SECTION E: EPILOGUE

The fifth and the final section comprise two chapters. Chapter 14 is devoted to analyse and discuss both the physical and human environmental situations and problems emerging out at present. This chapter also presents some valid and logical management plans. Finally in Chapter 15, an attempt has been made to sum up the details of each chapter.
In the previous chapters 3 to 12, details of physical, economic and human environment as well as structure and status of the society in the Southern Part of Nadia District (SPND) have been presented and analysed with relevant illustrations. With the understanding of all the aspects of foregoing chapters and intensive field study the researcher intends to make an attempt to mention the problems (as highlighted in Chapter 13) which have emerged out due to oscillating tendency of the river Bhagirathi since the historical past in this deltaic plain, interaction and encroachment of people in the meander belt and related aspects. Depletion of ground water for more production of crops to meet the need of rapidly increasing population, arsenic pollution for lowering of ground water table, transformation of wetlands to agricultural fields, land degradation, social disorders etc. This has enabled the researcher to arrive at some suggestive solutions for management of the problems.
and planning proposals for the better use of land as well as water in the SPND and its overall development so that the SPND may have a sustainable and prosperous future.

The study area represents a typical river dominated landscape with numerous *bils*, marshes, ox-bow lakes *etc.* and traditional agricultural economy. But the area has varying potentials in terms of land utilisation. Therefore, the problems of the study area are to be studied in detail and evaluated properly so that the lands of the SPND are utilized rationally.

### 14.1 Main Problems

The SPND possesses a lot of major and minor problems. The author has highlighted here only the major problems encompassing some very important areas.

#### 14.1.1 River Bank Erosion related Problems

**Loss related to Bank Erosion:**

In a rural economy based primarily on land, landlessness poses to be a major threat leading the marginalisation of the people. The impact of land loss involves primarily the loss of homestead land, housing structures, crops, cattle, trees and household utensils. Loss of homesteads forces people to move to new places without any option and puts them in disastrous situations. The major impact found here in terms of occupation has been a shift from agriculture in own land to primarily day labourers and minor service activities. The big farmers are the worst affected, followed by medium farmers, and marginal groups. The affected people lose their assets and are forced to draw on savings and often fall into further debt. In some areas of BJF one of the major shifts is from the life of a landlord to that of a poor daily labour due to engulfment of land by river. Such demoralising
effect is rampant in all along the bank line of either side of the river Bhagirathi.

**Population Displacement:** The displacement caused by erosion, mostly involve displacement of whole families. On an average, a household experienced riverbank erosion 2 to 3 times in the life of its members. Some of them experienced displacement 4 to 5 times or more. Most of the environment-induced refugees turn mainly into labourers or rickshaw pullers. A large proportion of the victims remain unemployed due to lack of work opportunities. Before erosion majority of the households had their own land to earn their daily bread and were not dependent on the market, afterwards they are forced to the market to sell their labour resulting in their susceptibility to the market forces causing severe hardship. As for the educated rich, few in number, they have shifted to settle in nearby towns. Some people have migrated in search of work to as far as Gujarat and Maharashtra where they are working as labourers in any kind of work.

**Health Hazard:** Decrease in land has further increased the pressure on the remaining land thereby contracting the living area and forcing people to live in sheltered areas. This has severe effect on the general health due to lack of proper sanitation facilities. With the given vulnerability of bank line the inhabitants do not wish to improve the living conditions and settle in make-shift arrangements.

**Sufferings of Women:** As in all major dislocation process, here too women are the worst sufferers. Landlessness has forced women to take up the additional burden of providing financial support to the family apart from adjusting with the extreme domestic hardships. The girls in their pre-adolescence stage are
taken away from schools and forced them to unhealthy conditions sometimes sexual harassment and lack of security.

14.1.2 Over Exploitation of Groundwater and related Problems

**Lowering of water table:** Over exploitation of groundwater for irrigation through the shallow and deep tube wells mainly during the time of winter cultivation is the main cause of lowering of water table in the SPND.

**Arsenic hazard:** The probable source of occurrence of arsenic has been reported to be of geological formation of source material. Occurrence of iron-pyrite and the change of geochemical environment due to over exploitation of groundwater or excessive fluctuation of groundwater table are the possible reasons of decomposition of pyrite to ferrous sulphate, ferric sulphate and sulfuric acid. Each block in the SPND has very alarming level of arsenic concentration in groundwater. All the four blocks contains arsenic above WHO guideline value of arsenic in drinking water (10µg/L) and Indian standard value 50µg/L.

The *boro* cropping is almost dependent on the tube-well irrigation. Immediate manifestation of that agro practice has caused lowering of ground water level at alarming rate.

Long-term exposure to arsenic in drinking water can cause cancer in the skin, lungs, bladder and kidney. It can also cause other skin changes such as thickening and pigmentation.

14.1.3 Over-population related Problems

**Increasing Demand of Agricultural Land**

Rapidly growing population demands more production of crops and increasing the area under agricultural practice.
Increasing Demand of Residential Land
Rapidly growing population puts huge stress on wet lands and agricultural lands which adversely affects the physical environment.

Transformation of Wetlands into other practices
Conversion of wetlands into other practices is a common phenomenon in the SPND. Wetland is a natural ecosystem. It has a life cycle. If they are not utilized rationally in course of time it would be eutrophicated, which ultimately creates various other problems.

Encroachment of human being into meander belt of rivers intensifies the bank erosion related problems
A river is a living reality that needs space. Deltaic rivers shift constantly, veering from one extreme right bank point to another on the left bank, may be over centuries, perhaps over decades. The behaviour of a river can be defined in terms of the rhythm of environmental systems. But the absence of proper attention to the basic delta building processes is the cause of such accelerated erosion. Encroachment of human being into this dynamic location for easy access of multidimensional facilities more intensifies the problem.

14.1.4 Low level of literacy and awareness related Problems

Adverse impact on available resources
Lack of literacy and awareness destroys natural physical endowment in the SPND. The biils and rivers are subjected to industrial and sewage pollution.

Over dependency on agriculture
Agriculture is the main source of economy in the SPND. Most of the lands are double or multiple cropped. This kind of practice
leads to the loss of carrying capacity, depletion of ground water, transformation of wet lands into agricultural land etc.

**Lack of efficiency in other works**

Low level of literacy leading the people to the low skilled, low wedge jobs which creates social backwardness. Most of the population in the SPND is solely dependent on agriculture and allied activities. If they are migrated due to any unavoidable situation, most of them are included in less skilled low profitable jobs.

**14.1.5 Scar city of Pure Drinking Water**

Most of the villages in the SPND are affected by arsenic hazard due to rapid depletion of ground water table. Government aided fresh and pure drinking water supply is not sufficient. People most of the times are compelled to take arsenic affected water and become victims of various health problems.

**14.2 Tentative Planning Proposals**

Planning is defined as an organised process by which a society achieves its developmental goals. It is a systematic procedure which aims at the implementation of several specific targets. Thus planning is a technique to evaluate the potential of an area and to develop the area to the best advantage of the nation as a whole. Consequently, it is necessary to a) specify targets; b) specify potential variants of reaching such targets; c) find out the resources available for reaching such targets; d) find out which variant is optimal; e) organize the instruments which will ensure operational implementation of the variant finally chosen; f) supervise the processes of implementation. Though it is the task of the local implementing authority to choose what principle to be adopted for the region concerned, yet it is true that, planning is
not a task of the professional planners; it is the task of the people, who are seeking the development of their own selves \( i.e. \) development from within, presupposes planning from within (Misra, R.P., 2002: 83).

**14.2.1 Planning to cope with River Bank Erosion related Problems**

**Floodplain Zoning:** Floodplain zoning means categorizing various zones based on administrative legislations for proper planning and development of floodplain areas for various purposes like agricultural activities, residential areas, industrial areas etc. Preparation of flood plain zoning maps takes into consideration the inputs from bank erosion hazard, measurement of meander belts of the rivers, flood inundation and risk zonation maps. The important aspect of zoning is that it can be used to regulate what uses may be conducted and how uses are to be constructed. Zoning is also used to restrict riverine areas to particular uses, specify where the uses may be located; who comes under immediate dangers.

**Insurance:** In developed countries insurance scheme is found to be most effective method to regulate the land uses in floodplain. In this scheme, depending upon the nature and location of establishment in the floodplain, insurance premiums are charged. The insurance plan is in such a way that very high premium are charged for the persons going for establishment very close to the rivers. But in our country especially the rural areas like in the SPND most of the poor people live by the river side for the locational advantage and fertile alluvial tract. They cannot bear the high insurance without the government and NGO support. If this scheme is supported successfully it would be very beneficial for them during the time of recurrent hazards.
Short term strategies

i. Storage and Supply of immediate relief materials
ii. Sale of property
iii. Place of re-settlement
iv. Help from Govt. & NGOs
v. Use of movable housing materials

Long term strategies

i. Desilting the rivers and water bodies
ii. Continuous monitoring with the help of remote sensing and GIS
iii. Occupational mobility
iv. Insurance with the help of Government and NGO’s
v. Counseling of people for hazard preparedness
vi. Plantation of trees for bank protection
vii. Construction of permanent flood shelter

Hazard warning and management: Warning about the hazards with advance software and GIS base is capable of providing the information to decision makers for taking necessary measures in real time. Such system requires the detailed spatio-temporal data base including the basin characteristics, hydro-geomorphological variables, meteorological data, socio-economic data etc. The system provides the information of hydrographs of the river stages and discharges in the required time which will be very useful for the decision makers to take necessary
action for preparing the rehabilitation plain during the time of bank erosion and flood.

14.2.2 Planning to Minimize the Ground Water depletion and related Problems

Groundwater table

Minimizing the use of water for cultivation

Strict policy by Govt. to establish shallow and deep tubewells

Community participation and awareness to minimize the use of groundwater

Research and monitoring for finding more information about the relationship between lowering of water table and arsenic hazard

Surface water bodies

More use of surface waterbodies

Gaining more economic benefit and social improvement

Rainwater harvesting and establishment of water treatment plant for supply of fresh water

14.2.3 Planning to Minimize Over-Population and Low Level of Literacy related Problems

Increasing the level of literacy

Mass literacy programme

Job oriented training programme and increasing skill

Increasing awareness about the resource potentiality of SPND

Government and NGO support to eradicate poverty and illiteracy

Social forestry for economic and social benefit

Finding alternate source of economy like the development of tourist spots to minimize the over dependency on agriculture
Potential Tourist Spots in the SPND

i. Aranghata: This village (J.L. No. 49) situated in the Ranaghat P.S. about 10 km north of Ranaghat lies on the Ranaghat-Gede line of the Eastern Railway and has a railway station called after its name. The village stands on the river Churni on whose bank is the temple of Jugalkisor, believed to have been constructed in about 1728. The temple contains the idols of Krishna and Radha. A big fair is held here annually throughout the month of Jyaistha (May-June) and is attended by about 10,000 pilgrims. Among the visitors females predominate, owing to the belief that any woman who visits the temple will escape widowhood, or if she be already a widow, will be spared from that fate in the next birth. To the south of the temple there is another and a more ancient one containing the idol of Gopinath, but this does not possess any special fame or sanctity.

ii. Birnagar: It is a small municipal town in the Ranaghat P.S. about 8 km from Ranaghat and is connected by the Eastern Railway line going from Sealdah to Lalgola. The ancient name of this place is Ula as mentioned in ancient Bengali literary works. The Ulaichandi festival is celebrated here annually in the month of Baisakh (April-May), and is attended by 20,000 pilgrims, who it is said, are housed and fed by the residents. There is a cluster of 12 temples in the Bengali hut style called the dwadasmandir in association with a Kali temple. The finest temple in the village is the jore bungla temple of Krishna built in 1694. The façade is decorated with terracotta plaques, now badly worn and damaged by lime wash. Nearby is a Chandimandap with extensive wood carving on the front pillar and interior roof supports, including many puranic and secular figures. In Paltipara, about 1.5 km north of Birnagar, two brothers Kanailal and Nilmoni Acharyya, invented the famous ornaments for idols known as daker saj.
**iii. Palpara:** It is located about 3 km from Chakdah railway station and has an early brick-temple of the *charchala* type, more massive than is usual with this design.

**iv. Debagram:** A village (JL No. 105) in Ranaghat P.S. about 4 km north east of Gangnapur on the Ranaghat-Bongaon section of the Eastern Railway. There is a large mound in the village, popularly known as *Deganr Dhibi.* This mound is said to cover the ruins of an ancient fort supposed to be the seat of a *Kumbhakar* Chieftain, Raja Devapal.

**v. Kulia:** A village (JL No. 83) in the Kalyani P.S. about 5 km north east of Kanchrapara railway station alongside the Kulia *bil.* A fair is held here annually on the 11th day of Paush (December). It is called the *Aparadh Bhanjan mela* because all who worship there on that day would be absolved of all sins. Owing to this reason, there is a huge rush on this particular day.

**vi. Phulia:** A town in the Santipur P.S. 6 km from Santipur on N.H. 34 is the birth place of the poet Krittibas. It is an important centre for the production of handloom textiles, especially handloom.

**vii. Santipur:** Handloom products especially *sarees* are a specialty of this place. *Ras* in the month of November is the most important festival and attracts visitors from far-off places.

These spots are sites of historical and religious importance and are well connected by roads and railways and can easily be upgraded to tourist spots by developing other infrastructural facilities.

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**Mangaldwip Char:** This river island has emerged at the confluence of the Hooghly and the Churni in the Ranaghat-I Block is another spot likely to be developed as a Tourist Transit Point – Cum – Resort along the river cruise to Murshidabad.
14.3 Policy Prescription

In addition to the concepts of an ecologic balance of land, trees and waters in a given region and a soil balance, established by the intake of the crops and soil replenishment, we have to introduce the concept of a vast and intricate natural balance established among the various channels of a river system. When man upsets this balance he has to pay the price. Majority of the problems in the study area are due to man’s artificial interference and disregard of the life and process of the river system. In order to combat with the various problems related to the physical and socio-economic environment of the study area, the following strategies need to be adopted at a war footing.

• The river beds in the area need to be excavated in order that there is flow of water during the lean season.
• Discharge of both untreated industrial effluents and sewage in the water bodies should be prohibited.
• Since these are required to be done both in India and Bangladesh, there is need for accord on this point.
• It is imperative that more water is needed to flow through Mathabhanga to reach the Pabakhari point at Majdia and allow a certain quantum of water flow to Ichamati through a feeder channel of about 9 km length, to be cut connecting Mathabhanga with the chocked Ichamati Water channel.
• The feeder channel has to be cut deep (greater than 15 ft.) because the floor of the Ichamati river base has raised up due to long many years of non-flowing dry state and the disuse by anthropogenic activities.
• Rational Management of Water Resources (surface & underground) is to be done with utmost priority.
• The bils should be given extra attention as they are potential resources and can be effectively used for aquaculture as well as for recreational purpose and hence will help to generate additional income to the local people.
• System of Rice Intensification, Organic Farming, Eco-friendly production technologies and Ecological Pest Management need to be adopted for sustainable agricultural production.

• For the protection of aquatic and agricultural biodiversity and enhancement of fish and agricultural production, a rational management program should be implemented.

• Arresting environmental hazards resulting from lack of sanitation facilities, encroachment, groundwater contamination like arsenic pollution, destruction of aquatic flora, fauna are some of the burning problems of the area that needs to be tackled through participatory mechanism.

• The sensitive social issues of child labour, haphazard settlement, illegal migration, char disputes need to be tackled through proper legislation and good governance.

• Finally, proper development of the identified tourist spots in the study area can help in additional income generation for the people of the area as well as upgradation of the SPND.

Thus, it can be inferred that the revival of water bodies are to be given the first preference in order to solve the problems of the Southern Part of Nadia District.

For the proper management of the SPND, a team of expert technicians of various disciplines, viz., geomorphology, hydrology, geology, zoology, botany, soil science engineering, agronomy, economics and sociology should be formed to collect data in respective spheres, aiming to find out the i) nature and intensity of problems, ii) prospect of the study area, iii) potentiality of overall development iv) availability of technology, v) infrastructural facilities and so on. In this way an inventory of land resource of the SPND may be prepared with the help of the aerial photography, intensive field work and through the investigation of physical and cultural environments. Such inventory will be a guide for the overall development of the people living in the region.
SUMMARY & CONCLUSION

The present study entitling Riverine Morphology and Socio-economic Environment in the Southern Part of Nadia District, West Bengal: An Impact Assessment has been an attempt to interpret and analyse in details all the general and specific geomorphic components of the Southern Part of Nadia District (SPND) on the one hand and to evaluate the relationship of all these aspects with existing and potential land utilization and ultimately prospects of and planning for the environment in the SPND on the other. The present study has been an attempt to analyse the surface and ground water hydrology in detail. History of fluvial dynamics and fluvio-morphological features, their impact on the land utilisation has also studied specifically with intensive field survey. The geomorphic character of the SPND is mainly evolved through fluvial action and processes. Agriculture had been known to be the dominant occupation in the study area and the development of
its agricultural land use has been the vital objective of the present study in the overall interest of an all round prosperity of its intra-regional and regional agricultural economy. Therefore, a detailed discussion of all the relevant aspects has formed the main theme of the present work.

General and specific components essential for assessment of agricultural advancement of SPND has been discussed in details for understanding the acceptability of people to adopt modern technology. To achieve the goal of 'holistic development' of society, to utilise the available and potential resources rationally, to increase the awareness among the population for immediate hazards within their living environment the present volume has been objectively fragmented into 15 chapters, each of which includes aspects of hydrological characteristics, fluvial morphology, land utilisation and environment which leads to the following points of conclusions:

(1) The study area the Southern Part of Nadia District lies in the moribund deltaic tract of the state of West Bengal where rivers have ceased the land building activity and in a decaying condition (Bagchi, 1943). The region extends from 22°47′33″ to 23°20′ N latitudes and 87°19′32″ and 88°45′27″ E longitudes covering an area of 1132.30 km². The river Bhagirathi-Hooghly forms the western boundary which has separated the area from Burdwan and Hooghly districts. In the south and south-east the area is bounded by North 24-Parganas District, in the east by Bangladesh and in the north by Krishnagar and Hanskhali Police Stations of Nadia District. The area consists of 5 Police Stations viz., Santipur, Ranaghat, Chakdah, Kalyani and Haringhata (Fig. 1.1) and lies entirely within the Kalyani and Ranaghat Sub-divisions. There are 5 Community Development Blocks viz. Santipur (analogous to Santipur P.S.), Ranaghat – I & Ranaghat – II (together forming the Ranaghat P.S.), Chakdah (comprising of Kalyani & Chakdah
P.S.) and Haringhata (analogous to Haringhata P.S.). The study area covers the portions of the 1:50,000 Survey of India topographical maps numbering 79 A/7, A/8, A/11, A/12 and 79 B/5, B/9 (Fig. 1.1). There are 492 villages in the study area (Table 1.1,1.2 & Fig. 1.2) within 61 Gram Panchayats (68 villages in Santipur within 10 Gram Panchayats, 65 villages in Ranaghat - I within 10 Gram Panchayats, 113 villages in Ranaghat - II within 14 Gram Panchayats, 159 villages in Chakdah within 17 Gram Panchayats, 87 villages in Haringhata within 10 Gram Panchayats). The villages are of different shapes and sizes as well as of varying socio-economic structures and environmental details.

(2) Being located in the moribund deltaic part, the area presents a picturesque configuration with palaeochannels, meander scars, bils, oxbow lakes, swamps, marshes, etc. The general elevation of the study area ranges from 6 metres to 30 metres. The high elevated areas are nothing but the natural levees which are located scatteredly with the association of present and past channels and low lying areas in the form of swamps and marshes.

(3) The study area is a part of the Lower Ganga Plain or more particularly of the Bengal basin. It is one of the most extensive deltaic plains of the world. The geological chronology of the Bengal basin has been discussed later without which the geological set-up of the Southern Part of Nadia District cannot be understood properly. Geographically, the Bengal Basin is a surface physiographic unit, comprising the entire lowland (Garo-Rajmahal Gap) bounded by the Chhotanagpur Plateau and Rajmahal hills in the west, the Himalayan foothills in the north, the Meghalaya Plateau in the northeast and the Manipur-Tripura hills in the east. The total thickness of the sediments progressively increases to the east and southeast. The original basement complex of Archaean formation was covered by the basaltic lava of the Rajmahal Volcanism during the upper Jurassic to Lower
Cretaceous age. Below the relatively thin (about 120 feet to 1250 feet) cover of Holocene alluvium in West Bengal, geophysical surveys and deep drillings have discovered a thick section of Cretaceous and Tertiary sediments lying on a basement of basalt lava flows (Sengupta, 1969: 1-2). The basin acts as a large sink where the huge sedimentary deposits accumulated to form the Bengal delta, for this reason the older geology remained below a capping of Holocene alluvium. Being a part of this delta, the SPND consists of rocks of monotonous formations of Quaternary period. The area is covered mainly by three geological units (Hugli formation, Chinsura formation and Bethuadahari formation) belonging to Pleistocene to Recent age (Table 3.1, Fig. 3.1).

(4) The SPND, like other parts of lower deltaic Bengal, fall under the ‘tropical monsoon climatic region’ (‘Am’ type). Oppressive hot summer with high humidities (75-80%), monsoon rainfall and dry, cold winter season are some of the typical characteristics of the climate of the study area. The average temperature during pre-monsoon summer season is 29.7°C with relative humidity 68%, associated with occasional thunderstorms in the afternoons locally known as Kalbaisakhi. Most of the rainfall (80%) occurs during summer monsoon (June to August). The average yearly rainfall is 1200mm. Relative humidity remains very high (>82%) during this period with low air pressure (varies from 997.8mb to 999.2mb). The winter season is cold and dry with temperature 10°C-18°C and is favoured with occasional visits by western disturbances. Heavy fogs sometimes occur during the winter season. This type of climate is very favourable for paddy, jute, sugarcane, various fruit and vegetable cultivation. The incident of snake-bite death in monsoon period, thunder storm lighting death during Kalbaisakhi period is most common. Instead of this the waterlogging in the ponds and low-lying areas are responsible for few seasonal diseases like Malaria, Dengue etc.
(5) The study area is a flat alluvial plain having pockets of villages and clusters of trees. The hamlets in this area are widely separated with occasional growths of bamboos and mango trees. At present there is hardly very low forest cover present in the SPND but early references claim that the area was covered by the dense forest containing tiger and wild beasts nearly 250 years ago. At present all the forest has been removed to build up the settlements and agricultural fields. Therefore, the forest cover of any significant amount is very negligible here and the botanical diversifications are also very low. The study area shows very little forest area in comparison to the area under other land use categories. It is observed that in 1971 only 5.61 km² i.e. 0.50 % area of the total area was under the vegetation coverage which has decreased to 2.24 km² i.e. 0.20 % in 2001. The principal species planted are Teak, Sissoo, Arjun and Akasmani. The mass afforestation will increase the gross forest resources in SPND. The river bank areas of SPND are posing challenges to the forest due to loss of land in bank erosion. The social forestry programme in SPND has started in few selected areas with initiative government and NGO’s which helps to increase the amount of area under forest from 1971 to 2001. Strict implementation of existing legal systems against the reckless exploitation of forest resource of the area concerned can prevent the forest loss. No conservation programme will be successful without any active support, participation and cooperation of the local people. So the education on forestry should be part of educational curriculum. The Forest Development Corporation shall provide employment to local people in sericulture management, extraction and utilisation of forest product as well as forest based-industries.

(6) The study area is an alluvial formation of the rivers belonging to the Ganga-Bhagirathi system. On the top surface it appears to be formed of recent alluvium, but below the top surface there is evidence
of the existence of an underlying plinth of older alluvium formed of different material. The parent material from which the soil is formed is Ganga alluvium (also known as newer alluvium from pedogenic aspect) which under different conditions forms three dissimilar soil associations: Ganga Riverine Lands, Ganga Flat Lands and Ganga Low Lands (Table 5.1, Fig. 5.1). The whole study area is very productive for agricultural point of view, thus use of soil rationally without destroying its inherent carrying capacity will be gainful for better future.

(7) All the area falls within the moribund sector of the Ganga delta, all the rivers viz. Hooghly, Churni, Ichamati, Jamuna (Table 6.1) are stagnated. The rivers have erratic water flow causing floods over large tracts spilling over the banks during torrential rains, but remaining practically flowless (even dry in stretches) during summer season. Link of these rivers with Padma remains cut off for most part of the year. Only in floods there may be some inflow from Padma into these rivers, but there are no fixed channels for the rivers to receive Padma inundation water. The repetitive occurrence of the 9-metre contour in the study area indicates that the ground slope does not have a persistent direction. The rivers are at a loss to find a perceptible slope and consequently have extremely intricate meandering courses. At some places the course of a river has taken a complete turnaround. Detached lengths of old courses (including ox-bow lakes and bils) are strewn over the entire area indicating the extent of degeneration of the drainage condition. The number of bils has reduced from 17 to 11 within a span of about 50 years mainly due to reclamation of land. The areas of the existing ones have also changed significantly.

(8) Ground water in the Southern Part of Nadia District occurs in a thick zone of saturation within the alluvium. The geological factors controlling the occurrence of ground water indicate that it generally exists under water table conditions, i.e. in the unconfined state. This is
due to the occurrence of permeable material from surface downwards to 160 m below the ground level and also due to the non-existence of any significant confining strata over the water-bearing granular materials. The upper limit of the zone of saturation – the water table, is very close to the surface. It generally rests at depths ranging from 4 m to 6 m below ground level. Water table is not static; it is always liable to fluctuate in response to changes in the seasonal conditions affecting recharge and discharge. Owing to the recharge of the ground water body through monsoon precipitation water table tends to rise during the rainy season. By October rainfall ceases in the area and recovery of the water table in response to monsoon precipitation is expected to be complete by November and, as such, depth to water table will be shallowest during these months. With the onset of summer, recession of water table gradually takes place and during the peak summer months of April, May and June the decline of water table is deepest. Winter measurements when compared with summer show a decline of 1 – 3 m. this recession may be attributed to the factors of evaporation and also to artificial discharge through withdrawals from wells. The river Hooghly receives effluent seepage from the ground water body during the months of December and January, when the total amount of supply from the parent river Ganga as well as the western tributaries is almost nil.

(9) The Southern Part of Nadia District lies in the maribund deltaic Bengal where post-Pleistocene alluvial deposits in the foredeep and relatively high amount of rainfall have facilitated for the storage of huge ground water resource. The low gradient, on the other hand, has facilitated the rivers to oscillate their courses over centuries and even over decades within their meander belts as a result of which numerous interesting fluvio-morphic features, like bils, ox-bow lakes, cut-offs, palaeo-channels etc. have been evolved. Floodplains are also characterised by complex assemblages of landforms which include
channel features such as bed forms (ripples and dunes) and bars (point bars, mid channel bars etc.), channel edge features such as banks, benches and levees. Some of other important features like palaeo-channels, scroll bars, ox-bow lakes, back swamps, crevasse-splays etc. are also observed.

The floodplain area is liable to frequent flood and river bank erosion. But the people with their rationality have built the land use pattern and cultural set-up in this area with the knowledge of geographical drawbacks they will have to face. The whole area is a fertile tract replenished with fresh silt during the time of annual flood. Agriculture is the main source of economy. The main source of water for agriculture is the rain water and groundwater collected through the shallow and deep tube wells. The use of river water in irrigation is very low except in the river side fields. The river is mainly used for transport and domestic purposes. The whole study area is a fluvial landscape, formed by the river Hooghly and its tributaries. The oscillating tendency of the rivers has produced many interesting fluviomorphic land forms. Natural levees are the linear ridges formed in association with present and past channels. These are mainly used for the construction of transport routes, communication lines and building of settlements. The crops that need mainly rain water with little irrigation for their growth are cultivated here, like pulses and oil seeds. Village orchards are also noticeable here. The riverine flats are mainly used for market gardening and Aman paddy cultivation. The higher well-drained parts like levee and interior part away from the rivers are used for Aus paddy and Sugarcane cultivation. Boro paddy and Jute require much water so bils and marshy lands are mainly used for their growth. Due to excessive pressure of population some of the bils and marshes in the study area have totally been transformed into agricultural fields. Bils are also used for pisciculture and jute retting. Scroll bars offer high ground for
settlement and village cart-tracks. The whole study area represents a true form of ‘hydraulic society’ where each individual has the knowledge about the possible hazards related with the lower deltaic plain. The people here live with the benefits associated with the flood like fertile silt deposit, higher water table and the numerous advantages of river side location.

(10) The discussion on geology and lithology, climate, natural vegetation, surface elevation and forms, hydrological conditions and soil properties reveals that these geomorphic attributes have spatial variation in general and have control on the land use pattern of the study area. They directly influence the irrigation potentiality and agricultural productivity of the region, whereas, they have an indirect impact on demographic characteristics of the study area. A better picture of such relationship can emerge if they are discussed in totality. The division of the Southern Part of Nadia District (SPND) into morphological regions on the basis of these attributes is an attempt to achieve such an objective. The area has been classified into three morphological units: Flood Plain, Lower Mature Delta Plain and Upper Mature Delta Plain (Fig. 8.1 & Table 8.1). The units resemble three zones parallel to the Hooghly river.

(11) The study area has a total population of 14,28,992 (Census, 2001) with 35.71% decadal growth rate against 17.34% of the State. The density of population is 1262 persons/km² (903 persons/km² in West Bengal). The population is distributed unevenly because of surface configuration. The flood plains, levees and the river banks are highly populated while the lowlands liable to annual inundation and swampy and marshy areas are usually devoid of population. Population in the general category comprises 54.86% while the scheduled caste and scheduled tribe comprises 41.40% and 3.74% respectively of the total population of the study area. The percentage of the literate
The percentage of main workers to total population is 38.10% and percentage of marginal workers to total population is 5.33% which indicates that the dependent population constituting house-wives, students, old and retired persons, infants, beggars, physically handicapped and others are greater in number. In the SPND, among the agricultural people, cultivators share about 18.44% and agricultural labourers about 21.29% of the main workers, thus indicating involvement of 40% of the working population in agriculture. The agricultural population is not uniformly distributed throughout the study area. It varies from village to village.

(12) The spectacular prominence of land utilization as noticed in the SPND is the land under various crop use in different seasons with a conspicuous regional variation in terms of crop concentration ranging from monocrops through double to the multiple crop cultivation. As the settlements are significant feature of cultural landscape in a plain area, they occupy more or less significant portion of the area. The study area is netted with an intricate network of roads. Therefore, the socio-economic use of land relating to transport and communication network holds a more or less major share of the area not available for cultivation. A considerable portion of the land is not under any form of optimum utilization and that includes road and rail side nalas, palaeo-
channels, bils etc. Major portion of the study area (73.12%) is agricultural land.

The district land use census categorizes the area into 5 categories viz. area under forest, irrigated area, unirrigated area, cultivable waste area and area unavailable for cultivation. There has been a significant change in the land use categories from 1971 to 2001 (Table 10.3 & Fig. 10.2) especially in the irrigated and unirrigated area categories. In 1971, only 11.83% of the total area was under irrigation which increased to 51.77% in 2001. Thus the share of unirrigated area abruptly reduced to 20.43% in 2001 from 58.40% in 1971. This helped in year round agriculture in major portions of the study area. The meagre area under forest in 1971 further decreased in 2001 giving evidence of conversion of one category of land use to another. Area under cultivable waste has increased slightly while area unavailable for cultivation has decreased in 2001.

(13) The Southern Part of Nadia District (SPND) is a fertile alluvial tract of the moribund delta of the Hooghly river. Agriculture is the mainstay of the population. It is practised throughout the year. But, the area experiences the vagaries of monsoon which is not at all predictable. Inadequate rainfall and its uneven distribution cause much suffering. So, the importance of irrigation in the study area is undeniable. Irrigation forms the backbone for the sustained successful agriculture in the study area. Agricultural development is influenced by the environmental, infrastructural, institutional and political factors. Irrigation is one of the most important infrastructures for agricultural production to meet the need of growing population pressure in the study area. The sources of irrigation in the SPND may be classified under three heads viz. surface, underground and rain-fed (Table 11.1). The surface sources are rivers and tanks, underground sources are tube wells (deep and shallow) and rain-fed sources are the stagnant water
bodies situated in the area. Canal irrigation is absent in the study area. Of all these sources, irrigation through tube wells has the highest contribution and is widespread throughout the area because the area has adequate groundwater and the soil is soft enough for deep boring. Tube wells help to carry out agriculture throughout the year. River lift irrigation is practised in villages adjacent to the rivers but its share is very minimal. The stagnant shallow water bodies are also sources of irrigation from where water is lifted manually or through pumping machines. The irrigated area has increased substantially from 1971 to 2001. In 1971, only 12595 hectares out of 74932 hectares net sown area i.e. 16.81% of net sown area was under irrigation. The percentage of irrigated area rose significantly to 88.22% of the net sown area (64093 hectares out of 72651 hectares of net sown area).

(14) Most of the wetlands (bils) in the study area are extensively managed for fish farming and are thus not good domain for adequate aquatic flora and fauna. These wetlands are significant in terms of biodiversity in respect of their flora and fauna. Moreover, these water bodies have diverse utilities and thus support a good number of human population that depend on these water bodies. A significant part of rural communities of West Bengal manage their sustenance from harvesting wetland products. Profile of the wetland area in the study area has been changed in course of time due to anthropogenic pressure and unplanned urbanisation.

From the wetlands of the study area, as many as 42 species of angiosperms belonging to 26 families and 2 species of pteridophytes were observed which are locally used for various purposes. Of these plants, 30 species have excellent medicinal properties. Wetlands are subjected to maximum threat from sedimentation rather than eutrophication, sewage, solid waste dumping, overfishing, detergent use, and mixing of agricultural wash.
The Southern Part of the Nadia District is essentially an agricultural country. The economy and social life of the people is intimately linked with its two main resources: land and water. The rivers and other surface water bodies such as bils, lakes and ponds all make a major contribution to the agriculture and general economy of the country by providing navigation, fish, water for irrigation and fresh alluvial sediments replenishing the soil. However the river systems also give rise to some of the problems faced by the country such as periodic floods which lead to destruction of human lives, livestock, property and crops and also the loss of land on the river banks by erosion. But these problems have been intensified by man himself due to his faulty and unsustainable practices. Groundwater is also an important resource of the study area. Over the past 20 years thousands of Hand, Shallow and Deep Tube wells have been sunk all over the country and are being extensively used for both domestic and agricultural purpose. Although the groundwater aquifer is substantial but the excessive rate of exploitation of the groundwater reserves has become a matter of concern in terms of lowering of groundwater level as well as arsenic contamination. Artificial works such as the construction of railways and roads, bridges and embankments, the silting up of marshes and the premature reclamation of lowlands for cultivation affect the natural drainage, bring about changes in annual floods and disturb the entire river system.

A comprehensive attempt has been made to focus on the various environmental issues (both physical and socio-economic) in the Southern Part of Nadia District (SPND) where the riverine regime and man are closely interrelated to one another. There is impact of the rivers and surface water bodies on man and at the same time the anthropogenic interventions have brought about a lot of harmful changes in both the physical and socio-economic environment.
(16) In addition to the concepts of an ecologic balance of land, trees and waters in a given region and a soil balance, established by the intake of the crops and soil replenishment, we have to introduce the concept of a vast and intricate natural balance established among the various channels of a river system. When man upsets this balance he has to pay the price. Majority of the problems in the study area are due to man’s artificial interference and disregard of the life and process of the river system. The river beds in the area need to be excavated in order that there is flow of water during the lean season. Discharge of both untreated industrial effluents and sewage in the water bodies should be prohibited. Since these are required to be done both in India and Bangladesh, there is need for accord on this point. It is imperative that more water is needed to flow through Mathabhanga to reach the Pabakhali point at Majdia and allow a certain quantum of water flow to Ichamati through a feeder channel of about 9 km length, to be cut connecting Mathabhanga with the chocked Ichamati Water channel. The feeder channel has to be cut deep (greater than 15 ft.) because the floor of the Ichamati river base has raised up due to long many years of non-flowing dry state and the disuse by anthropogenic activities. Rational Management of Water Resources (surface & underground) is to be done with utmost priority. The *bils* should be given extra attention as they are potential resources and can be effectively used for aquaculture as well as for recreational purpose and hence will help to generate additional income to the local people. System of Rice Intensification, Organic Farming, Eco-friendly production technologies and Ecological Pest Management need to be adopted for sustainable agricultural production. For the protection of aquatic and agricultural biodiversity and enhancement of fish and agricultural production, a rational management program should be implemented. Arresting environmental hazards resulting from lack of sanitation facilities, encroachment,
groundwater contamination like arsenic pollution, destruction of aquatic flora, fauna are some of the burning problems of the area that needs to be tackled through participatory mechanism. The sensitive social issues of child labour, haphazard settlement, illegal migration, char disputes need to be tackled through proper legislation and good governance. Finally, proper development of the identified tourist spots in the study area can help in additional income generation for the people of the area as well as upgradation of the SPND. Thus, it can be inferred that the revival of water bodies are to be given the first preference in order to solve the problems of the Southern Part of Nadia District. For the proper management of the SPND, a team of expert technicians of various disciplines, viz., geomorphology, hydrology, geology, zoology, botany, soil science engineering, agronomy, economics and sociology should be formed to collect data in respective spheres, aiming to find out the i) nature and intensity of problems, ii) prospect of the study area, iii) potentiality of overall development iv) availability of technology, v) infrastructural facilities and so on. In this way an inventory of land resource of the SPND may be prepared with the help of the aerial photography, intensive field work and through the investigation of physical and cultural environments. Such inventory will be a guide for the overall development of the people living in the region.

Summarising the whole discussion, it may be concluded that there is a strong relationship among hydrological characteristics, riverine morphology and land utilisation. The river channels have an oscillating tendency from the ancient times in the SPND. There is also a clear relationship between river channel change throughout the historical past and related fluvio-morphological features such as bils, ox-bow lakes, marshes etc. The land use characteristics totally coincide with the fluvio-geomorphic features. Any kind of change in fluvial geomorphology alternates the age old economic and occupational structure of that
particular place. The existing agro-based socio-economic structure with high rate of illiteracy and lack of awareness indulge huge stress on natural physical endowments such as ground water resource, wetlands etc. However, the existing resource potentiality of the study area can be fully utilised and it can also be enhanced by proper implementation of scientific techniques. In a nutshell, it can be said that all the research questions taken are fully confirmed.