CHAPTER 8

GENERAL DISCUSSION

The Subansiri river basin is one of the largest sub-basins in the Brahmaputra river valley of Northeast India. The river Subansiri originates beyond the Great Himalayan Range (Central Himalayas) at an altitude of 5340 m. The length of the river Subansiri from its source of origin to the point of confluence with the river Brahmaputra is 520 km. The total downstream floodplain of the river Subansiri from the dam site at Gerukamukh to its confluence with the mighty river Brahmaputra is approximately 130 km. Throughout its journey from the Central Himalayas to the Arunachal foothills, the river Subansiri receives the water discharge from numerous big and small mountainous streams. The Subansiri river is the life line of the downstream inhabitants. It plays an important role to the distribution of terrestrial as well as aquatic biodiversity, agricultural diversity and socio economic aspects of local communities which live in the downstream of the Subansiri river, whose local economies are linked with the river system and the its associated wetlands (beels). At present, the NHPC has been engaged for the construction of the 2000 MW capacity Lower Subansiri Hydroelectric Power Project on the Subansiri river close to the Assam-Arunachal Pradesh border town of Gerukamukh in Dhemaji district of Assam. The height of the dam is proposed to be 116 metres and there will be 8 turbines of 250 MW each in the power station.

To know the key regulatory factors of water of the Subansiri river downstream, study was carried out on the parameters like water temperature, pH, current flow, transparency, dissolved oxygen, free carbon dioxide and total dissolved solids during the period from January 2009 to June 2011. All the physical and chemical parameters of the downstream of the Subansiri river water presented here represent optimum
conditions that would support many organisms. The values of water temperature at surface ranged between 28.2 and 12.6 with a mean of 20.41 ± 4.83. The Secchi disc visibility ranged from 19 to 80.7 cm with a mean of 43.10 ± 20.54 at different study sites. The mean value of dissolved oxygen was recorded 9.66 ± 0.76 mg/l. The highest value of free CO₂ (7.8 mg/l) was observed in study Site-C (Dhunaguri ghat). The values of pH in the river water ranged from neutral to alkaline (7.0-8.2) in all the sampling sites. It exhibited a narrow range of fluctuation throughout the study period. The mean value of total dissolved solids was recorded 163.93 ± 14.84 ppm. All the parameters are suitable for the growth and development of planktons and fishes. The physico-chemical characteristics of the river water in all the four study sites suggested that there was no harmful chemical contamination till now (Chapter 4).

The study of the aquatic macrophytes in the downstream of the Subansiri river ecosystem along with its ecotone region was carried out during 2009 to 2011. A total 71 numbers of aquatic macrophyte species were recorded in the downstream of the Subansiri river belonged to 33 families of angiosperms and pteridophytes. Occurrences of aquatic macrophytes in the main river channel are less due to its rapid water current than the open oxbows and the separated oxbows. In terms of the number of species, emergent plant species constituted the largest group (43 species) in the downstream of the Subansiri river ecosystem, followed by rooted floating-leaved, submerged and free-floating species. In comparison to amphibian plants, the number of pure hydrophytes in all the study sites in the Subansiri river ecosystem was less. This is due to the fluctuating water level of the river ecosystem throughout the year, as a result of which, while the hydrophytes cannot tolerate such fluctuation, the amphibians can adjust to such changed situation. Similarity indices revealed that in respect of the vegetation
covering ten study sites, the percentages of similarity were above 50% in 19 cases. The results highlight the differences in the vegetation patterns in response to different ecological conditions and the fluctuating water level of the main river channel and the oxbows. Oxbows of the Subansiri river had a high diversity of aquatic macrophytes, most of which grew profusely in the rainy season especially the submerged and the free floating groups, whereas emerged group grew profusely in winter season. The most frequent macrophyte in the Subansiri river ecosystem is *Eichhornia crassipes* which dominated in both the bank of the main river channel and the oxbows. The local people who are living in the downstream riverbank of the Subansiri river were interviewed and it was found that at least 34 aquatic macrophyte species were harvested by the local people. The riverbank people used 8 species of macrophyte as food, 18 species as fodder, 9 species as medicine and 12 species of macrophyte for other purposes (Chapter 5).

Primary production in an aquatic ecosystem is the rate at which energy is stored by photosynthetic process of phytoplankton and aquatic macrophytes. The productivity of any aquatic water body depends on the amount of planktons and aquatic macrophytes present in the said water body. Primary production depends on the density of various planktonic groups, availability of light and changes in environmental factors such as temperature, meteorological, hydrological, nutritional and biological characteristics. Spatial, seasonal and annual variations of primary productivity were studied during the period from January, 2010 to December, 2011 in the 130 km downstream of the Subansiri river. The values of GPP varied from 0.16 mg C/l/hr to 1.13 mg C/l/hr. The average GPP in all the four study sites was 0.57 ± 0.20 mg C/l/hr. The values of NPP varied between 0.12 mg C/l/hr and 0.43 mg C/l/hr. The average value of NPP in all the
four study sites was $0.26 \pm 0.07 \text{ mg C/l/hr}$. Community respiration (CR) in the four sites was ranged between 0.08 and 0.60 mg C/l/hr and highest was recorded in the month of June 2010 in the Jamuguri ghat. From the study in the entire downstream of the Subansiri river, it was observed that the values of gross primary productivity were found in following trends pre-monsoon>winter>monsoon>post monsoon. The trend of fluctuation of productivity shows that the values of GPP increased gradually during winter (December to February) and pre-monsoon (March to May) months and decreased during post-monsoon (September to November) months. The rapid water current during the monsoon period destabilizes the population size of algal vegetation could be one reason of lowering primary productivity (Chapter 6).

The socio-economic conditions, resource utilization and the livelihood patterns of the people depending on the downstream of the river Subansiri was also studied during the period from 2009 to 2011. From the study it was found that the downstream areas of the river Subansiri is dominated by the Scheduled Tribe (Mishing or Miri community) population, which was exactly 54 percent of the total population. Agriculture was the main occupation of the downstream inhabitants as it has been seen that 53 percent of the heads of the sample households were cultivators. From the study it has been found that 46 percent of the respondents were illiterate. It was found that 58 percent of the respondents earned less than Rs. 5000.00 per year. From the study it has been noticed that Subansiri riverbank people directly use the river water for fishing (51%), agricultural purposes (18%), drinking water (12%), collection of sand and gravel (7%), collection of drift wood (4%), transportation and business (3%) and others (5%). From the study, it could be said that majority of the respondents (62%) had very much concern about their livelihood and socio-economic condition. They believed that the
Lower Subansiri Hydroelectric Power Project would definitely change their present livelihood condition. It clearly shows that the tribal dominant population of the downstream areas of the river Subansiri completely depends on the river directly or indirectly (Chapter 7).

**ANTICIPATED IMPACT OF LOWER SUBANSIRI HYDROELECTRIC POWER PROJECT ON DOWNSTREAM RIVER ECOLOGY AND ON PEOPLES’ LIVELIHOOD OPTIONS:**

Over the last 30 years, extensive studies have been made on the impact of big dams on downstream river ecosystem, its biodiversity, especially phytoplanktons and zooplanktons, fish diversity, and the socioeconomic aspects of the downstream people by different researcher. The lower Subansiri Hydroelectric Power Project, at the lowermost site in the Subansiri river basin – at the same site of the earlier high dam investigated by the Brahmaputra Board – has been taken up for construction by the National Hydroelectric Power Corporation (NHPC), Govt. of India. The corporation has already completed about 65% construction works of Lower Subansiri Hydroelectric Power Project. Some of the most important anticipated impacts of this project on downstream river ecology and on people’s livelihood options are discussed below:

**8.1. On flow regime:** The effect of a dam and its reservoir on the river flow regimes depends on both the storage capacity of the reservoir and the way the dam is operated. The most common attribute of flow regulation is the decrease in the magnitude of flood peaks and an increase in low flows. A consequence of reduced flood peaks is reduction of the frequency and extent of over bank flooding. The Subansiri river experiences the highest flow of the year in the late monsoon (July-Aug) period when snow melt in the Himalaya. In the lean months there is more or less uniform flow throughout the day in the Subansiri river ranging between 450 to 550 cumec which regulates the downstream
areas and nourishes its associated ecosystems as per the seasonal requirements. The power project is likely to be commissioned in the near future. According to the EIA report of the project (2003), after commissioning of this power project during every 24 hours, there will be a lean flow of water of only 06 cumec because of “off line” for power generation during that period and the river water will be stored in the reservoir to be used in the next 4 hours when the project goes “on line”. According to the same report during this 4 hours period the volume of water flow may becomes 2,400 cumec. This indicates that while a negligible amount will be released for maximum periods of the day, a huge quantity of water will be released from the reservoir to produced powers for 4 hours. Obviously, this unnatural flow of water will adversely affect the whole ecosystem of the downstream areas of the Subansiri river.

Damming on the Subansiri river will disrupt crucial natural flood cycles leading to widespread damage to the river ecosystem, affecting flora, fauna, regional economy, and food production, affecting the people who depends on the river and its flood cycles. Seasonal flooding is essential for re-fertilizing the river banks and the surrounding flood plains. This dam will decrease the water flow and change the rate, duration and timing of flooding. Forests play a critical role in regulation of flood by absorbing high flood waters during rainy season and slowly releasing the stored water in dry season. With extensive deforestation, there is an increased severity of flooding as the water rushes into the river, taking with it valuable top soil. Furthermore, this dam, when overfill, may release water much larger than natural amounts of water in very short periods causing more devastating flood than previously known in the river basin. This was experienced by the people of Assam during the devastating flood in 2004 by sudden released of water from the Kopili Hydroelectric Project and also sudden released of water from the
Ranganadi Hydroelectric Project of Arunachal Pradesh in 2008. There is no specific provision for flood control in the Subansiri power project but the reservoir (storage capacity 427 million cubic meters water) would be kept at minimum draw-down level during the monsoon period to provide some flood moderation benefit.

8.2 **On sediment influx:** The Subansiri river has relatively high levels of sediment concentration. The sediment flux in the downstream is crucial for health of the entire river ecosystem and any changes in the present sediment behavior might be potentially detrimental to the health of the entire Subansiri river ecosystem. Reservoirs at the project site will reduce water flow velocity and therefore, it will enhance sedimentation rate. The rate at which sedimentation occurs within a reservoir depends on the physiographic features and land-use practices of the catchment areas, as well as the way the dam is operated. Frequent fluctuation of water levels in reservoirs can cause erosion of the shoreline areas of the river.

River flow and the sediment regimes are the physical elements and driving factors of river ecosystem (State Water Report of Victoria, 2004-2005). The river uses the energy of its water flow to carry the sediments in the water. When the river flow nearly stops in the impoundment, coarse silt, sand and gravel settle on the bottom of the impoundment. Finer silt and clay suspended in the water are carried out into the impoundment and deposited in the reservoir. This process results in large amounts of sediment accumulating in the impoundment and consequently, the downstream of the river becomes “starved” for sediments and woody debris.

Damming of the Subansiri river may lead to excessive trapping of sediment as the most sediment entering a reservoir will store behind dams, resulting in sediment-starved conditions in the 130 km downstream, which will have a negative impact on the
river dependent ecosystem. Simultaneously, this may also creates the probability for channel incision, river bank erosion, change in river channel platform and development of a coarse armor layer on the streambed of the river. All these combined effect may lead to the loss of habitats. This physical barrier will pose a serious threat to the riparian wetlands, aquatic biodiversity; indigenous deep-water rice varieties and people’s livelihoods in the Subansiri river ecosystem.

Sedimentation is a primary consideration in the design and construction of dams; indeed, when a river is impounded behind a dam, conditions become so favorable for sedimentation that dams are given ‘trap efficiency’ ratings (the percentage of sediment entering a reservoir that is trapped there) (McCully, 1996). The large volume of reservoirs yields slow currents allowing carried materials time to settle, maximizing sedimentation rates. For many large dams, the trap efficiency is nearly 100 percent. Not surprisingly, as material accumulates on the bottom of reservoirs, their storage capacities are eventually reduced. Most of the hydropower plants in the Himalayan rivers are affected by excessive sediments, which decrease the capacity of reservoir and cause erosion of turbine components (Thapa and Dahlhaug, 2003).

There is a distinction between sediment flushing and sediment sluicing (White et al., 1999). Sediment flushing is a man made process concerned with the removal of sediments which have settled in the reservoir at a previous time whereas sediment sluicing is a natural process concerned with the sediments passing straight through the reservoir during the times of flood. Generally, sediment flushing is use to remove the deposits from the impoundment at any time when necessary, whereas sediment sluicing is a natural process during excess precipitation and flood which remove only the finer fractions from the upper layers. It can be predicted that flushing reservoir sediments
from the Lower Subansiri Power Project will create habitat fragmentation in the downstream and their associated ecosystems. The process will create multiple floods in the downstream because flushing from the dam may be done any time especially in the wet spell. Changing in habitat will thus affects the species composition, agricultural productivity, fish productivity and many other livelihood earning options of the downstream people. Because of heavy sediment deposition from the flushing reservoir sediments, people have lost their fertile cultivable land, destroy many wetland’s ecology, those are roofed by sand, leading to the loss or degradation of many essential services provided by the river and its associated flood plain wetlands. The release of sediment from the dam during the flushing will be catastrophic not only to the downstream but also to the mighty river Brahmaputra. The frequent release of sluicing sediment and flushing sediment and debris will create a ‘sediment dam’ in her confluence. This will again create a barrier in the river Brahmaputra, and the river Brahmaputra will have to change its morphology by swelling, resulting in more inundation in the Upper Assam areas. The most possible risk may be on the Kaziranga National Park, the habitat of IUCN’s Red Listed Endangered mammal, one horned rhinoceros (*Rhinoceros unicornis*) and Majuli, the world’s biggest river island and centre of Satriya culture.

The flushing sediment will be deposited on the downstream of the Subansiri river & the floodplain areas, reducing the soil fertility and encourage the habitat fragmentation. It has been already experienced in the Ranganadi river in Assam where 405 MW Ranganadi Hydroelectric Power Project is in operation. Even grasses, sedges or forbs are not able to grow where these sediment get deposited. So, these sluicing finer fractions and flushed coarse reservoir sediments can be termed as starved
sediments, because this sediments are composed of very fine silt with low cohesive force which make them loose, having low water retention capacities and probably nutrient deficient. Local people use these flushed sediments as sand components of R.C.C. construction.

8.3. On thermal regime: Water temperature is an important factor affecting the growth of freshwater fishes, both directly and indirectly, through feeding behavior, food assimilation and the production of food organisms. Water stored behind a dam in a reservoir becomes stratified into layers of differing temperatures (Poff and Hart, 2002). When water is release from the dam, the cold hypolimnion layer of water flows to the downstream (American Rivers, 2002). Aquatic species can reproduce, grow and survive only within a particular range of temperatures. Changes in water temperature in the Subansiri river can lead to a shift in species composition or density.

8.4. On water quality: Water storage in a reservoir at the dam site induces physical, chemical and biological changes of the river, all of which affect water chemistry. Nutrients, particularly phosphorous, are released biologically and leached from flooded vegetation and soil. Oxygen demand and nutrient levels generally decrease as the organic matter decays. Some reservoirs require many years for the development of stable water-quality regimes (WCD, 2000). After maturation of the reservoirs, like a natural lake, can act as a nutrient sink. Eutrophication of reservoirs may occur as a consequence of large influxes of organic material and nutrients, often arising as a consequence of anthropogenic activity in the catchment areas. Hence catchment management has a key role to play in sustaining reservoir water quality. The quality of water release from a reservoir is determined by the elevation of the outflow structure(s). Water release from near the surface is generally well-oxygenated, warm, nutrient-
depleted water. In contrast, water release from near the bottom is often cold, oxygen-depleted, nutrient-rich water that may be high in hydrogen sulphide, iron and manganese.

Dams also contribute to global warming. Methane released in significant volume from anaerobic decomposition of reservoirs plants, is also a major greenhouse gas. Accumulation of water in the large reservoir of the Lower Subansiri Power Project may also have an effect on the micro climate of the area where Lower Subansiri Power Project is being implemented.

Most of the areas of Lakhimpur and Dhemaji districts of Assam and the adjoining areas near to the dam site in particular are malaria and encephalitis prone. Every year hundreds of lives are lost due to these epidemic diseases. There will be a high risk of the diseases with the formation of large stagnant pools in the upstream areas. Diseases, especially malaria and deadly encephalitis, would occur frequently as stagnant water is the prime breeding ground for mosquitoes carrying the vectors of these diseases.

8.5. Loss of Species: This hydroelectric project can have serious impact on survival of some species that live and depend on the Subansiri river ecosystem. All the systems in the Subansiri river are delicately balanced and interrelated. Therefore, disrupted food chains and other systems will have serious impacts, affecting both the terrestrial and aquatic species. Reservoirs created by the dam can also block animal migrations towards upstream. Besides the total aquatic habitats will also be destroyed. The threatened hill stream fishes *Tor tor* and *Tor putitor* are found in the downstream of the Subansiri river (Hazarika *et al.*, 2011). Subansiri dam will make obstruction for these fishes to reach downstream areas for spawning and feeding. The downstream of the
river (last 80 km) up to the confluence with the mighty river Brahmaputra, is a suitable habitat for endangered Ganges river dolphin *Platanista gangetica*. A total of 29 individuals of this species were recorded in 2006-2007 (Baruah *et al.* 2012). The construction of the dam will threaten these species.

8.6. **Socio-Economic Aspects:** Huge economic benefits are gained from the Subansiri river ecosystem by the downstream river bank inhabitants through fishing, collection of driftwood, economically important plants and dairy farming, etc. (Chapter: 7), which maintain a balance between the human use and the ecology of the river. Floodplain grazing areas and cultivable lands are also very productive due to the seasonal flood of the Subansiri river. River bank inhabitants use the river water for drinking, washing, bathing and agricultural purposes. The Lower Subansiri Power Project will curtail these benefits through creating barriers for drift wood, causing downstream habitat fragmentation, degradation, changes in water quality and quantity, loss of species, etc. and will make negative impacts on the flood plain inhabitants whose social and economic status is directly related with the Subansiri river ecosystem.