97	3.59	2221.41	29.52
1973	23.09	1.64	1440.04	18.47
1974	N.A.	N.A.	1366.11	N.A.
1975	1.24	0.17	124.55	2.32
1976	2.52	N.A.	865.13	4.40
1977	10.24	N.A.	2664.00	45.49
1978	3.06	N.A.	393.00	9.17
1979	6.73	N.A.	2614.00	23.51
1980	10.60	N.A.	3237.00	33.59
1981	4.57	N.A.	701.00	13.58
1982	68.85	N.A.	469.00	14.24
1983	6.95	N.A.	1032.00	21.21
1984	9.36	3.57	4899.00	38.79
1985	6.46	0.82	8290.00	23.66
1986	4.26	3.22	33,867.00	23.45
1987	25.73	10.70	36,859.00	94.60
1988	46.50	13.35	33,410.00	126.77

Sources: Goswami D.C.

Embankments:

Through out of the oldest and easiest methods to confine the flood water to the river bed is by raising its banks, the harm caused hereby in the long run is either not generally realised or ignored altogether. There has been a great proliferation of these purely short term measures in the state, especially after the formation of the national policy of flood control in 1954. Assam now possesses 4134 km of embankments out of the country's total of 13500 km. The ill effect of these piecemeal type measures on the regime of the rivers are visible everywhere in the shape of aggraded river beds, reduction of their conveyance capacity and intensification of the flood hazard. Long term measures for management of floods through erection of multipurpose reservoirs and adoption of sound watershed management practices especially in upper catchment area will definitely go a long way in reducing the intensity of the present hazard and ushering in a new era of progress and prosperity.

Flood due to erosion of levees:

Each time the stream over flows its bank. The current is checked at the margin of the channel and a part of the load of materials is dropped there to build up a low embankment or levee. The natural levees of the Brahmaputra and most other Assam's rivers are typical examples. The highest part of the

plain being along the bank of the river from where the land slopes almost imperceptibly downwards. The levees of the Brahmaputra may be several miles wide and up to 12 feet high. River breaks through the levees and brings disasters to enormous areas lying beyond. Many Assam floods are not due to over flow but to lateral erosion of banks.[11]

The levees or the embankment built to obtain increased protection can check flood locally, but they accentuate the tendency of the river bed to rise and thereby increase the danger and devastation from floods to a much greater extent. Embankments moreover greatly upset natural drainage.

Channel Congestion:

The increase in the severity of floods in the Brahmaputra valley after the great earthquake of 1950 appears to be due to congestion of river beds. Landslides initiated by the earthquake formed temporary dams across rivers. Subsequent bursting of the dams caused great floods and as an aftermath enormous volumes of silt were deposited in the downstream regions clogging these river beds almost permanently, so much so that a slight increase in the level of water causes the rivers to overflow their banks.[12] It is likely to be more effective in case of the Brahmaputra not deepening the channel

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[11] Baruah B.B. Flood and Erosion control in Brahmaputra Valley by making use of natural features. Indian Journal of Power and River Development, December 1970, p.496.

[12] Ibid., p.496

containing perennial water, but removal of sand for, most of which are high and dry for at least half the year.

Storage Dams:

One of the most effective remedies against floods is storage dams. But construction of high dams in a region tectonically unstable and subjected to severe earthquake. Which can be solved only at a very high cost. The foot hills often provide good sites for locating dams, but such areas near the Himalayas, the Naga-Patkai ranger and the Assam plateau are marked by well known Faults.

Alternative Cannel:

B B Baruah has given alternative methods for controlling flood in the Brahmaputra valley, which are primarily based on the principle of using the natural features as extensively as possible. The objectives are:

(1) To reduce the discharge of the river Brahmaputra by diverting a part of the water through additional water ways developed within the valley.

(2) To interconnect the rivers by possible canals for diverting excessive water.

(3) To stagger the flow through places vulnerable to flood either by making it to pass out quickly or by holding it back in reservoirs built in the plains.

(4) To disperse flood water and silt by controlled flooding and upland agriculture areas in terraces.

(5) To improve the drainage and flow condition of the water in the rivers including the Brahmaputra.[13]

Manas Mahananda diversion:

The idea of linking up the Brahmaputra drainage system with that of the Ganges by a navigation canal was first suggested by DN Barbora. Such a link will be easy if water is trapped near the foot hills of manas river in western Assam and drawn to Mahananda in North Bengal by a 165 mile long canal. The canal is expected to have a natural gradient almost up to Teesta but about 19 miles between Teesta and Mahananda may need a few feet of additional digging. The head of this canal can even be extended 31 miles eastward to draw water from the Pagladiya river as well.[14]

Barrage at Kobo:

The topographical features suggest that a multipurpose barrage can conveniently be built across the Brahmaputra near Kobo in order to develop the Saikhoa though for storage. The barrage beside storing water will help in

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[13] Ibid., p.496

[14] Ibid., p.497.

increasing the velocity of the stream just before it enteres the valley. Through this barrage will protect Dibrugarh Town.[15]

Other Diversion:

A 70 mile stretch of the Dhansiri river with a deep meandering bed and extremely low gradient (1:14256) can then be used for storage. To which water from Dikhu and Bhogdai can be drawn by 68.4 mile canal, which will save Johrat and Sibsagar town. Flood in the Kopili valley can be checked by storing water in reservoirs area (118 miles) to be developed in depression marked by innumerable beels between foot hills and the levee of the Brahmaputra, which can protect Nagaon and surrounding area.[16]

Flood in the pagladiya can possible be control by diverting its water with only 4 miles of canal to neighbouring rivers and to storage basins (only 153 sq. miles) proposed to be developed in the depression rear Barpeta.[17]

The canal system and the gates on tributary rivers will provide means for dispersal of flood water in relected upland agricultural areas to check floods further down. The major part of the silt carried by the diverted water will settle on the inundated areas, thus reducing congestion of permanent water courses and raising parts of the valley. Crops are not expected to be

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15 Ibid., pp.497.

16 Ibid., pp.498.

17 Ibid., pp.498.

damaged because the water will spread in a shallow sheet. The deposit left behind should normally increase the fertility of agricultural lands which do not usually receive much flood water.

Removal of Meanders:

Meanders of rivers flowing in sort materials and in a valley of little slope cause more harm than good. Besides causing erosions, the velocity of the stream which is already low the plains, is reduced further by the repeated meanders. This is turn leads to deposition and clogging of the river bed. Removal of meanders can increase the velocity and reduce sedimentation.[18]

Removal of Sand bars and islands:

Studies based on survey of India maps published prior to 1950 showed that the total area of sand bars and island in the Brahmaputra between Kobo and Dhubri was 31.3 million acre feet, representing nearly 46% of the bed's total volume of sedimentation. The average cross sectional area of the waterways as existed prior to 1950 found to be 343,000 sq. feet.

An O indirect method of estimation indicates that the depth of the bed has on the average been reduced by at least 5 feet after 1950. About 5 million acre feet or roughly about 11500 million tons of sediments will have to be

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[18] Ibid., pp.499

removed from the bed between Kobo and Dhubri if its capacity is to be restored to pre 1950 levels.[19]

Erosion

The Brahmaputra has braided channels in most of its traverse through plains of Assam. Due to excessive sediment charge there is constant shifting of these channels and formation of sand shoals. The flood discharge and sediment charges of its numerous tributaries, also influences the formation of these channels. This process of constant shifting of the river has been continuing through ages.[20]

The river has a tendency to shift laterally as can be observed clearly from the changes in the outfalls of its various tributaries. Near their outfall normal flow parallel to the Brahmaputra. The lateral movement of the river in a southerly direction has the effect of shifting outfalls of these tributaries eastward. For instances Dibrugarh as its name implies, was situated on the Dibru river. The confluence of the Dibru and the Brahmaputra used to be about 6.5 km, downstream of the town on the later part of the last century. Now it is about 13 km. upstream of the town.

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[19] Ibid., pp.500.

[20] Brahmaputra Broad, Brahmaputra Master Plan, Vol.I, 1986, p.146.

Besides this lateral movement the river attracts it banks sporadically through active erosion. There is considerable loss of land each year through their process of erosion. The extent of loss due to erosion in the valley varies from year to year depending on the severity of flood.

Due to copious rainfall and sufficient soil cover, the hill slopes in the region are generally well covered with forest. Along the foothills there exists a fairly wide belt of forest and thick grass which helped against soil erosion.

In the plain area also have the problem of erosion in the form of sheet erosion and gullies, which is rampant. This is more prominent on the north bank of Brahmaputra where the terrain has a slope of 1 to 5 per cent towards the river from the foothills. Since the soil in this area consist of no cohesive material of variable depth with long continuous slopes where erosion is extensive.[21]

Modes of Bank Erosion:

Sediment gets into the river not only from the catchment area but is also contributed the erosion of its banks. Causes of erosion of river banks due to the following reasons: [22]

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[21] Ibid., pp.148.

[22] Ibid., pp.161

1. Underwater erosion along the toe of the bank during the falling stage of the river.

2. Direct erosion of the riverbank.

3. Sloughing of saturated banks caused by rapid drawdown.

4. Liquafaction of saturated hilly and sandy bank materials.

5. Erosion due to sepage from banks at low river discharge.

6. Scour along waterline due to wind or wave wash of passing vessels.

Erosion Control:

Diversion of water through canals, impoundage by barrages and mid river coffer dams can check erosion generally. But local measures will be needed. Remady for erosion is often to be found not at the actual point of attack but several miles upstream or downstream. Most of the places where vigorous erosion is going on are associated with sharp south ward bends of the Brahmaputra on the upstream side and construction on the downstream side. The bend causes a major deflection of the current to the south bank and the constriction. Impounds water to an extent which cannot be contained within the bed of the river. The surplus water is trying to accommodate itself but on course widens the bed by eroding the weaker south bank. Removal of

constriction and preparation of the bed may provide an alternative method for erosion control.[23]

Bank erosion will be prevented, as the lateral impact of impounded water will not be significant. The reservoir basin can also help in restoring the imbalance between the weaker south bank and stronger north bank

Drought:

Water scarcity on both the causes and the effect is the most visible attribute of drought. It is occurred whenever and whatever the links in the water cycle are broken or destabilised. The government of India's meteorological Dept declares drought in the meteorological subdivision where annual rainfall has been less than 75 per cent of the normal. Severe drought is declared in years when rainfall has been 50% below normal. This data based on annual average rainfall but does not take into account on the seasonal distribution of rain.

Nineteen percent of India's total are a with 12 per cent of its population is considered drought prone. India has faced drought in 1966-7, 1972-3, 1979-80 and 1986-87. In each instance food production fell below the national average. There were large scale losses through starvation,

[23] Baruah B.B., Dec. 1970, Flood and erosion control in Brahmaputra Valley by making use of natural teatives. Indian Journal of Power and River Valley Development, p.501.

depletion of assets and livestock and high mortality. In 1987 over 267 districts where 166 million people were recorded drought affected.

In meteorological subdivision of Assam where drought generally occurred in every 15 years. Recently it was occurred in three districts of Assam namely Jorhat, Karbi Anglong and Dhubri where normal rainfall generally taken place 1159, 1901, and 1929 mm respectively, but in 1998 it was 1800, 604 and 1409 in Jorhat, Karbi, Anglong and Dhubri which are -31, -36 and - 68% less than the normal rainfall.

Due to drought, crop failure produces minimum production which trigger famines. The purchasing power of the affected population fell drastically. The affected population under distress, sales of assets, migrated or subsisted on forest produce. Not every one would be equally affected by the scarcities. Drought chose its victims from the lowest rungs of the socio-economic hierarchy.

Although drought is a major national disaster but it is not an major as for Assam in comparison to Orissa, Rajasthan and Gujarat. In Assam valley it generally occurred 10-15 years gaps. Particularly during the winter season due to North east monsoon which carries dry air contact with western disturbance.

National remote sensing agency identified particularly three districts of Assam, where ground water table are much lower than the other districts.

These are Jorhat, Karbi Anglong and Dhubri where drought occurred in 1987.

Therefore drought is as much as natural process of ecological imbalance as it is a human process of marginalisation, a national disaster as much as a demographic one.

From the above discussion it is clear that the Brahmaputra causes various types of disaster to the people inhabiting along its course and its tributaries, effecting the economy, society, politics and aspiration of the population. To manage this disaster, there is a need for a long term permanent solution, which could be possible through an integrated planning on behalf of the government, NGO, policy maker, academician and local level. Same as well as to manage the disaster needs a scientific study with proper data analysis.

APPENDIX - I

DEMAGE CAUSED BY 4 WAVES OF FLOOD IN ASSAM 1988:

	Total area affected (lakh hec)	Population affected (lakh nos.)	Crop damage area affected (lakh hec.)	Quantity (lakh tonns)	Value crore
Dhubri	3.9	22.2	1.0	17.9	25.8
Goalpara	3.6	8.8	0.3	.8	6.7
Kokrajhar	1.9	3.8	.2	.4	6.1
Barpeta	4.3	13.6	1.2	2.1	29.0
Nalbari	2.8	5.7	1.0	1.8	24.2
Kamrup	3.5	16.5	1.0	3.4	46.8
Darnang	3.2	3.2	.7	1.1	15.4
Sonitpur	2.9	2.5	.6	1.1	15.8
Nagaon	7.3	25.5	2.4	4.1	58.9
Golaghat	2.2	1.7	.5	.9	13.2
Jorhat	3.4	6.4	.7	1.2	17.1
Sibsagar	2.2	2.5	.4	.8	10.5
Dibrugarh	2.6	4.3	.9	1.6	22.4
Lakhimpur	3.9	10.7	.9	1.6	21.8
Cachar	1.8	2.7	.4	.7	9.4
Korimgang	.9	.8	.4	.6	8.8
Karbi Anglong	.3	1.2	.1	.2	2.5
NC hills	.004	.003	.004	.01	.09

Source: *Gowsami D.C., 1989.*

APPENDIX II

RATE OF BASIN EROSION OF THE BRAHMAPUTRA AND FEW SELECTED TRIBUTARIES.

	Drainage area km^2	Average rate of basin erosion
Dihang	12120	3765
Lohit	22077	1960
Subansiri	27400	959
Jia Bharali	11300	4721
Puthimari	1187	2887
Pagladiya	383	1883
Manas	36300	1581
Buri Dihing	4923	1129
Desang	3950	622
Dhansiri	10240	379
Kopili	13556	230

Source: Goswami D.C., 1989.

CHAPTER V

HOPE FOR FUTURE

From the earlier three chapters it has been cleared that for the harnessing of the Brahmaputra, there is a need for an integrated planning for the Brahmaputra basin area.

The integrated planning for the harnessing of the rivers is the planning where every aspect of the river is to be discussed, incorporate planned and developed basin wise with an integrated aspect. It has various dimensions. These are:

1. For Harnessing River, River should be treated as basin wise single entity.

2. River's potentialities should be explored and developed for better future. A river has various potentialities, which should be developed at the point only through multi purpose Dam. It can generate electricity, enhancing irrigation potential for higher food grain production, cheap communication through navigation, high production of fish, increasing per capita income through enhancing the economy. Also integrated planning helps to provide drinking water, promote tourism industry in the Dam site in the upper reaches of the river which has generally has scenic beauty.

3. The disaster is created by the river due to changes in courses, shallowness of bed, erosion of soft alluvial soil and also dryness of the riverbed.

Physical disaster generally led to economic, political, social and even psychological disaster. Hence forth integrated planning for controlling the Disaster is necessary, because it can look at every aspect of the Disaster. Before emergence of concept of integrated planning, flood is been controlled through construction of long embankment which is not in scientific as well as long term solution for the flood problems.

4. Through harnessing for future generation, measures also should be used to manage the disaster.

5. While harnessing its potentialities and managing the disaster, one should look the often affect of harnessing the river e.g. Displacement and Rehabilitation trauma, soil salinity, environmental degradation deforestation and seismic hazards.

6. Basin wise integrated planning needs a better coordination and cooperation between the various government dept NGO, local population and media. It also should be highly transparence in their planning, implementation managing and future benefit.

The basic objective of this discussion is to make an integrated planning for harnessing the vast potentialities of the river Brahmaputra. It can be through construction of multipurpose Dam in various places which are already identified, surveyed in the main course of the river and in various tributaries. Integrated planning is the planning through which maximum

benefit can be gain instead of less loss of flora and fauna, less loss of submerged village and town areas, less displacement of human and animal population, and causing less disaster through flood, erosion etc.

Necessities of Integrated Planning in the Brahmaputra basin area:

Very objectively from the earlier two chapters, integrated planning for the harnessing of the river Brahmaputra is necessary for the following reasons.

1. Very essentially and wartime emergency Brahmaputra and its tributaries should be harness for controlling flood which has been regularly occurring since 1954. Estimating lost about total more than 5000 crore rupees, irrespective of loss of human and animal population. It also led stagnation in the economy during the occurrence period of flood, making disaster in economy through high price rise, non availability of flood grain disruption of communication etc. Flood also helps to make political disaster for the ruling party due to losing popular support. In Assam Opposition parties take the opportunity to blame the ruling parties for not properly managing flood relief programme and permanent solution to the flood. During the occurrence of flood hue and cry is created for permanent solution to the flood problem in the Brahmaputra basin area but after that people and political parties resort to hypernation.

Flood also created social disaster during the time of the flood. People in Assam are generally rehabilitated in relief camps for time being. But in

district like Demaji in upper Assam where flood water created havoc to the population in annual basis, this relief camps now become almost permanent. People generally stays in these camps almost eight months in a year after losing everything from home to the material properties including their relatives. During there stay conflict has arised due to differences of opinion in various field e.g. Relief method, relief material, discrimination in distribution etc. Differences also arise due to differences of various communities living style and aspiration. Which has lead to the small-scale mob violence to big riots. This violation sometime leads to killing of the people and also destroying their shelters.

This socio-economical disaster created a psychological fearness among the people in their life time for the flood. The trauma which they bear due to displacement from their original home leads to psychofobia about their loss of property, relative etc.

After seeing all these disaster that is created by the Brahmaputra through Flood, it is come to a conclusion that for controlling flood as suggested by different author (see chapter IV) is not enough. For that an integrated planning for controlling flood through harnessing the river is necessary for these purpose. That integrated planning for harness is not only for controlling the flood but also getting other benefits as maximum as on economically and technically feasible ways. These benefits are:

2. As told earlier that higher needs of food grain production is necessary for growing population in the state of Assam. For higher growth of food grain production needs high yield variety of seeds (HYV), Fertilizers, pesticides and very essentially irrigation water, which can be provided through harnessing the Brahmaputra only. For the development of irrigation projects, identification of the location, method of channeling irrigation water, quality of irrigation water, pricing of irrigation water is needed an integrated planning.

3. As the Brahmaputra basin has 34000 mw generation capacity of 60% load factor with 59000 mw installation power, but only 700 mw will be able to generate at the end of 2000 with an installation capacity about 1350 Mm. The basin area always facing lack of enough electricity for consumption in the domestic, agricultural manufactured and industrial sector, which has been fulfilling through thermal electricity production. Although it is non-conventional renewable energy sources which can generated at a cheaper rate in comparison to other generation but still proper attention has not given to this sector.

Generation of hydel electricity in the Brahmaputra basin has some difficulties. If properly manage and suitable technology applied than it can be cheapest form of electricity generation. These are:

1. Generation site is located in remote corner which is mostly inaccessible and inhabitable.

2. Road and other type of communication is poorly developed.

3. Carrying huge machinery for the generation site is difficult.

4. Market for selling surplus production is limited.

5. Other problems are long distance transmission line construction needs huge investment, time consuming, loss of electricity on transmission, managerial problem etc.

Although having all these problem it is necessary to develops the hydel electricity project with the multipurpose dam for growth of industrialization in Assam and other states in north east India to speed up of Economic activities through manufacturing unit, agricultural development and communication through railway electrification etc. After that if surplus is generated than it can be exported to Bangladesh and Myanmar where electricity is in high demand.

4. North East India is look like a geographical entity in the Indian States. Which is linked through a corridor of 22 km breadth. Communication from any part of India to this land is very pathetic. Rail and Road communication needs to be developed. River communication which was the lifeline in the pre-independence period stopped because of the partition of India in 1947. In pre 1947, the entire North Eastern population had directs access to the sea.

Assam has 2253 km long national highway and 2482.59 km long railway line. These national highway has capacity to carry only 20 tons. Load, which is not properly developed and poorly maintained due to lack of fund. Generally, these highway are yearly damaged due to Flood Landslide, Bomb blast etc. Therefore Assam needs an alternative highway or express way to boost up the economic activities. These highway will also help to link Southeast Asia to exchange export-import activities. Same as well as railway line is more or less meter gauge which has less capacity to carry huge goods. These railway line has not connected all the trading centre with rest of India. Henceforth this trading centre has to depend either on Roadways or a river ways ways. Although all these mode of surface communication look like substitute to the another but is not.

Assam has six airports but is strictly for military and civilian passenger only. Not a single even Gopinath Bordoloi airport at Guwahati has not cargo and night lending facilities. It is obvious fact that Assam has to depend on road and railway for economic activities. For speed up of the economic activities with respect to the Global context communication especially in three sector has to be developed. If navigation facility in the Brahmaputra has developed then people of the valley as well as North Eastern India will get cheapest, comfortable, less time consuming Journey and cheap commodities due to less transportation cost.

5. Due to higher transportation cost price of the commodities that has been imported to the entire seven states will get reduced. These helps to make a common unified market with same tariff rate in the country. Same as well as if the transportation cost will cheap, subsidy which has been bearing by the central government since independent will reduced. It helps to control the fiscal deficit and also helps to invest the surplus money in different area for development.

6. Brahmaputra has always played a transition route to the South East Asia and South China till 1947. Before 1947 trading activities were take place to south China and South East Asia through the Brahmaputra up to Dibrugrah. After that trader took land route through Tinsukia, Digboy, Lekhapani, Pangasu Pass in Indo Myanmar Border to Bhamo which is in upper Myanmar. Bhamo was the main trading centre, which control trade route to South China, South Myanmar and North East India. Kunming is in South China, is an industrial centre and trading point controlling trade in entire South East Asia and South China and nearer to South China sea. British constructed steel well road during the world war II through this road to easy access to the Chinese territory. Now it is closed by the government of India for security purpose. If still well road will be opened after taking all security meanness, then entire Indian economy will be very accessible to the China and South East Asian booming economy.

7. Also much debated trans-Asian railway line if linked between Lekhapani in upper Assam and Seniku in northern Myanmar which is the northern point of Myanmar's railway connection, then it will link Tehran with Bangkok. It helps to make a common market zone connecting Central Asia, South East Asia, South China and South Asia. It also helps to explore the vast resources of North East India and Northern Myanmar where Economy is almost closed. If this link will be established cheap electricity which has to be produced from various multiple purpose dam on river Brahmaputra has get huge market to export. Also helps to the Indian population to get cheap manufactured items covering from electronics gods to silk from South China, and South East Asia. Therefore Infrastructure development in these area is necessity for the development of the people. Establishment of bridge between these, is the only gap between the development and under development. For that needs an integrated planning, political will, motivation of the people and above all needs a philanthropist.

What the People Will Get:

Properly and scientifically harnessed River Valley projects give us lots of benefits. Specially harnessing the Brahmaputra may give us much expected fruit for future generation.

1. *First* and foremost scientifically harness Brahmaputra can reduce perennial flood problem for forever.

2. *Secondly* it will help to boost up agricultural economy through extensive irrigation through the canal networking.

3. *Thirdly* it will help the state of Assam to become self sufficient in food grain production and also will help to produce more cash crops with more export potential.

4. *Fourthly*, it will help to generate hydel electricity in its cheapest form for consumption in domestic, in industrial, in manufacture and in agricultural activities. It will help to gain foreign exchange through exporting to neighbouring countries.

5. *Fifthly* surplus electricity will boost up economic activities through in industry and manufacture unit, irrigation activity etc. It will help to industrialise the region which is far behind in comparison to the other states in India.

6. *Sixthly* it will help to get cheap mode of communication through navigation. Also will help to get cheap commodities due to less transportation cost.

7. *Seventhly* if properly managed and developed river will be used on nodal point of tourism development. If picnic spot, holiday resort, moving hotel will be developed through both state and private

participation and investment in along the river, state will get maximum revenue through selling the scenic beauty of the mighty Brahmaputra.

8. *Eighthly* the Brahmaputra is the biggest store house of fresh water fish. In numerable of fish variety are found in the Brahmaputra, and its tributaries, lakes and wetlands. A proper and scientific breeding of fish in these wet areas will boost the economy as well as give enough food to feed the growing population.

9. *Ninthly* if the economy will boost, standard of living will rises due to rise of per capita income in the economic zone of the Brahmaputra covering north Bengal, entire North East India, Northern Myanmar, where Valley is the nodal point of all the economic activities.

10. *Tenthly* if the state will get maximum revenue which will help to invest in the social sector like health, education and community development in rural and urban areas. Then hopefully state will get less mortality rate, high literacy rate, high saving rate with high standard of living.

Modes of harnessing:

For harnessing a river for beneficial uses has various mode of harnessing. Construction of multipurpose dam in the upper reaches of the river is the most scientific and acceptable mode of harnessing a river. Other mode is construction of drainage channel, along the river making artificial

lake in the mature phase of a river for irrigation, fishing, generation of electricity etc.

1986 Brahmaputra Broad proposes construction of multipurpose Dam in the upper reaches of the Brahmaputra and some of its turbulent tributaries. Among them Dihang (main river in Arunachal Pradesh). Lohit, Dibong Subansiri, Jia Bharali, 'Pagladiya. Puthimari, Manas, Noadihing, Disang Dhansiri and Kopili for generation of hydel electricity, supply of irrigation water, control of flood, and enhancement of navigational facility. These river are selected on the basis of their geo-morphological advantages in their flow which is shown in the Table 5.1.

Table 5.1

	Run off (Mha M)			Storage (m ham)			Peak Flow	Catchm ent area	Distance of Dam site from Confluence	
Dihang	11.74	6.16	1790	1.15	3.55	4.70	29.643	247500	100	
Lohit	2.37	1.33	3.70	0.185	0.331	0.516		19100	23400	150
Dibang	2.33	1.66	3.39	0.15	0.47	0.62	11190	10350	12270	80
Subansiri	3.78	1.49	5.227	0.40	1.00	1.40	18799	2700	37700	95
Jia Bharali	1.82	0.77	2.57	0.14	0.51	0.65	9.939	9980	14450	120
Pagladiya	0.073	0.027	0.00	0.004	0.014	1733	570	1820	70	
Puthimari	1.77	0.073	0.25	0.03	0.40	007	861	1180	1787	70
Manas	2.96	0.86	302	0.20	0.72	0.92	70840	29400	38176	19
Noa Dihing	12.181	0.084	0.27	0.014	0.024	0.038	729	1719	2800	100
Disang	0.29	0.13	0.42	0.02	0.06	0.08	1093	1095	3950	65
Dhansiri	0.154	0.066	0.22	0.03	0.12	015	2296	2606	4550	60
Kopili	0.084	0.042	0.126	0.024	0.059	0.063		1256		

Source : Brahmaputra Broad, Brahmaputra Master Plan, Vol.1, 1986.

About Dihang and Subansiri Dam:

The Dihang dam site is located about 4 km upper stream of Rotung Village of Siang district in Arunachal Pradesh. The catchment area of the basin up to the Dam site of 247600 sq. km. out of which 235800 km lie in Tibet. The mean annual yield at the dam site is 17.9 mham (145 maf). The maximum and minimum discharge observed at Pasighat (50 km down stream of the dam site) one 29640 cum. and 1076 cum respectively.[1]

The Broad has proposed 296 m high rockfile dam across the Dihang, a chute spillways on the lift bank of the river and three surface power houses with a total installed capacity of 20000 mw comprising 40 unit 500 mw each on the left bank.[2]

According to the Brahmaputra broad proposal, the project is a multipurpose one and would afford large benefit of hydro power, flood control, navigation, sericulture and industrialization due to availability of cheap power which they has estimated in 1983 prices about 19.05 paisa/kwh.[3]

The proposed Subansiri dam is 257 high rock fill dam at 2.3 km up stream of Gerukamuch in Arunachal Pradesh with 12 unit of 400 km power station (4800 mw) install capacity. Specialty of this dam is that three head

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1 Brahmaputra Broad, Brahmaputra Master Plan, Vol.I, p.209.

2 Ibid., p.210.

3 Ibid., p.212.

tunnel of 15 m diameter will carry water to the left bank power station. The Broad has estimated generation cost for per unit electricity production in 1983 price was 21.22 paisa/kwh.[4]

Important things in two dams in comparison to other multi purpose project in India is that investment and generation cost is higher than these two dams at 1983 price. Which are:[5]

Name of the multipurpose project	Rs. per kw installation (1983 price)	Cost per kwh generation (1983 price)
Narmada	8390	46.20
Sardar Sarovar	7450	35.00
Dihang	4300	19.05
Subansiri	6392	21.22

Comparatively with other Indian multi purpose project both these project submerged less area, which is 490 km and 334 km in both Dihang and Subansiri in Arunachal Pradesh respectively. Both these project comparatively displaced less animal and human population in comparison to others. Estimated in 1983 figure that both Dihang and Subansiri will displaced about 35000 and 7500 population respectively covering 91 village and 3 towns and 13 village and one town in Arunachal Pradesh. Both the projects

[4] Ibid., p.215.

[5] Ibid., p.216.

submerged 377 sq. km. and 150 sq. km which is out of 51539.40 sq. km. of forest area in Arunachal Pradesh.[6]

Geo-morphologically the tributaries of Brahmaputra has potential for harnessing for varied purposes. Table shows that according to Brahmaputra broad projection the tributaries Lohit, Dihang. Jia Bharali, Pagladiya, Puthimari, Manas Nua Dihing, Disang Dhansiri and Kopili has tremendous potentialities for dam construction. Analysist observe that monsoon/non monsoon run off in million ha meter is much higher in these rivers than other Himalayan and peninsular river. Some storage Dam has capacity to store maximum quantity of water during the peak and lean reason flow.

The technique for he harnessing a river through Dam construction is not a new phenomenon in India. Although the recorded history of major dams in India dates back to as early as the 1700 when the Jalsmand Tank near Udaipur (in Rajasthan) was built, the era of modern day large dams began in the early 1930's. This was also the time when dams were considered the symbols of technological advancements and development in world. By the late 1980's India had more man 1500 large Dams. These dams, it was believed would do it all, provide electricity to meet growing industrial and domestic demands, control devastating floods and most important, provide irrigation

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[6] Ibid., pp.209-215.

and water to parched lands and throats. True enough they did provide employment and irrigation facilities.

Lands were acquired, people were displaced and deviated. But all this was in the interest of the nation and the spirit of "national good" and national development carried the people".[7] With the increase in population pressure on land increased, Relocation began to become difficult. At the same time there was a growing awareness of the disparity between the looser and the beneficiaries. Among them 40 per cent of these are tribels.[8]

Hirakud was the first major project under taken in independent India, work on which began in the 1940s. It is also an example of a dam in the Eastern part of the country over Mahanadi. Nagarjuna Sagar is an example of a project in the Southern Part of India undertaken in the 1950s over Krishna. It is also an example of what the Government claims as a successful rehabilitations exercise. Pong is a project in the north of India began in the 1960s over Beas. Although, construction was completed in 1974 the rehabilitation of its oustees is still not complete. It is also an example of an inter-state project. The Ukai projects over Tapti in the Western Parts of India began in the 1960s.

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7 Roy, Dunu 1985, Politics of environment in the state's India's Environment, 1984-85, the second citizen report, New Delhi, Centre for Science and Environment.

8 Government of India 1985, Report of the Committee on Rehabilitation of Displaced Tribals due to development propet, New Delhi Ministry of Home Affairs.

Like this there are hundreds of projects undertaken since independence for harnessing the water resources in India. some of these projects giving us minimum benefit through generation of hydel electricity, irrigation, enhancement of navigational facility, fisheries development, drinking water and over all generation of employment and up gradation water harnessing technology. Among them Damodar Valley Projects in West Bengal and Bihar over Damodar and Bhakra Nangal in Punjab over Sutlej is countable. It has been facilitating through providing electricity irrigation and drinking water, navigational facility especially for Calcutta etc. But on the other hand these successful projects has some negative aspects like, it increases soil salinity in Deltic region, submerged huge area which is the rich source of flora and fauna. And above due to these projects displacement was created of thousands of people, loosing everything from their land to the material properties including their own life. Detail picture of these has given below through four big projects developed in last 50 years in four sides of India.

Land acquisition for submergation:

To establish a storage reservoir land has to be acquired. For the contribution of Hirakud Dam reservation land was required under the land accession act 1894 for that all land feel on RL632 was acquired. According to available source total 1,67, 376.83 acres of submerged and 1,15,127,97 acres of good agricultural lands were acquired, Another source puts the total land

lost at 182, 592 acres of which 123000 acres was cultivate.[9] In Nagarjuna Sargar Dam also, the reservoir covering an area of 110 sq. miles stretches. According to Dam site office, it has submerged 29506 acres of agricultural land 1078 acres of government land and 147 acres of house plots and structures. A total of 26 village and 31 hamlets were submerged. A total population of 28000 were displaced.[10] The total land acquired under Ukai multi purpose projects or is spreading over two districts in Gujarat and one district in Maharashtra. A total of 170 villages were affected due to the project. The area of land acquired thus totaled 60802 hectares.[11] In Pong multi purpose Dam also for the reservoir land acquired about 71724 acres inclusive private land belonging to 3000 families comprising 94 villages and 15000 population.[12]

Due to the such type of land acquisition and displacement of population, people lost their land, house material property and sometime their own life also. According to the Government of Orissa, due to Hirakud dam 22,144 families were affected covering the population about 1.1 lakhs.[13] However as the area were inhabited predominantly by Gohds, it may be

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9 Pattanaik, SK et al undated Hirakud Dam Projects. Enpection and realities in participatory research in Asia, People and Dam New Delhi.

10 Dogra, Bharat 1984. The Indian experience with large Dams, et al. The social and environmental affect of large Dam UK.

11 Ganguly, Enakhsi et., 1992 Big Dam, Displaced People.

12 Ibid., p.105.

13 Ibid., p.36.

assumed that a large proposition of those displaced were tribals belonging to this community. In same way out of 170 villages affected due to submerged in Ukai multipurpose project, 100 village were fully submerged while the remaining were partially submerged. According to official estimates a total of 16080 families were affected by the project out of these of these 14148 families were rehabilitated in 17 groups of settlement whereas the remaining 1932 families moved away in their own after accepting ad hoc grants.

In Pong Dam also, displaced population was to be rehabilitated in the command area of the Pong dam which is in Rajasthan. The Himachal Pradesh government on its part ignored on behalf of the oustees.

The displaced family were generally rehabilitated in various rehabilitation camps. Generally this illiterate ousters were unable to realise that their village would submerged. The oustees were mentally unprepared for displacement and made little effort to identify alternate land in every projects. When they did begin to look for land they were left with very little time. Some were forced to vacate their houses, others moved to higher slopes close to their old village, knowing well that they would eventually have to shift to an area allowed by the government. This left them feeling both unsettled and insecure. The compensation offered was quite inadequate, considering the quality of land acquired. The acquired land was mostly fertile, enriched as it was by the silt deposited on the river banks. It was also well drained and

capable of yielding multiple crops even without irrigation or fertilisers and land holding tended to be large and viable. Against the land offered in return was far two inadequate to be economical. Apart from cultivating the deforested land in return, the oustees could also cultivate in the exposed bed of the reservoirs when the water receded from the banks in the dry season. By and large, the facilities provided in the resettlement villages were inadequate. Since no through socio-economic cultural survey of the oustees was done prior to rehabilitation, the result of this effort to help the government with rehabilitation was in some respects unfortunate. It is conceivable that the role of well meaning voluntary agencies in assisting the government with rehabilitation might change for the better.

The big dam issue has indeed become very controversial. The controversy becoming serious in respect of the Tehri and Narmada dams. Planner are under attack because of silence and indifference to sharing vital information with public. On the other hand environmentalist, the natural scientists and social scientist raise objections on discipline specific - ground. The various grounds on which the idea of big dams is being questioned in India are follows as the forest cover of the earth is receding at an ominous rate, environmentalist naturally worry about any development that causes deforestation. A dam can reduce forest cover in two ways. One, the reservoir behind a dam can submerge forest on the upstream side because the submerged area for a dam can typically vary from 5 to 15 per cent of the

irrigation potential created by the irrigation project. Two. the dam building activity can lead to removal of nearby trees for building projects, roads and housing colonies. The other ways of damage are:

1. Illegal feeling of forest trees in dam site.

2. Unauthorised ploughing of forest land.

3. Authorised allotment of forest land to dam oustees or the landless people.

4. Increased pressure from grazers as the village and the cultivable waste lands are dismissing.[14]

The environmentalist second major apprehension relates to land degradation due to watch logging and rising soil salinity within canal commands area served by the big reservoirs.

The social scientists, the social Anthropologist have never been at ease with one most bothersome aspect of the water related development process, the uprooting of population from the village submerged by the reservoirs created by damming rivers. Among them affected population are often sizable numbers of tribal population.[15]

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[14] Dhawan B D 1999 Big dam claims Counter Claims, New Delhi, pp.25-26.

[15] Ibid., p.28.

The controversy regarding big versus small multi purpose dams needs to be examined in its entirety in a multi-disciplinary approach and not in piecemeal manner as objections raised by Environmentalist, Ecologists Technicians, Economists, Sociologists, anthropologists etc. with the advancement of knowledge and expansion of its frontier. It is now possible to analyse and discuss the issues in developmental planning in all aspects from the long term perspective, so that the social out put could be increased by maintaining and preserving the natural resources and not at the cost of depleting these. It is against this background that there is an urgent need for an overall long term national policy for the efficient development and management of land and water resources in the country.

Seismic Hazards:

Entire North East India especially the Brahmaputra, valley is the earthquake prone zone. Nearly 6-8 medium range of Earthquake generally occur during every year, which is in Richter scale between 4.5 to 6: According to seismological science it is due to that:

(1) Entire North East India is in Gondowana land plate which is near to the Australian plate. Due to plate tectonic movement. Earthquake generally occur in this origin.

(2) The Valley is in the foothill of Swalik Himalaya, which is very much young in the sense of evolution. Due to evolutionary tendency these Earthquake generally occurred.

(3) Entire Arunachal Pradesh has red mountain soil which is less cohesive. Due to it landslide generally occur in these areas. It may be because of this Earthquake.

Although seismologists are trying to find the reason of occurrence of Earthquake but it is failure on the part of development of seismological science that it unable to predict Earthquake occurrence.

Proposed dams in the Dihang and Surbansiri will be rock fill dam. The rock fill dam is covered three sides by mountains and one side by concrete wall which is to be constructed and expectedly more than 150 m high.

Environmentalist is concern because of the nature of the reservoir. It is due to the soil condition, Earthquake proneness. If this rock mountain will create some hole or gap, in their natural structure then concrete structure will be collapse. If it will be happened entire valley will be swept away in flood current in a short time. Therefore constructing a dam in these high risks area is dangerous in long term. Only solution to this is that before constructing the dam a proper scientific study should be done to tackle the future problem regarding the Earthquake. Earthquake safety dam construction technology should only allowed to apply. Although it cost more but people should bear it for their safety in long run. Also a public awakening cell should set up to monitor the future danger, which also awaken the people about the earthquake.

Political Situation Prevailing in the State:

For the implementation of developmental projects, state should be stable in political, economic and social terms. Without socio-political stability, economic stability won't come. A socio political stability generally boost the economic activities for the development al purpose.

Through construction a dam in the Brahmaputra may boost the economic activities in the regions as told earlier. Construction a dam is a long-term plane needs huge investment, selfless-dedication on the part of the population. For getting this; needs a peaceful mind but in the state of Assam peace becoming a mere mirage in last 10 years. It is due to socio political upheavals. State, intelligentsia, academician, bureaucrat has no time to think for the future of the state. All the time knowledgeable people in the state is thinking about the prevailing situation and their measures to get the solution.

Although every body is thinking about very short time measures to handle the situation, no body is thinking about the future of the state. This is may be due to lack of visionary idea on the part of the population, and it may be due to the local population unconcerned attitude in what is happening in world and also due ethnocentric in their behaviour, thinking, attitudes and ideas.

Corruption:

Another problem in starting a big development project is high rate of corruption in the state. It is observed that from lower to lower official to

higher official everybody is taken bribe for any kind of small to small works. No body is doing their service as oblige service man. For development work like dam construction is a project of huge investment. If this type of huge investment started to flow, it is definite that every body will try to grasp the money by anyhow. It may be through increase the gestation period, land acquisition, clearance of government red trapisim etc.

We can get this type of experience from other Indian power projects like Error and Cogenitx. Even in Tehri and Narmada, corruption is in high stage. Power policies is one of the corruption which led delays in getting the benefits.

Therefore get the fruit through harnessing the Brahmaputra is a distant dream. There is a saying in Assamese that *Raije Nakh Jukarile Nai Boi* means that, if people desire and stands together, river can also flow in their wishes. People of India and especially people of Assam will get the cake if they backed it properly and scientifically backed it. For that needs only a single visionary idea and selfless dedication.

CHAPTER VI
CONCLUSION

The long existing debate, on the issue of the harnessing of the Brahmaputra has no one dimensional answer to its long back in 1986, the Brahmaputra board had proposed to construct two multipurpose dams in the rivers of Dihang and Subansiri. But to construct huge dams like Dihang and Subansiri has a set of relative problem, such as:

(1) For the construction of Dihang and Subansiri dams need, there is a need for huge investment of money, material and manpower. It also requires a time span of more than 10-15 years.

(2) There is no market to sells the generated surplus electricity in Assam and the neighbouring states.

(3) To export electricity, there is a need for huge investment for construction of long distance high voltage transmission line.

(4) To construct the Dihang and Subansiri dams, there is a need for well-maintained railway and roadways.

(5) Due to the construction of huge reservoirs, very rare species of flora and fauna would be submerged, which will to environmental degradation.

(6) If a proposed reservoir will be set up in Arunachal Pradesh and the benefits will be received by the people of Assam then an inter state conflict is bound to arise..

(7) The present political environment may not allow any type of big development projects.

(8) For such a huge investment, centre's initiative is necessary, because the centre is a nodal agency for doing research and investing huge money on India's river valley projects.

(9) Centre as well as other organisations do not want to invest huge money on this remote part. Even the centre does not give counter guarantee to multinational companies and other organisations for investment in such projects.

(10) For harnessing the river, state government initiative is also necessary.

(11) Finally for harnessing the water resources primarily there is a need for a data base resources which is not done by any level of government, academics for the river Brahmaputra.

Therefore my discussion about the harnessing of the Brahmaputra is an initiative on this direction.

What should we do for harnessing the Brahmaputra:

As told in earlier chapters that through harnessing the Brahmaputra, Assam may be economically developed. For that purpose, the river should be harnessed with a prospect to develop Assam and therefore planning should be river centric. As told earlier that the river is the lifeline of the surrounding inhabitants for that reason, planning should be integrated, concerning other aspects of river basin development.

On the project site, the planner should not emphasise on harnessing the entire potential at once. Like in the Dihang dam, total electricity generation potential is 20,000 mw. As the Brahmaputra board advises, it is divided into 40 x 500 mw power projects. Therefore right now it should be harnessed through one project. For that thousand of crores of rupees is not necessary and also a problem will not arise for the distribution and marketing of the excess power.

The reservoir will be the same, whether power is produced from one or several power plants. Therefore irrigation facility, fishery and Tourism will get expected opportunity to develop.

If power will be produced from single power plant it will solve the problem in many ways.

(1) Immediately it will solve the power crisis problem in domestic, industrial and agricultural sectors in the North Eastern States.

(2) Government will save money by not investing huge amount at a time for construction of power plants and high voltage transmission line.

(3) Immediately, the government need not go door to door from one neighbouring country to the another for selling excessive power.

(4) It will help government to maintain the fiscal deficit.

River basin development needs huge investment and long gestation period. It is very a ambitious project that needs an in detail analysis of cost and benefits. Whether the government or other private financial institutions invest money, it would not be with aim to do it as a social service. From their investment, they would want their due share in the long run. The Central and state government in both the Narmada and Tehri Projects is fighting over the cost and their due share on the benefit. These projects generally do not talk in monetary terms only, they talk about other benefits also, like for what ground these projects were started e.g. facilities of irrigation potential, hydel electricity generation at cheap rate etc. But after spending thousand of crores of rupees and 10-15 years of the time, it has been realised by that such plans are futile, and make such project debatable It is now evident from various river valley projects in India which are now almost in ruinous state that such projects are the live examples of wasting public money.

Therefore proper management of money, time, natural resources is to be guaranteed, if these type of projects is handed over to multinational companies. It is because these companies work will be in equity participation, with central and state government, local power finance organisations such as NTPC, NEEPCO, Power grid etc. These multinational companies generally watch under various organisations, e.g. finance commission, power commission, Judiciary, media and local population. For the sake of their own risk, these companies generally take less time for construction of these projects.

In reverse of these public sector power organisation has no accountability to any authority. Central and state government use them to show their power through this public sector undertaking. It is evident from the Karbi Lungpi power plant in Assam, which is under construction since 1977 ignoring everything by their various promoters during the years.

If multinational companies will take these projects on the basis of build, operate and transfer (BOT), after a certain time then hopefully the benefits will be received. These companies generally emphasise to construct the dams a shorter time to get maximum benefits. For them getting financial assistance from the various financial institutions in the world is not a difficult task, because of their deposits. But if the central and state

government initiate to get a loan for harnessing these river valley projects, then it is very difficult to avail of it because of other reasons.

Recently, the central government is trying to endorse a National water policy on the basis of establishing a statutory commission on the river valley development. This arouses a hue and cry among the states especially southern states about their share on water. More or less every state is opposing the centre's plan to make the commission. If the centre is able to make it, then the centre will be more powerful in controlling the water resources in India. Till today the state role is more dominant in regulating the sharing of water with another state on the basis of their catchment area. Henceforth it can be solved in the following ways:

(1) The centre should allow the state to establish a state statutory water commission for the state river

(2) For the inter state river, a regulatory authority which will look at the mode and modalities on the sharing issue should be create to look after such issues.

(3) For the international river, a joint commission among the co-basin countries should be constituted, especially in the case of the River Brahmaputra.

The state and central regulatory authority will be on under the perview of the Supreme Court Water Tribunal on water sharing. The international river is as it already under the helsinki declaration of 1988. Therefore, to harness the Brahmaputra, there is a need for an inter state statutory commission to settle the dispute between the state of Arunachal Pradesh and Assam and it also needs an international joint commission on sharing issue between India and Bangladesh for an integrated development.

It can be concluded by saying that it was a dream long years ago to study about the Brahmaputra. Now it is a dream to see and eat the fruit through its harnessing.

BIBLIOGRAPHY

PRIMARY SOURCE:

Agriculture Towards 2010, 1993, FAO.

Basic Statistics of the North Eastern region, 1998, North Eastern Council, Shilong, N.E.C.

Brahmaputra Basin, Studies of Geology in Brahmaputra Basin, 1972, Geological survey of India, New Delhi, Government of India.

Census of India, 1991, Census Commission, Government of India.

Central Board of Irrigation and Power, 1979, *Major Dams in India*, Indian National Committee on large Dam, Government of India, New Delhi,.

Central Board of Irrigation and Power, October 1979, *Registrar of Large Dams in India*, New Delhi.

Central Ground Water Board, April 1983, *Proceedings of a seminar on Assessment Development and Management of Ground Water Resources*, Ministry of Irrigation, Government of India, New Delhi.

Central Water Commission, 1988, *Water resources of India* Publication No.30/88, New Delhi.

Central Water Commission, April 1992, *Water and Related Statistics*, Statistics Directorate.

Central Water Commission, August 1975, *Guidelines for investigation of Major Irrigation and hydro electric irrigation projects* Government of India, New Delhi.

Central Water Commission, October 1981 *Report on the status of irrigation Development in India through major medium minor and CAD schemes*, New Delhi.

Ground Water Development in India, 1986, Central Ground Water Board, New Delhi.

Hand Book, 1997, Economic and Statistics Division, Government of Assam.

India's National Power Plan, 1985-2000, 1987, Central Electricity Authority, New Delhi.

Master Plan of the Brahmaputra Basin, Vol.I, Main Stream, 1986, Brahmaputra Board, Government of India.

Parliament Debate on National Disaster Vol.I and Vol.II, New Delhi, Oxfam (India) Trust.

Planning Commission, 1965, *Criteria for Appracining the Feasibility of Irrigation Projects*, Research Programme Committee.

Planning Commission, 1988, *National Water Policy*.

Planning Commission, 1992-97, *Eighth Five Year Plan*.

Rashtriya Barh Ayog, 1980, Vol.I and Vol.II, Irrigation Department, Government of India, New Delhi.

Report of the Irrigation Commission, Ministry of Irrigation and Power, Government of India, New Delhi.

Statistical Hand Book of India, 1997, Registrar General of India, Government of India, New Delhi.

SECONDARY SOURCE:

Assam Science Society, 1978; *Symposium on Harnessing the River Brahmaputra* Guwahati, A.S.S.

Biswas A.K. et. al., (ed.), 1983, *New and Renewable source of Energy*, Tycooly international Publishing Limited, Dublin.

Central Water Commission, 1998, *Annual Report*, New Delhi, Government of India.

Crow Ben et al., 1995, *sharing the Ganges Technology of River Development*, Sage Publication, New Delhi.

Dhawan B.D., 1989, *Studies in Irrigation and Water Management*, Common Wealth Publishers, New Delhi.

Dhawan B.D., 1998, *Irrigation in India's Agricultural Development*, Sage Publishing Co., New Delhi.

Goel, R.S. and Srivastava R.N. (ed.), 2000, *Hyrdopower and River Valley Development*, Oxford and IBH Pub. Co. Pvt. Ltd., New Delhi.

Guha S.K. and Sen Sarma S.B , 1986, *In Farakka A Gordian Knot Problem of Sharing Ganges water*, Shika. Calcutta.

Gupta S.C. 1999, *Participation, Report on Water Management in Developing Countries*, Central Water Commission, New Delhi.

India Disaster Report 2000, Oxfam (India). trust, New Delhi.

Kanwar J.S. (ed.), 1988 *Water Management The Key to Developing Agriculture*, New Delhi.

Kumar P.N; Gupta S.N. and Parthasarthy P.K. *State of the Art of River Training in Brahmaputra Valley.*

Majumadar S.K. et. al., (ed.) 2000; *Challenges in the resources and environment in the Next Millennium Need for Inter Institute Collaboration*, Touchstone, London.

Nigam P.S., 1999, *Hand book of Hydro Electricity Generation,* Rorkee, H.C., Bros.

Pathak M.T., 1991, *Sardar Sarovar Project,* Oxford and IBH Publication Pvt. Co., Ltd., New Delhi.

Prasad, K.K., 1980, *Hydrology and Ground Water Resource Development Perspective of Assam*, Central Ground Water Board, North Eastern regional branch; Shillion.

Raj K.N., 1988, *Economic Aspects of the Bhakra Nangal Projects* Asia Publication, New Delhi.

Rao K. L., 1979, *India's Water Wealth*, Orient Longman, New Delhi.

Serwant P.R., 1985, *River Dam Construction and Resettlement of Affected Village,* Inter media Publication, New Delhi.

Singh, Satyajit, 1997, *The Political Economic of Large Dam in India*, Oxford University Press, New Delhi.

Thapa B.B. and Pradhan B.B., 1995, *Water Resource Development Nepalese Perspective*, Konark Publication Co., New Delhi.

Vachney R.S., 1988, *Concrete Dams*, Oxford and IBH Publication Pvt. Co. Ltd., New Delhi

Verghese B.G., 1994, *Winning the Future*, Konark Publication Co., New Delhi.

Verghese B.G., 1992, *Harnessing the Eastern Himalayan River-Regional Cooperation in South Asia*, Centre for Policy Research, New Delhi.

Verghese B.G., 1999, *Water of hope - From Vision to Reality*, Oxford and IBH Publication Co., Pvt. Ltd., New Delhi.

Verghese B.G., et. al., 1994, *Converting Water into Wealth Regional Cooperation in Harnessing the Eastern Himalayan rivers*, Konark Publication Company, New Delhi.

JOURNAL:

Baruah, B.B., December 1970, *Flood and Erosion Control in the Brahmaputra Valley by making use of national features*. Journal of Power and River Valley Development, New Delhi, pp.495-502.

Binadar R.S. and Thakur N.K., 1999, *Fish Production Prospects in India by 2020*" in Abidi SAH, et. al., (ed.), \Indian Fisheries of 21st century;, CIFE Mumbai.

Charan A.S., 1983, *Impact of Irrigation on Agriculture*, A Farm Level Analysis; Indian Journal of Agricultural Economics, Vol.39, No.3.

Dhawan B.D., December 24-31, 1988, *Impact of Irrigation on Farm Economy in High Rainfall Areas*, The Kal Projects, Economic and Political Weekly.

Goswami P.C., *Flood and their Impact on the agriculture of Assam* in Goswami P.G. (ed.), 1989, Agriculture in Assam, Guwahati..

Gupta Harish K., 1984, *Seismicity in the Vicinity of Dams and Problems of reservior induced Earthquakes, Environmental Impact of Water Resources Development in Himalayan Geo Physical Aspect* Journal of the Geological Society of India.

Kothari Ashish, 1989, *Environment aspect of Narmada Valley Projects* Indian Journal of Public Administration, Vol.XXXV, No.5, July-September.

Pal S.P., 1984, *Contribution of Irrigation to Agricultural Production and Productivity*, NCAER, New Delhi.

Prasad, K.K., 1977, *Scope for Ground Water Development in North Eastern Region*, Journal of North Eastern Council, Shilong, Vol..III, No.1.

Vam Dev N. N., 1988, *Transport Requirement by 2000, A.D. and Role of IWT*, National Workshop on Indian Water, New Delhi, IWAI.