Chapter – V

Conclusion and Recommendations

5.1 Conclusion

Landscape ecology related research is the science of learning and improving links between ecological progress in the environment and particular ecosystems. This is done restricted by a diversity of landscape scales, improvement spatial outlines and directorial levels of research and strategy. As an extremely interdisciplinary ground in systems science, landscape ecology incorporate biophysical and systematic advance with humanistic and holistic standpoints athwart the natural sciences and social sciences. Landscapes are spatially diverse geographic regions characterized by varied cooperates territories or ecosystems, varieties from reasonably natural terrestrial and aquatic ecosystems such as forests, grasslands and lakes to human conquered environments together with agricultural and urban surroundings. The foremost significant individualities of landscape ecology are its prominence on the association among pattern, process and scale and its center on expansive scale ecological and environmental concerns. These require the combination between biophysical and socioeconomic study.

The perception of landscape was primarily anticipated by German geographer Carl Troll in the explanation of Remote Sensing images in East Africa. As an intricate of the natural facade, the landscape is of a spatial heterogeneity of a provincial ecosystem compilation. It consists of a variety of heterogeneous rudiments. Due to the environment of soaring heterogeneity of the landscape modification, the transformation of its complete arrangement and dynamic process is comparatively slow, but spatial workings of the landscape can be distorted in diverse speeds and intensities when troubled.

The coastal belt of the tropics is an ideal site for coastal chenier plain topography. They are categorized into sequences of chronological development in the present study. Topographically, it is also visible from the present contour plan (50 cm interval) that the morphological features behind the Ramnagar-Deuli beach ridge sections represent three categorizes of surface formations under different processes. Some isolated ridges with above 10 m elevation are extended in a linear pattern with parallel to the modern shoreline behind Ramnagar-Deuli beach ridge sections belong to first category of landform.

The second category of landform of the region is extended in the form of sandy terrace and continuous sand ridge surface along the sides of first category landform which is ranging from 7 m to 10 m in elevation from the MSL and the surface was probably the remnant of ancient wash over sand fan lobes developed with landward encroachment of storm surge induced over wash deposits.

The third category of landform is visible along the margins of second category of continuous sand ridge topography in the form of extensive sandy tract with reactivated sand surface. The reactivation of the surface was probably possible by storm surge induced wash over deposition and extension of lobes. They are ranging from 5 m to 7 m elevation at present.

The another category of ancient surface with elevation of 2.5 m to 5.0 m above MSL is also clearly visible from the wide valley flat surface depressions in between Contai-Paniparul beach ridge section and Ramnagar-Deuli beach ridge section at present. They are probably developed in the form of tidal basins or tidal lagoons in the ancient period and modified gradually by tidal deposition as well as by monsoon flood plain deposition with Subarnarekha distributaries channel of the area in the past.

Landscape index is frequently used to determine the landscape pattern at a province scale, and thus in a learning of landscape ecology, it is concerned in the landscape ecological appraisal outline. A landscape ecological expansion index is often assembled by using information of provincial land use and landscape construction derived from remotely sense data. It is an incorporated ecological pattern index that is spatially changeable, reviewed by using a methodically sampling system. This is reliable with an improvement inclination of macro ecology in modern years, which put emphasis on the impact of human behavior on an ecosystem and focuses on the revise of ecological setting social economic intricate. The Shannon Diversity Index, Hierarchical Cluster Analysis, Sorenson's Coefficient shows that the vegetation diversity is very high in the beach ridge surface, beach ridge fringed coastal plain, swale topography, inner coastal plain with abandoned creeks and older natural levee bank surfaces. These areas of vegetation diversity are weakly susceptible to infrastructure development and contain high soil moisture and subsurface ground water sources. However, the dense orchards also have been grown up due to plantation by people resided there from the time of

immemorial. They are also the only topographic highs of the region suitable for the spread of settlement in the past to avoid the salt water inundations through repeated cyclone landfalls.

The landscape itself is a resource of human economic activities and an entity of human utilization. The economic activities of human beings are mostly conceded at a landscape level. The landscape has become a suitable scale to appraise the impact of human activities on the environment. Compared with the provincial landscape ecological progression and its change estimation that focuses on a widespread appraisal of manifold risks and on an overall risk quantitative consideration of ecological environment, the landscape ecological development estimation arranges more prominence on the consequence of landscape pattern on ecological procedures or functions. The valuation estimation of ecological services designates high anticipated values of diversified vegetated arenas of the coastal tract and economical services on the other side specify the probable higher values in favour of profitable fish farming plots and open marine fishing sectors of the sea shores. However, the study also shows the lowest values of agricultural rice paddy fields for the region.

A systematic landscape ecological consideration and landscape pattern evolution investigation may endow with a significant orientation for setting up an ecological risk early warning system, dropping an ecological risk prospect and endorsing a coastal landscape pattern optimization. As an entity of human activities to resource uses and environment exploitations, the landscape is an apprehension of ecological researchers. As per the landscape ecological pattern progression study at a regional scale, the possibility and impact enormity caused by human activities, natural disasters and environmental pollution on ecosystem configuration and function can be calculated and evaluated. Accordingly, a variety of prospective ecological environment impact features, processes and their collective consequences can be comprehensively assessed through the landscape ecological pattern evolution study.

The coastal sector ecological pattern is a dynamic procedure that is characterized by constant update and transforms. Further, the risk factor, environment and acceptance can drastically influence the ecological pattern in the coastal zone. Along with the economic expansion in the world, particularly developing countries per India as a

representative, the prompt urbanization, and the tribulations of population density, traffic congestion and deficiency of resources, environmental pollution and ecological weakening have become foci of concentration of the whole human society in the procedure of urbanization in the coastal zone. The impact of human activities on the alteration of the earth scheme is further than the natural strength and cannot be ignored. Rapid urbanization directs to a large diminution in arable land, annihilation of habitat, extermination of species, and diminution of net primary productivity. Due to the prompt urbanization, the impact of human activities on the environment will unswervingly alters the unique land use pattern and cause the change of land use/cover, thus intensely distressing the Earth's ecosystem.

5.1.1 Essence of the Present Study

The physiographic of alluvium coast plays a very significant role in coastal morphodynamics in response to outer environmental impacts with significant change in boundary conditions of the local area. Chronological Development of Coastal Landscapes through landform units in different orders of formations, their surface morphometry, drainage features, hydro-geomorphology and changing tidal prisms to explain the nature of shoreline dynamics of the coastal plain topography. The chronology of the coastal evolution is explained in this part of the thesis with the application of available dating records of different landform units in the existing literatures, estimation of present day wave hydro-dynamics and energy level along with the sediment budget estimation of the near shores to predict and establish the evolution of chenier coastal plain. There are three bifurcated ridges in the form of narrow and low height ridges in the wide valley flat surface in between Ramnagar-Deuli beach ridge section and Digha-Junput beach ridge section. The three barriers are separated by linear depressions running parallel to the present ridge lines and represent as linear tidal basins of that time. To the east, the wider flats of tidal basins are characterized by location of younger natural levees and older natural levees and some depressed wetlands. Tidal prism is the volume of tide water entire into the tidal spill grounds through the tidal inlet channels from the sea face and return the same volume tide water at the ebbing stage of tides through the same tidal inlets. Tidal prisms are the result of high standing tidal

waves keeping pressure on the seaward sides to spill over the back shore area by entering into the tidal channels at the time of high tide levels in the coastal belt. A large volume of salt water flux with sediments are always transferred into the low lying wetlands by the tidal prism for the maintaining of life support systems of the vegetated tidal flat behind the sand dunes or barrier bars along the coastal plain.

The modern shoreline of the coastal plain is fringed by high elevated sand dunes up to 17 m in height, but presently, they are isolated and segmented into 12 dune ridge topography along the shore face by extensive erosion for the landward advancing sea and human activities. As the sediments deposited by the down drift currents are modifying the inlets by high rate of deposition, the inlet mouth become narrower by advancing sand spit. However, the up drift current coming from north north east wind systems along the shore parallel direction with moderate energy transport limited amount of sediments to fill the narrow inlet mouths.

The present studied coast is under the coastal plain topography of alluvium surface with beach ridge chenier and swales which formation had been exicuted during Early Holocene, Middle Holocene and Late Holocene period extending from 7,000 YBP to 500 YBP and sub recent stage. The chenier plain is the product of the combination of sediment discharge into the coastal zones by fluvio marine deposition with presence of strong long shore currents at the sea face, activities of repeated coastal storms, impacts of tectonics and past sea level fluctuations. Seven stages of coastal chenier formations are found in the studied coast, among them the long shore current energy is calculated and estimated as highest for the Contai-Paniparul beach ridge chenier, Ramnagar-Deuli beach ridge chenier and Digha-Junput beach ridge chenier after consideration with the volume of sediment estimation under modern sea face energy levels. However, the shorter beach ridge cheniers are produced under weaker long shore current energy in East-East North (E-EN) direction, parallel to the present day shoreline. On the other hand it is also observed that the wide shallow flats in between landward and seaward beach ridge cheniers were formed by the finer sediments (swale topography) deposited under lagoonal setting behind the barrier bar systems, and supply of finer sediments by Hugli river mouth discharges into the Late Holocene tidal basin. Most recent the shoreline beach ridge cheniers are segmented by older distributary channels and acted as

tidal inlet mouths along the shore face and modified by present day coastal processes. The effects of tidal prisms are significantly increased in 2017 in compare to the year 1990 in the coastal belt of today.

The native vegetation in coastal areas plays a significant role in stabilizing the surface against wind erosion and provides habitat for wildlife. So the protection of coastal vegetation is important for the long-term protection of beach front properties. It is not sufficient to describe the patterns of species turnover at an ecotone; one must think about the underlying causes of that turnover, how species are responding to the environment and the relative distributions of these species along the gradient. The Proximity Matrix shows the distances between cases first two cases could not to be joined together. The agglomeration schedule displays how the hierarchical cluster analysis progressively clusters the cases or observations. Each row in the schedule shows a stage at which two cases are combined to form a cluster, using an algorithm dictated by the distance and linkage selections. The vertical lines in the dendrogram represent the grouping of clusters or the stages of the agglomeration schedule. They also indicate the distance between two joining clusters (as represented by the x-axis, located above the plot). As the clusters being merged become more heterogeneous, the vertical lines will be located farther to the right side of the plot, as they represent larger distance values. The icicle plot is easier to interpret when examining it from the bottom to the top. Each of the yellowish bars in the plot represents one case. However, it is important to note the areas between cases and when they become shaded. The point at which the space between two cases becomes shaded represents when the cases were joined together. Five types of vegetation community are identified through the transact method (e.g., grasses, heaths, scrubs, small trees and large trees) with 106 types of species and 25 types of micro landscape ecological units in the present study area. The vegetations are widely distributed and extended over the beach ridge surface, beach ridge fringed coastal plain, swale topography, inner coastal plain with abandoned creeks and older natural levee bank surfaces. The maximum diversity of vegetation is found in transect B (4.29) in compare to other two transects, whereas transect A shows very high Shannon diversity index (4.00) while transect A denotes a very high evenness character than the other two transects. The Sorenson's Coefficient is 0.7692, 0.6885 and 0.7731 of AB, BC

and AC transect respectively, which indicates that the presence of species communities are common in AC transect when the estimated value is close to 1. The Hierarchical Cluster Analysis result shows that the vegetation belongs to relatively homogeneous groups of species community. Therefore, B transect has carried out more heterogeneous characteristics than other two transects in the present study. Accordingly, A and C transect denote the consistency of clustering habit of the species.

The study also reveals the concept of landscape and how landscapes are valued. It does so from the perspective of policy decision-making, which is concerned with the need for a value for money evidence base to guide the allocation of public support for the supply of landscape as a public good and they cannot capture benefits from all forms of users. While we do not know the counterfactual of no public intervention, current landscapes are the result of a range of statutory and voluntary designations where government attempts to meet public demand by proxy. Instead of resolving this shortcoming, landscape research has essentially moved onto a formal process of Landscape Character Assessment (LCA), which guides current landscape planning. LCA is unambiguously subjective but within a process that claims to reconcile a range of concepts and elements that are deemed relevant in most cases of characterization. Today, approximately half of the world's population lives within 200 km of the coastline. So, the effects of booming population growth, economic and technological development are threatening the coastal ecosystems that provide these economic benefits. Population pressure and the associated levels of economic activity will further degrade many coastal habitats. The change detection matrix of land use / land cover shows that the area of dense vegetation is highly converted to newer land use practices, and the minimum alteration has been occurred in open sandy tract area. The population pressure is very high in back barrier dune area which comprises with band three layers and having the population density of 1453.34 behind 6 km from the shoreline. Identification of different landscape units like vegetated land, coastal wetland and agricultural land are utilized to estimate their services in the form of economical as well as ecological valuation of these landscape units. The total biomass concentration of vegetation is very high in ridge crest part and at the same time it is available in low concentration in low lying coastal plain surface, while ground water recharge capacity

(infiltration rate) is very high in vegetated land which is estimated as 10,33,355 liter/ha/year. Comparative ecological service of different landscape/ha/year shows that vegetated land's carbon sequestration is very high than other land unit. On the other hand, the coastal wetland has a greater power of nitrogen receive capacity than other two land units. Fishery with open marine fishing is highly significant than agricultural land in connection with productivity, and economically, commercial fishing is much more significant than other economic activities of present study area. In connection with the ecological service and productivity, the vegetated lands occupy the more ecological services and respectively commercial fisheries have a greater power of productivity capacity than other landscape units.

5.2 Recommendations and Suggestions

Coastal zones in Ramnagar, Kanthi Coastal Plain have been concerned critically by an extended olden times of a variety of exploitations and recurrent anthropogenic tricks. In modern times, the improvement and exploitation of the coastal zones in Ramnagar zone have become a hotspot of economic development there. The hotspot of economic expansion mostly comprises reclamation, coastal tourism, marine aquaculture and pollutant emissions. Along with the hurried economic development in Digha coastal zones, the coastal population pressure also augments. Human extremely ransacks biological resources and the utilization and exploitation activities of open land resources also strengthened. The deficiency of resources and worsening of ecological environment are becoming more and more severe, which mostly imitate in the extreme recovery of tidal flat and wetland, the decrease of cultivated land caused by urbanization and the diminish of natural vegetation coverage. As the transform of landscape pattern, landscape types, such as cultivated land, sea area, forestland, water surface and so on are reinstated by edifice land and farmland and the scale of salt and sea aquaculture continues to enlarge, which leads to an amplify in ecological risk sensitivity and vulnerability in coastal regions. Furthermore, the extent of ecological risk enhance and coastal areas are revealing to a diversity of hazards, such as sea level rise, seawater intrusion, coastal flooding and water logging etc. caused by continuous Landscape Ecological alteration by human beings. Thus, it is imperative to learn and recognize

environmental changes in relation with the landscape ecological alteration in Ramnagar coastal zone.

To achieve the objectives of ecologically sustainable development and incorporated resource management, premeditated setting up and integrated management of coastal zones should be developed and executed by the states through:

- Formulate the strategy objectives precise for the coastal areas and their resources to bestow with guideline and advance co-ordination of national, regional and local government plans for coastal zones.
- Strengthening the incorporation and synchronization of sectoral strategies for sustainable coastal zone management and resource exploitation.

This can be accomplished through more successful utilization or conservatory of available preparation and supervision configurations by designating an authority to match up action. The necessary resources for this synchronization are to be supplied by all concerned levels of government.

Presence of the diverse and frequent conflicting uses of pressures on coastal stretches, states and local authority should exploit strategy implements, independently or in combination, in integrated coastal zone setting up and management, including:

- Variety and modernizing of pertinent in sequence and growth of coastal environment indicators to conduct planning and monitoring of coastal zone performances and procedures.
- Organization of ecological objectives for land use planning and zoning, coastal waters planning (including inland waters, semi-enclosed seas, estuaries), conservation necessities, ecosystem strengthening and restoration, discharge limit limitation, water quality for receiving waters and waters flowing into the coastal zone and supervise and lessening of inputs from polluting and dangerous materials.
- Establishment and maintenance of supervising and enforcement measures for environmental objectives and intentions. Environmental appraisal including economic and social criteria.

- Public edification and contribution in decision-making at an early stage of policy formulation and project assessment and acceptance of wider public participation procedures
- Application of regulations and economic instruments within the framework of the Polluter-Pays Principle and worthing coastal zone resources to replicate social costs of use and exhaustion
- Suitable endorsement of national legislation to implement coastal zone management objectives.

Meticulous attentiveness should be given to complete sustainable management and maintenance of fishing resources at the local, national and international levels and co-ordination of all relevant authorities should be make certain.

In observation of the economic and environmental significance of tourism and its associated infrastructure, a designated co-ordination authority should ensure that a proper stability is found between tourism development and the carrying capability of the coastal zone.

Assistance from the international agencies for the management of shared or common coastal areas should be enhanced by accessible or widespread worldwide coastal zone management bodies through setting up, implementation and monitoring an integrated action plan that is steadfast with other related coastal zone management initiatives.

Coastal morphodynamism, cyclonic hazard in the present coast are open to flow in all direction and don't intermittent by human modification. Diminution of impacts of those severe events may be exempted through setting up of engineered structure and community shelter.

Authority shall have the preeminence to take the following actions for protecting and improving the distinction of the coastal environment, preventing, dwindling and controlling environmental pollution in the coastal areas of the State of West Bengal namely:

- Estimate of proposals for revolutionizes in classification of Coastal Regulation Zone vicinities and in the Coastal Zone Management Plan (CZMP) received from the West Bengal State Government and making comprehensive

recommendations to the National Coastal Zone Management Authority therefore.

- Find out into cases of supposed infringement of the provisions of the said Act or the rules prepared there under or under any other law which is connected to the substance of the said Act and if found important in a particular case, issuing directions under section 5 of the said Act, insofar as such instructions are not confused with any direction issued in that specific case by the National Coastal Zone Management Authority or by the Central Government.
- Appraise of cases connecting to violations of the provisions of the said Act and the rules made there under or under any other law which is associated to the substance of the said Act and if found indispensable referring such cases, with comments, for review to the National Coastal Zone Management Authority.
- The Authority shall convention with environmental issues connecting to Coastal Regulation Zone which may be referred to it by the West Bengal State Government, the National Coastal Zone Management Authority or the Central Government.
- The Authority shall sort out ecologically receptive areas in the Coastal Regulation Zone and get ready area specific management plans for such recognized areas.
- The Authority shall ranked coastal areas into highly vulnerable to erosion or degradation and originate area specific management plans for such recognized areas.
- The Authority shall recognized economically important stretches in Coastal Regulation Zone and arranges Integrated Coastal Zone Management Plans for the same.
- The Authority shall inspect all projects connected with Coastal Regulation Zone areas and endow with their recommendations before the project proposals are referred to the Central Government or the agencies who have been assigned to clear such projects under the notification of the Government of India in the Ministry of Environment and Forests vide number S.O. 144 (E) dated 19th February, 1991.

A coastal region as an intermediary zone between land and sea is always measured an vicinity that has a better defensive purpose than that of production. Thus, in the development of Ramnagar coastal region exploitation the governments should steadily raised the dynamic utility of coastal areas, pay concentration to the possessions of the development and consolidation of land preserve possessions on coastal ecological environment and support coastal land use planning. The governments should also appraise combination of associations between natural resources and ecological environment and socioeconomic progress concerns, originate suitable preparation for regional development, optimize the industrial construction and initiate high-tech industries to regulate the present ecological economic development approach that in excess of relied on natural resources. The coastal zone is a significant natural fortification zone and wetland ecological concentration area. Thus, the governments should firmly direct the scale of construction land, such as ports. The buffer zone must preserve in a convinced variety to defend the ecological environment and to execute the ecological recompense scheme efficiently. As for the circumstances of diminutive forestland scale in the study area, the governments should reinforce the creation of coastal ecological forest. Coastal (beach) resources should be reasonably subjugated by controlling their own propagation pollution, improving the water quality of aquaculture area, intensification and monitoring of the maritime environment quality of key aquaculture areas and firmly controlling the demolition of coastal shelterbelt behavior that is for the growth of aquaculture. Through these procedures above, we can make convinced the ecological construction and economic development jointly in the study area to lastly accomplish a sustainable development of the ecological delicate areas.

5.3 Limitation of the Research

Meanwhile, landscape ecological risk estimation carried out in natural areas that are ecologically delicate and have a strong rejoinder to global change in the form of climatic condition change still needs to be further studied. Such natural areas comprise the coastal zone, the wetland. The general landscape pattern in these areas is comparatively disjointed and has a poor constancy and resilience, and the pattern's transforms are rapid and clear under pressures of both human activities and natural

annoyance. Therefore, these quarters will be a focal theme of future research on landscape ecological risk assessment. Meanwhile, a difference between resources and environment leads to prime troubles caused by rising human activities, and the coastal zones have malformed to responsive regions where a variety of hazards and risks happen repeatedly.

The present study recommend for further studies to investigate the more scrupulous result concerning the development processes of costal tract as well as the species diversity of the studied coast. The monitoring of coastal processes are needed for the understanding of modern coastal dynamics such as data bases on coastal marine hydraulics (waves, tides, currents, sea level variation); coastal weather phenomenon (winds, storms, temperatures, rainfall amounts, relative humidity); coastal river hydraulics (annual discharges, flood discharges, annual sediment discharges with suspension loads and bed load transport, estuarine bathymetry); coastal near shore bathymetry (depth contours, pattern of bed morphology); coastal zone contour plan (at local level on 10 cm interval and at regional level 50 cm interval); coastal sediment budget estimation (sediment transport and associated sources and sinks of sediment relevant to sediment budget) and sediment cell circulation systems (local, regional and seasonal).

As for the estimation component, the nominal cell (grid) is used as the assessment unit, and the consequences are interpolated as the unremitting variety spatial distribution value in a study area. However, using the smallest cell as the assessment unit is not completely measured as the spatial heterogeneity. To some extent, it splits the unique surface physical geography links, which may obstruct with the overall snatches of a landscape pattern and complete study. Therefore, a study of landscape ecological appraisal should commence to pay more concentration to appearance of the geographical consequence of the evaluation unit, which needs further study.

As for the technique of weight assignment, the technique does not have a universality of the experts and swindles itself; just needs to decide a suitable weighting technique based on considerable ecological appraisal objectives. The weight fortitude in this study was mostly based on the expert understanding and decision. Although this estimate process is not objective sufficient, but usually it can essentially work and

reproduce the dissimilarity of significance between dissimilar assessment indices, and its applicability and realism are stronger contrast to the objective weighting technique. However, the weight assignment procedure is still a complicated point in the landscape ecological appraisal. This is because using an improper technique may openly influence the distribution characteristics of the assessment results and considerably augment the vagueness of the estimate results.

Finally, a landscape ecological estimation is a procedure of decision based on knowledge, in which there are unavoidably unfinished data or haphazard interfaces and other reservations. Because the present study was not able to set up a direct association between the landscape arrangement and the category of ecological problems in precise areas, the ecological pattern index assembled in this study was just measured as a complete likelihood determine of the prospects of ecological problems happening without allowing for other factors, such as the social, economic and ecological environment.

Thus, the consequences have a convinced extent of ambiguity. A landscape ecological evaluation at this stage hardly ever carries uncertainty assessment into risk appraisal, which makes the consistency of appraisal results more complicated to grasp. Therefore, in the future study of landscape ecological assessment, an analyst must reimburse more concentration to the evaluation of the ambiguity of the appraisal results in order to make certain the legitimacy and dependability of the landscape ecological assessment results.