Chapter 10

SUMMARY AND CONCLUSION

10.1 Summary

The present treatise is to find out the impact of geomorphology on land use in South-Western Midnapur, West Bengal, India. The whole work has been divided into nine chapters. The first chapter deals with introduction (concept, review of past work, database, etc.)

Geomorphology is the study of the landforms or physical features of the earth, and of the relationship between these landforms and the geological structures beneath. In the present juncture, the application of geomorphological knowledge in land resources appraisal is more relevant to fulfil the increasing needs and desires of the human society. Thus applied geomorphology is the application of geomorphological methods of survey and analysis for the benefit of the society. Geomorphology, the science of landform, obviously can play a pertinent role in the investigation, evaluation and classification of land and soil resources. In land utilisation especially in agriculture, it is not only necessary to know the general character of the relief and the value of surface materials but also the present morphogenetic processes which are actively modifying the landscape.

In applied geomorphological study especially in the field of land utilisation the concept of landscape ecology provides a more scientific base. In landscape ecological study, land is considered as an important resource. Accordingly the study of landscape ecology is very
much relevant for land use planning which is concerned with the ecology of mankind as well as of plants and animals and offers long term benefit. From the utilitarian point of view, the various attributes of land (called land resources) viz. climate, parent materials, relief, soil, water, vegetation etc. are mutually exclusive but genetically and ecologically correlated.

'Land Use' commonly applied interchangeably to the use made by human beings of the surface of the land. Broadly speaking, use of the land is 'land use'. The term may be defined as the putting up of a parcel of land for productive purposes. According to Nanavati (1957) [200] land utilisation is "the conversion of land from one major use to another general use".

Land use is the application of human controls systematically to the key elements of any ecosystem to derive benefit from it. Man being an essential part of the ecosystem tries to manipulate it. Landuse is the result of a scarcity of land. Although sufficient land was available, but adequate fertile and productive land for human sustenance was scarce in most of the continents over thousands of years.

As a whole, land utilisation mainly deals with the problems of the regions. In strict sense, it is mainly confined to the optimum use of limited land among the alternative major types of land use. Land use is thus the result of interaction of geomorphic and socio-economic factors in macro and micro-regional levels. It may, however, be mentioned in this context that geomorphology sets the foundation and background of land use irrespective of any geomorphic environment.

So far as past experiences as regards geomorphological aspects, it is a very difficult task to provide a comprehensive view of work in this extensive and rapidly developing field.

The application of geomorphological knowledge to land classification for the resource development of a region started in the nineteenth century. In the first quarter of the twentieth century geomorphologists like Powell(1896), Davis(1915) [208],[77] and others made a systematic approach for regional divisions of the United States. After the First World
War the American Scientists emphasized on the physical factors like geomorphological attributes and soil character for the initial classification of land.

Land classification system (topographical and pedological approach) was familiar in the United States. Based on the geomorphological analysis Milne (1935) formulated the concept of 'Soil catena' for soil formation. Ecological approach in land classification system was recognised in the United States. Linton's (1951) morphological regions were delimited on the basis of the concept of ecological site and soil-landform relationships. Vink (1961) visualised an integrated survey based on ecological approach.

In the post-war period (World War II), with the rapid change in political, social and economic spheres, planned utilisation of land was felt in many countries. The UNESCO stressed the need for integrated survey of planned development in the developing countries with an aim to analyse and use of various geomorphological components. In recent years survey methods have become sophisticated with the application of remote sensing technique because the principal data source for reconnaissance and photographs are taken from aircrafts and satellites. Geomorphological contributions to terrain evaluation and resource surveys were considered by Beckett (1962), Stewart (1968), Mabbutt (1968), Verstappen and Van Zuidam (1968), Mitchell (1973), Cooke and Doornkamp (1974) [15, 273, 170, 290, 186, 62]. Vink (1963), Christian and Stewart (1968), Doornkamp (1971), Cooke (1974), King (1975), Young (1976) and Mitchell (1977) [293, 56, 160, 302, 187] gave outlines for integrated land resource survey with land system approach using photointerpretation technique.

No such serious attempt has been made in the field of geomorphology and its applications in India, though relevant imperative works on regional forms and processes, soil, vegetations and hydrology have appeared in various journals, proceedings of seminars and symposium organised by the academic societies and institutions. In this context, the works of Niyogi and Chakraborty (1967), Desai (1968), Kayrker et al (1968), Singh (1977), Mukhopadhyay (1981), Sen (1988), Dasgupta (1989), Patnaik (1993), Bedi (1983), Rao et al (1981), Pal (1979), Sarkar (1988) and Sharma (1991) [202, 100, 157, 256, 198, 244, 72, 206, 17, 222, 204, 236] and [250] are worth mentioning.
Scientists in different countries have contributed a lot to diverse aspects of land use. Adam Smith (1776), David Ricardo (1819), Vothunen (1826) and Alfred Marshall (1890) were some of the pioneers of the early land use studies and their works are still serving as the foundation of most of the present day theories. It may be mentioned that L.D. Stamp was the pioneer in the field of land use studies whose valuable work (1951) has provided primary guidelines to geographers and planners to carry research works on land use in different parts of the world.

Inspired by the classical work of Prof. L.D. Stamp the Indian Geographers initiated land use studies in different parts of the country. Prof. S.P. Chatterjee was the pioneer of land use in India. According to Chatterjee (1953, 1956, 1962) the different types of land use reflect an intricate pattern which needs geographical investigation in respect to their physical environment. He further pointed out that emphasis should be laid on sample surveys due to the rapid change in physical conditions from one region to another. For solving India’s land problems he suggested to undertake a scheme of land use survey on a national basis which may be of great help to the Planning Commission, Government of India. Besides, land use surveys (both rural and urban) in several parts of India were conducted by many Indian geographers in different years.

The work is limited to the study of geomorphological attributes and agricultural land use which is mainly based on intensive field work. Survey of India Toposheets for the entire area and aerial photographs in case studies have been used in the present analysis.

Basic data have been collected both from primary and secondary sources. For secondary information government / semi-government, private organisations, libraries and related administrative machineries have been approached for necessary data for all practical purposes.

The South-Western part of Midnapur District, West Bengal, India extends latitudinally from 21°44′N to 22°26′N and longitudinally from 86°42′E to 87°33′E. Comprising an area of about 2392.88 sq.km it includes Gopiballavpur (I & II), Nayagram, Sankrail, Keshiary, Narayangarh, Dantan (I & II) Blocks. As a whole the study area represents dual
character of Chotonagpur plateau fringe in the west and Gangetic alluvial plain in the
east. The geological formation of the area belongs to older alluvium (laterite) and newer
alluvium. Majority of the area shows beds of gravels, grits and sands of Tertiary age. The
surface is mostly of pisolitic, gravelly and nodular in character, while the eastern part as
well as the river valley are alluvial in nature. The area is traversed by R.Subarnarekha
(golden-streaked river) and its tributary Dulung followed by R.Keleghai. As a whole it
has modified tropical monsoon climate. Laterization is the predominant process of soil
formation. Alluvial soils are common in the east and along the river valleys. The area
under investigation represents tropical vegetation. Situated in a rural backward tract of
West Bengal, the South-Western Midnapur has a poor agro-based economy.

In Chapter two the methodology in detail has been discussed. The methodology
has been divided into three phases viz. pre-field methods, field methods and post-field
methods. In the pre-field methods, all available maps (topographical maps - 1 : 50,000;
aerial photographs - 1 : 25,000; geological maps and soil maps etc.), literatures and statisti-
cal data have been collected, processed and interpreted for arriving at an understanding
about the existing situation of the area concerned. The field methods include morphologi-
cal divisions and their associated land units, measurement of general gradient, observation
of drainage pattern, study of underground water situation, collection of soil samples (both
surface and profile), identification of general land use pattern, collection of data regarding
irrigation and production, detection of problems through questionnaires, taking of
photographs of typical features etc. In the post-field methods data collected so far are
compiled and analysed which include determination of physical and chemical properties of
soils, morphometric analysis of the study area, analysis of aerial photographs, evaluation
of land potentialities, land capability classification, formulation of planning strategies etc.

Chapter three deals with the factors of land use (both physical and human) in
the area under study. Physical factors include geology, relief, drainage, climate, soil,
vegetation etc. whereas human factors include irrigation, fertilisers, pesticides, high-
yielding variety seeds, power, credit facilities, population etc.

The geological formation here displays two pronounced diversities viz. older alluvium
(laterite) of Tertiary period and later formations as well as loose unconsolidated recent alluvium of the Quaternary period.

The south-western Midnapur can be divided into two major units mainly based on relief pattern and altitude: (i) the Plateau Fringe and (ii) the Plains. The plateau fringe (extending from 50m to 120m and covers 60% of the study area) with predominantly lateritic topography and erosional surfaces are common, while the eastern part possesses the depositional characteristics of low-lying plain (20m to 50m, 40% area coverage) formed by the younger alluvium which experiences a very low intensity of soil erosion.

The area understudy is drained by the R.Subarnarekha, Dulung and Keleghai. The R.Subarnarekha (golden-streaked river) is the principal river of the area. It enters the area on the north-west from Dhalbhum at an elevation of 60m above m.s.l. and flows through the southern portion of the region and finally falls into the Bay of Bengal. It is a swift flowing stream with sandy beds and its banks are generally high and well defined.

The R.Dulung, the most important tributary of R.Subarnarekha, drains a considerable part of the area under study with its source in Jangal chaukisal (J.L.No.152), at an elevation of 250m above m.s.l. It joins the R.Subarnarekha near Rohini in Sankrail Block.

The R.Keleghai, second tributary of the Haldi rises in the west of Midnapur district and flows in an easterly direction through the Narayangarh and Sabang police stations till it unites with the Kasai to form the Haldi. Unlike other rivers, the Keleghai is prone to floods and has vigorous gully erosion in the upper reaches causing serious drainage congestion.

Thus, the drainage systems of the R.Subarnarekha and its tributaries reflect the most dominant geomorphic agents of the fluvial changes of the area and accordingly has a direct and indirect impact on landuse.

Climate is one of the important determinants of land use. Distribution of temperature, rainfall, and relative humidity are responsible for the variation in the types of land use.

Generally speaking, the climate of the study area is characterised by hot and moisture conditions (tropical monsoon climate). It is distinguished as Aw type according to Kop-
pen's classification with a wet dry seasonal condition. The temperature condition is more or less moderate in nature. January is the coldest month whereas May is the warmest month. The average maximum temperature for the month of May is 32.2°C. Owing to the existence of laterites in the study area, the surface becomes hotter.

June, July and August are the months of low pressure. The area is occasionally invaded by cyclonic disturbances. August is marked by maximum humidity (84%). The monsoon precipitation (annual average: 1450mm) is less in the undulating west than the eastern alluvial tract (1750mm). The agricultural prosperity is very much dependent on the arrival, duration and quantum of rainfall. If the monsoon is delayed, there is every possibility of recurrence of floods. In the area, drought and flood are the alternate climatic hazards which cause severe damage to standing crops.

Soil is the part and parcel of land as well as basic determinant of land use. The soils of the area under study can broadly be grouped into four major types viz. lateritic, red gravelly, older alluvial and newer alluvial. Each of the soil types with their natural capability and limitations reflects different categories of land use as well as intensity of land use practices. The lateritic soil with fluctuating underground water and having poor nutrient status poses constraint to optimum land utilisation whereas the older and newer alluvial soils offer favourable conditions for good crop production. In the red gravelly soil the scale of land utilisation is comparatively better than the lateritic soil.

Vegetation is one of the major soil formers and indirectly controls land use. The fertility of soil which is dependent on vegetation to some extent regulates the scale of land use practices. The study area reflects two distinct physiographic diversities hence the diversification of vegetal cover. Forest as such is found in the lateritic tract. The main concentration of forest is at Nayagram and Gopiballavpur, whereas a small quantum is found at Sankrail, Keshiary and Narayangarh Blocks. The lateritic undulating tract contains jungles of Sal, Kusum, Peasal etc. with many shrubs and climbers. In the alluvial terrain of the east as well as in the riverine floodplain no such remarkable forest cover is present. Only indigenous plant species viz. Bamboo, Neem, Mango, Babla etc. are found in scattered patches.
Due to diverse geomorphological character of the area under study the quality of terrain varies from west to east, accordingly the vegetal cover in the area also varies. The west is dominated by forest land use (main concentration is at Nayagram) whereas in the east agricultural land use is predominant.

Human factors include irrigation potential, fertiliser, pesticide, H.Y.V. seeds, power, credit facilities, training programmes and population.

Irrigation is considered as one of the most important parameters in the transformation of land use because here rainfall by nature, is inadequate, uneven and uncertain. It is quite evident that the study area generally suffers from prolonged drought which needs proper irrigation facilities. Irrigation is used to overcome the drought condition.

In the area, irrigation (both from surface and sub-surface) mainly depends on the monsoonal rainfall. Water is extracted directly or through controlled outlets of reservoirs as well as from dams, weirs etc. for agricultural land utilisation in the dry periods. Presently groundwater is also increasingly used for irrigation and domestic purposes especially from dugwells, deep and shallow tube wells. Irrigation practices here are mainly confined to the aggradational plains (Subarnarekha, Keleghai and Murli basins).

Fertiliser is the basic input for a secured agricultural production. In recent years, manures and fertilisers are increasingly used to raise the fertility status of the soil thereby to increase the agricultural production in the area under study.

A variety of liquid, globule medicines are used to protect the crops from pests, insects, fungus and bacterial infection.

Rural electrification is one of the most basic need for transformation of rural life and agricultural production. Electricity has been extended to some parts of the area under study by West Bengal State Electricity Board.

The credit facilities are essential for the optimum utilisation of land. Commercial banks provide loans to a section of cultivators for the construction of shallow tube-well, purchase of fertilizers, pesticides and other agricultural implements. The co-operative sector supplies fertilizers, seeds and pesticides in the area but these are not to the desired
For the optimum utilisation of land as well as implementation of modern agricultural methods, proper training of farmers is an utmost necessity. The training programmes (i.e. short demonstration camp, field visit, Kisan Mela etc. and audio-visual aids) have been introduced in the area since 1980 and is still being continued.

Population including labour force plays an important role in land utilisation. A close relation can be traced between the concentration of population and land use practices and patterns of land use.

The occupational structure of the area reveals that most of the females are non-workers and a quite insignificant number is engaged in agricultural activities. But the recent investigation by the author shows that the picture has been changed significantly due to the exposure of females to modern education which is important for optimum land utilisation.

The people of the area concerned are exposed to modern technology and are also agreeable to accept it, but their poor economic conditions prohibit them to use the technology freely.

Chapter Four deals with the geomorphological characteristics which includes land forming processes (erosional and depositional processes), morphometric analysis (average relief, relative relief, stream frequency, drainage density, dissection index, ruggedness index, average slope), nature of underground water (groundwater fluctuation scenario and groundwater recharge), soil forming factors and processes, pedological variations (lateritic soils, red gravelly soils, older alluvial soils and newer alluvial soils) and geomorphological regions.

Land forming processes include both erosional and depositional processes. Different types of weathering, erosion and deposition are the important factors in the development of landscape in south-western Midnapur. Diverse erosional agents such as surface water, groundwater etc. play a vital role in the development of landform in different environmental situation (plateau fringe and plain). It may be mentioned that weathering, erosion
and deposition are the acting processes which are responsible for the dynamics in the landscape of the area under study. In addition, some non-physical factors viz. deforestation and boulder extraction accelerate the erosional processes and hence the development of landforms.

Morphometric analysis provides sufficient clues to visualize and reconstruct the analysis of regional morpho-units. This analysis helps to pinpoint those parts of the area where drainage, relief and slope aspects need intensive investigations. In the present context, different morphometric attributes (i.e. stream frequency, drainage density, average relief, relative relief, dissection index, ruggedness index, slope etc.) have been applied to represent the nature of topography and its relevant relationship with land utilisation.

The range of stream frequency in the area under study has been divided into four categories viz. very low (55.81% of the total area), low (28.06%), medium (13.64%) and high (2.48%).

In South-Western Midnapur the range of drainage density has been divided into three categories viz. very low (44.95% of the total area), low (33.02% of the total area) and medium (22.01% of the total area).

In the present context the author has adopted the technique of average relief in order to categorize the study area into several average relief zones for land utilisation purpose.

The range of average relief has been divided into three categories viz. very low (27.35% of the total area), low (56.68% of the total area) and moderate (15.95% of the total area).

The relative relief map shows that there is no such abrupt variations in relative relief in the area, although the western lateritic undulating tract reflects some changes. Three major categories of relative relief have been identified in the present context viz. extremely low (86.90% of the total area), moderately low (10.86% of the total area) and low (2.24% of the total area).

On the basis of dissection index the area has been divided into three major categories viz. low (41.67% of the total area), moderate (38.83% of the total area) and moderately high (19.50% of the total area).
Based on the ruggedness index the area has been divided into two major categories viz. low (95.06% of the total area) and moderate (4.94% of the total area) to assess the nature and magnitude of ruggedness for practical purposes.

The average slope of the area has been divided into three categories viz. level (81.04% of the total area), very gentle (16.97% of the total area) and gentle (1.99% of the total area) for assessing the intra-regional capability and limitations for agricultural development.

Ground water influences the land use pattern of a region. It may be mentioned that the lateritic tracts are intimately linked with the oscillation of ground water table. The groundwater table oscillates between the monsoon and dry season which apparently corresponds with the periods of leaching and capillary actions respectively. The ferralitic soils, result of groundwater actions are not always conducive for agricultural land use while in the alluvial tract groundwater contributes saturated soil and favours large scale cropping practice.

To assess the groundwater conditions the detail study of hydrogeology of the area is essential. For this purpose the study area has broadly been divided into two hydrogeological zones viz. Platform zone and Alluvial zone. So far as groundwater fluctuation is concerned, the depth of water table in the laterised platform experiences a substantial variation from 2m to 15m below ground level. It may be more in drought-prone areas. In the alluvial zone the depth of water level varies between 2m and 20m below ground level.

It is evident that the pronounced seasonal fluctuation of water table is the main constraint of water use for land utilisation. The summer months experience drought condition when the extraction of groundwater becomes quite difficult.

Soil is the product of parent material, climate, relief, biosphere and time. The soil forming factors and processes in regard to the soils of the area under study have been analysed.

Soils of the area are classified as (a) lateritic, (b) red gravelly, (c) older alluvial and (d) newer alluvial.

Lateritic soils cover the north-eastern and south-western parts of the area (roughly
lying between 50m and 120m contour lines). Soils are characterised by sandy loam in texture, reddish brown in colour, presence of iron concretions, moderately acidic and low organic matter content.

Red gravelly soils are found in the extreme western part of the area. These soils are generally lying between 100m and 120m and mainly developed on newer alluvium. Soils are characterised by thin, very coarse in texture, brown to grey brown in colour, low water holding capacity, slightly to moderately acidic and very low organic matter content.

Older alluvial soils are found in the central part as well as in the south-eastern and north-western parts of the area. Soils are characterised by sandy clay loam to clay loam in texture, brown to grey brown and olive brown in colour, high water holding capacity, slightly acidic and high organic matter content.

Newer alluvial soils are found along the valleys of R.Subarnarekha. Soils (developed on newer alluvium of recent origin) are characterised by sandy-clay loam to clay loam in texture, brown to grey brown in colour, very high water holding capacity, slightly acidic and high organic matter content.

By superimposing the maps of different land attributes (geology, average relief, relative relief, dissection index, ruggedness index, average slope, depth of water table, stream frequency, drainage density, soil etc.) a final map showing geomorphological regions has been prepared. Thus, the area under study may be divided into two broad geomorphological regions which are classified into units as follows:

I. Plateau Fringe (Degradational Surface)
   1. Upper Degradational Surface
   2. Lower Degradational Surface

II. Gently Sloping Flat Plain (Aggradational Surface)
   1. Upper Subarnarekha valley (older & newer alluvial tract)
   2. Lower Subarnarekha valley (older & newer alluvial tract)
3. Keleghai Basin

4. Murli Basin

Plateau Fringe

It is a degradational surface which experiences accelerated soil erosion mainly caused by gullyng, leaching and human interference in the form of deforestation. Covering a major part of the area the region is confined to the extreme northern, north-western, southern and south-western parts. It is covered by older alluvium (lateritic) with moderate average relief (60m - 100m), moderately low (10m to 30m) to low (above 30m) relative relief, gentle (above 2°) to very gentle (1° - 2°) average slope, moderately high (0.3 - 0.4) to moderate (0.2 - 0.3) dissection index, moderate (above 0.02) to low (below 0.02) ruggedness index, high (above 2.00) to medium (1.00 - 2.00) and low (0.5-1.00) stream frequency, medium (above 1.00) to low (0.5-1.00) drainage density, deforested, lateritic and red gravelly soil. The soil is relatively mature with moderate to low fertility and has fair to poor potentiality for agriculture and agro-forestry.

Considering the geomorphological attributes, it may, however, be pointed out that the lower degradational surface has got comparatively much more potentiality for land utilisation than the upper one which is confined to the extreme south-west.

Gently Sloping Flat Plain

The region is an aggradational tract confined mainly to the eastern and south-eastern parts as well as along the river valleys of the area under study. It is an outcome of the deposition of sediments brought down by the rivers. The region experiences very low (below 30m) to low (30m - 60m) average relief, extremely low (below 10m) to moderately low (10m - 30m) relative relief, level (below 1°) to very gentle (1° - 2°) average slope, low (below 0.2) to moderate (0.2 - 0.3) dissection index, low (below 0.02) ruggedness index, very low (below 0.5) to low (0.5 - 1.00) and medium (1.00 - 2.00) stream frequency, very low (below 0.5) to low (0.5 - 1.00) and medium (above 1.00) drainage density, older and
newer alluvial soils. The soil is rather mature in the older alluvial tract and it is younger along the river valleys. Rivers in general are sluggish in nature.

The upper and lower Subarnarekha valleys as well as Keleghai and Murli basins although are included under aggradational tract experience river bank erosion. Due to level slope, availability of surface and underground water, periodic renewal of alluvial soils through siltation by occasional flooding this geomorphological region offers favourable conditions for agricultural land utilisation.

Chapter five deals with land evaluation and classification of the area under study. Land evaluation may be defined as the result of expressing the worth of the concerned land. Keeping in view the problems of population and crisis of land it is necessary to evaluate the inherent land qualities as well as to solve the problems of land use in the area concerned. In the present context rating values are given for the individual geomorphological attributes for the proper land evaluation and land classification purposes.

Land classification is a scientific appraisal of the physical characters of the land, inherent soil qualities etc. for optimum utilisation. In the present context different land units of the area under study are categorised as class I land (excellent), class II land (very good), class III land (good), class IV land (fair) and class V land (poor) on the basis of their potentiality and capability.

In Chapter six, land use characteristics of the area concerned have been dealt in detail. Agriculture is the mainstay of the study area. So, the author feels it necessary to interpret land use in general and agricultural land use in particular. The discussion deals with the existing land use characters, changing patterns and trends of land use.

Chapter seven deals with geomorphology and land use. It is beyond doubt that land use of any area is primarily dependent on the nature of landforms and their morphological characters. In the present context, the land use pattern in relation to geomorphological attributes in the area concerned has been established.

To establish this relationship the detail geomorphological attributes and land use practices of the different land units have been assessed in tabular formats and correlated.
In Chapter eight, the micro-level case studies have been made primarily based on the aerial photographs (1 : 25,000). Two micro-level case studies belonging to two broad (macro) geomorphological regions have been undertaken in the present context to establish relationship between geomorphology and land use which are supplemented by topographical maps and thorough ground check. The case studies as identified in the photographs are: (1) Sorrong - Anikola Area and (2) Keshiary - Bhasra Area.

Bounded by the latitudes 21°48'N - 21°54'N and longitudes 87°17'E - 87°22'E, the Sorrong - Anikola area (Dantan I Block) is located in the south-eastern part of the area. Covering an area of 32.45 sq.km it is a part of the gently sloping flat plain. The general geology is alluvium (newer). It is characterised by modified tropical monsoon climate with occasional cyclonic disturbances. No such forest cover is present but tropical deciduous species in scattered patches are common here. Based on the photo pattern the Sorrong - Anikola area has been divided into three geomorphic units viz. (i) Unit-1 (upper tract), (ii) Unit -2 (middle tract), and (iii) Unit -3 (lower tract).

Bounded by the latitudes 21°1'N - 21°10'N and longitudes 87°10'E - 87°15'E the Keshiary - Bhasra area (Keshiary Block) is situated at the northern part of the area. The area represents a dual character of undulating terrain and aggradational plain. General geology belongs to both older and newer alluvium. It is characterised by warm and moist climate (tropical monsoon) with cyclonic disturbances. Drought in the undulating terrain and flood in the riverine floodplain are the regular phenomena. The undulating section is dominated by forest cover whereas in the upper and lower floodplains, scattered patches of deciduous species are common. It covers an area of 32.67 sq.kms. Based on the photo pattern the Keshiary - Bhasra area has been divided into: (i) Unit -1 (undulating terrain), (ii) Unit - 2 (upper floodplain) and (iii) Unit - 3 (lower floodplain).

The geomorphological and land use characteristics of the different units belonging to (1) Sorrong - Anikola area and (2) Keshiary - Bhasra area (two case studies) are discussed in detail and correlated.

Finally in Chapter nine, land use planning in the area has been discussed in
detail. Keeping in view the future planning of land use in the area problems are identified and accordingly strategies are suggested as follows:

Problems: (1) gully erosion, (2) soil erosion, (3) flood hazards, (4) drought problem, (5) deforestation.

Strategies: (1) measures to check gully erosion, (2) measures to check soil erosion, (3) flood management, (4) management of irrigation, (5) watershed management, (6) dry farming, (7) measures to check deforestation.


10.2 Conclusion

The Golden Jubilee year of India’s independence provides a question mark - is the rural poor/people self sufficient or they have been able to meet their expectations at least the five basic needs? Poverty is a common phenomena in India which sets limitations to significant economic development. The evil of poverty is the resultant outcome of population explosion which according to Malthus expands in geometric progression. Hence the increased food production in arithmetic progression can not be able to cope with the situation as well as can never bridge the existing gap rather it increases gradually. The urban affluents are quite aware regarding exceptional growth of population but the rural folk still remain in the camouflage in this regard. Thus instead of becoming an asset or resource in its right number, excessive population has become a liability to the nation.

The Government is conscious about large manpower, poverty and problems of underemployment. Keeping these social mishaps in view, several attempts have been made to reduce this through the implementation of different schemes under five year plans viz.
National Rural Employment Programme (NREP), Rural Landless Employment Guarantee Programme (RLEGP) and Integrated Rural Development Programme (IRDP) etc., most of which are agriculture oriented. In addition, a scheme entitled 'Technology Mission' was introduced during the tenure of Rajiv Gandhi Government with the aim to pursue the development in agriculture in some selected districts of India by providing modern infrastructural facilities. Despite all such measures the crux is that the poor becomes poorer and the rich richer.

In the vastly populated country like India, pressure on land is a matter of great concern. For want of ecological perception amongst the people, the land is not utilised in its optimum. In such a circumstance, actual understanding, proper measurement of land potentiality and its required management practices are a major field of research for the geographers.

As the study area is an agrarian one and as there are no alternatives to economic development, relevant measures are to be taken by the Government to optimise the land utilisation to form a sound agro-based economy.

In the area under investigation several measures have been suggested to eradicate the identified problems towards effective land utilisation. The Government has also adopted some measures for the economic development in general and agricultural development in particular. It may be pointed out in this context that an important barrage project has already been introduced and designed (at the first phase of construction) on the R.Subarnarekha which is expected to provide a fresh lease to agriculture - the main pillar of economy in the area concerned. The alluvial tract of the east (Naryangarh, Dantan-I & II Blocks) will be benefited only from the project whereas the undulating lateritic terrain (Nayagram, Gopiballavpur -I & II, Sankrail Blocks) suffering from water crisis and prolonged drought have not been included under the proposed irrigated area of the project. The researcher categorically points out that it is a major drawback of the project and accordingly suggests that the Government should refresh and rechalk the scheme so that the drought prone areas may be benefited.
There are, however, some minor irrigation schemes (few completed, few ongoing and few proposed) in the western undulating tract. For optimum land utilisation purposes these are quite insufficient and hence are required to be integrated with the main Subarnarekha Project to get better result and long-term benefit.

Inspite of the Government efforts the study area is still backward. It is not beyond doubt that the Government efforts already mentioned (in chapter 9) fails to give effective result to land utilisation or these are insufficient than the desired level.

During the course of entire research work the necessary data and relevant information which the researcher has consulted are duly supplemented by thorough field work. It may especially be pointed out that the study area is the native place of the author which provides an added advantage to him to carry out the work in a proper perspective.

Despite many constraints as well as research handicaps the author has tried to reveal the area in real sense and pinpoint those problems which need rational management for effective land utilisation. However, the present work is considered not only as a scientific one, but also precise, accurate, easy, less time-consuming and at the same time this can safely and satisfactorily be applied to any scale of working for the regional development whether large or small, under-developed or developed.

Finally, the strategies for land use planning and development as suggested can be meaningful and worthwhile and take its proper shape provided the government takes the responsibility of implementing it. And here lies the achievement and success of the researcher's humble contribution to this effect.
Plate 1: Undulating lateritic topography subsequently sculptured by the R. Subarnarekha. The then English trader’s (East India Company) ‘nilkuthi’ (building for processing indigo), the remnants of which are seen.

Plate 2: A view of soil (red gravelly) profile at Bhola, Gopiballavpur-I.
Plate 3: A contrasting view of river bank at Hathibari, Gopiballavpur-I (border between Bihar and West Bengal). The demarcated areas indicate steep and gentle river banks respectively. The blue arrows indicate very deep water of R. Subarnarekha.

Plate 4: Another view of R. Subarnarekha at Hathibari with big sandbar and river lift irrigation device.
Plate 5: A view of boulder excavated field (laterite) near Keshiary leading to land degradation.

Plate 6: A view of the weathered laterite near Keshiary.
Plate 7: Nature of river bank erosion (R. Subarnarekha) at Kuthighat, Gopiballavpur-II.

Plate 8: The researcher, on the vast stretches of flood plain on the R. Subarnarekha (near Nayagram), observing the surrounding topography with the help of a binocular.
Plate 9: Small and scattered Sal forest along Nayagram-Kharikamathani road. The demarcated area indicates duricrust formation.

Plate 10: Auto-flow at Gopiballavpur village.
Plate 11: Deep tube well, a means of irrigation used for double cropping near Belda area, Narayangarh Block.

Plate 12: The background shows degraded Sal forest whereas in the foreground newly growing sal saplings near Kharikamathani are seen.
Plate 13: A view (in the background) of moderately undulating topography with some acacia trees. In the foreground, alluvial tract is being used for H.Y.V. rice cultivation at Dangarsai, Gopiballavpur-II.

Plate 14: H.Y.V. paddy cultivation in the fertile tract of Sorrong village, Dantan-I.
Plate 15: Potato cultivation in the alluvial tract of Belda area, Narayangarh Block.

Plate 16: Vegetable gardening (Cauliflower, Palang- a species of spinach) near Bhasraghat, Keshiary Block.
Plate 17: Sugarcane cultivation on the left bank of R. Subarnarekha (Bhasraghat area) and unutilised extensive sand deposit.

Plate 18: Babui grass cultivation at Kharikamathani (Nayagram Block), a source of income to the people inhabiting the area.
Plate 19: A view of current fallow (more than 1km) between Dahi village and the main channel of R. Subarnarekha, Nayagram Block.

Plate 20: Plantation of Eucalyptus, a part of social forestry programme, near Kharikamathani, Nayagram Block.
Plate 21: Sidhu-Kanu-Birsu Setu (bridge) on the R. Subarnarekha at Gopiballavpur.

Plate 22: A part of the embankment (mainly boulders) along the left bank of R. Subarnarekha to prevent the ingress of floodwater during rainy season near Nayagram.
Plate 23: The trainees (mainly tribal) with some babui products at Kharikamathani, Nayagram Block.

Plate 24: A weekly village market at Kharikamathani, the place for marketing the agroproducts and agricultural implements.