Chapter – I

Foundation of the Research

1.1 Introduction

The German word Landschaftsokologie, means landscape ecology was first ever transformed by German geographer Carl Troll in 1939 (Troll, 1968). He developed this term and also numerous spontaneous discernments regarding landscape ecology as the module of his near the beginning work, which consisted of pertaining remotely sensed data explanation to revise of associations involving environment and vegetation.

A landscape is extensive vicinity where a bunch of acting together locates or ecosystems are frequent in parallel outline. The landscape is produced by two systems working jointly contained by its edge specific geomorphological methods and precise disorders of the factor situates. Landscapes are different considerably in aerial extent, and a confined to a small area of a few meters or hundreds of meters transversely is at a finer level of scale than a landscape. Because of the area's geomorphology, the multifaceted of landforms and parental materials present is comparatively invariable over a landscape. Each situate has an attribute commotion regime (the summation of the frequencies, intensities, and kinds of individual conflict). Landscapes encircle us, yet inquisitively it is firm to discover people with the similar notion of a landscape. Artists and humanists usually depict the landscape as what the eye can distinguish and some-times bound the thought to expected landforms or communities. Such a landscape commonly comprises a soaring amount of spatial heterogeneity. In geographical literature, the landscape acts an essential part, with most explanations focusing on the dynamic association connecting two characteristics-natural landforms or physiographic regions and human cultural groups (Sauer, 1963; Mikesell, 1968; Grossman, 1977). Landscape dynamics is the fluctuation of energy, mineral nutrients and species surrounded by the constituent ecosystems and resulting transforms in those systems. The key landscape configuration questions nowadays center on the significance of numbers, kinds and configurations of eco-systems. Unpredictability is exceptional within a landscape.

Landscape ecology is the study of how landscape structure influences the profusion and allocation of organisms with the multiplicity scales of the landscape. So, landscape ecology focuses on three characteristics of the landscape such as structure, function and modification. Structure stands for the spatial associations between the typical ecosystems or rudiments where as Function deals with the relations among the spatial features and modification comprises with the modification in the arrangement and purpose of the ecological mosaic over time.

The coast is an exclusive environment where land, sea and atmosphere interrelate and interaction constantly influencing a narrow piece of spatial zone distinct as coastal zone. In other words, coastal zones are the vicinities having persuaded of both marine and terrestrial processes. Coastal zones are the most delicate, dynamic and prolific ecosystem and are fairly often under anxiety from both anthropogenic conducts and natural course also. It supports a great quantity of floral and faunal biodiversity. Coastal Zone is capable with an incredibly extensive variety of habitats such as coral reefs, mangroves, sea grasses, sand dunes, vegetated stungle, mudflats, salt marshes, estuaries and lagoons etc., which are considered by diverse biotic and abiotic processes. Limitations of the coastal zones are defined in diverse traditions depending on the focus of attention and accessibility of data. Typically, an amalgamation of distance to coast and altitudinal data is used. Different nations exploit diverse distance criterion for defining the coastal zone. In India, 500 m expanse from the high tide line (landward) is engaged for separating the coastal zone. Total coast line of the world is 35, 6000 km and the coastal area covers up more than 10% of the earth surface. Because of the monetary benefits that accumulate from admittance to ocean navigation, coastal fisheries, tourism, recreation and industrialization, human settlements are frequently more concerted in the coastal zone than in another place. It is documented that near about 40% of the worlds people lives peripheral 100 km from the coast. Accordingly 10% of the world's inhabitants resides in low lying maritime vicinity (<10 m) with an extremely susceptible to coastal adversities.

In our country 35% of people live within 100 km of its sea shore determining 7517 km. Maritime region in India suppose to significant for the reason that of soaring efficiency of its bionetwork, attentiveness of population, utilization of renewable and non-renewable natural property, discharge of squander effluents and metropolitan mess, industrialization and squirt in frivolous conduct. Maritime arenas are continuously varying because of the energetic interactions between the ocean and terrestrial system. Erosion and accretion of maritime sector, outpouring due to sea level expanding and landfall, changing of seashore caused by usual or anthropogenic forces, such as sea shore of India edifice of artificial construction, port and waterfront conducted to convert in the coastal region and its surroundings. Thus, expected administering of coastal vicinity is extremely essential. Furthermore, groundwork of a suitable coastal zone supervision arrangement as well as implementation of conventions in the coastal zone require spatial data on the maritime land use, land cover and land forms next to high tide and low tide lines, the record and distinction of coastal habitats and in sequence on ESAs (Ecologically Sensitive Areas).

In fact, 'landscape' is an inmost observation in landscape ecology. It is, nevertheless, discrete in somewhat different traditions. For example, Carl Troll visualizes of landscape not as a sensible create but as an impartially agreed 'organic entity', a "harmonic entity of space". Neef (1984) describes landscapes as division surrounded by the incessant earth-wide relationship of geo-factors which are clear as such on the foundation of their steadiness in situation of a precise land use and are subsequently defined in an anthropocentric and relativistic technique. According to Godron and Forman (1983) a landscape is an assortment of land area composed of a cluster of interconnected ecosystems that is common in alike form throughout, whereby they list woods, meadows, marshes and villages as examples of a landscape's ecosystems and state that a landscape is an vicinity at least a few kilometres wide. Wiens in 1997 combats the conventional analysis explained by Troll (1968), Godron and Forman (1983), Zonneveld (1989), Naveh (1995) and others that landscapes are grounds in which humans proceed jointly with their surroundings on a kilometre-wide scale; instead, he defines 'landscape' in spite of scale as "the template on which spatial patterns persuade ecological processes". Some illustrate 'landscape' as an area adjacent two or more ecosystems in close proximity. Tropical marine ecosystems often endure as energetic and spatially varied seascapes in which altered habitat types (e.g., coral reef, sea grass, open water, mangrove and sand) are connected to one another by a multiplicity of biological, physical and chemical processes. Water movements, including tides and currents, help out the exchange of nutrients, chemical pollutants, pathogens, sediments and organisms among workings of the outlook. The dynamic movement of organisms also unites environment patches across the seascape (Sale et al., 2010; Gillanders et al., 2011). For example, many tropical maritime species disclose comprehensive life histories that utilize resources from spatially and compositionally disconnected habitat patches (Parrish, 1998; Pittman and McAlpine, 2003). Extremely travelling species can bond patches during daily foraging movements, including tidal movement, as well as, broader scale voyages for generating and seasonal migrations (Zeller, 1998; Kramer and Chapman, 1999). In addition, numerous species of fish and crus, taceans divulge diverse transfers in habitat through ontogeny (Dahlgren and Eggleston, 2000; Nagelkerken and Van der Velde, 2002). A landscape ecological approach is the learning of ecological connectivity to appropriate patches, mixture of balancing resources.

Recuperating our deliberation of ecological connectivity in tropical maritime ecosystems is one of the tremendous desires of resource managers and decision makers today. For example, optimally connected seascapes for accurate species can be documented and mapped provided that expensive spatially unequivocal information in prop up of resource management etiquette such as the plan of Marine Protected Areas (MPAs). In addition, such information can also provide to invent of optimally connected habitat restoration projects. Presently, we have diminutive considerate of the manners of tropical maritime organisms at spatial and temporal scales applicable to their key life cycle arrangements. As a result, we stay behind mainly with ignorant of the spatial and temporal example of ecological connectivity that is probable to endure in maritime environments. This is very much slow down our potential to comprehend the influence of seascape outlining on connectivity.

Recent scientific earnings in Remote Sensing, acoustic telemetry, Geographical Information Systems (GIS) and spatial statistics approved to us to detain, manage and analyze the data essential for connectivity studies in a spatially exact approach and at correctly broad spatial scales (Crooks and Sanjayan, 2006). Incorporating spatial technologies with the instruction of landscape ecology pays for both the functional and theoretical frameworks obligatory to endeavour these comprehensive environmental applications at frequent spatial scales. Landscape ecology is a restraint that indentures with environmental intricacy as well as spatial heterogeneity and the implication of scale (Wu, 2006) and has established enormous helpfulness in the appraisal of ecological connectivity in terrestrial environments (With et al., 1997; Crooks and Sanjayan, 2006). An extensive set of notions, terms and examine equipments for considering the associations in between spatial patterning of land surfaces and ecological measures have recently been developed (Turner, 2005). Landscape ecologists have uncovered that a spatially unmistakable and quantitative assessment of fluxes in heterogeneous schemes (Turner, 1989) is the explanation to improving our observation of how the physical structure and temporal dynamics of spatial mosaics affect ecological connectivity (Crooks and Sanjayan, 2006). A lot of tropical maritime organisms, mainly fish and crustaceans, divulge a well built relation with benthic structure. For this intention, landscape ecology has been strongly and increasingly more endorsed as an ecologically significant advance for investigative species environment associations in a widespread assortment of structured (Grober-Dunsmore et al., 2009) shallow water maritime habitat types (Robbins and Bell, 1994; Irlandi et al., 1995; Pittman et al., 2007; Grober-Dunsmore et al., 2008; Grober-Dunsmore et al., 2009). We argue at this time that the significance of a landscape ecology approach to the tremendously heterogeneous arrangements that differentiate coral reef ecosystems will help out in understanding the inter connections between movement behaviour and the spatial patterning of the seascape. Ultimately, this should direct to more ecologically important decision making in resource management. This is such progress that has been commencing for a dissection of the West Bengal coastline. The map geared up for the West Bengal coast underneath this study can be dilapidated by the districts and blocks administration drawn in the disaster lessening and executive plan.

We recommend that “services concepts”, such as ecological services, landscape services and environmental services, accentuate the relationship between physical systems (ecosystems or landscapes) and human values. “Services” (which is shorthand for “goods and services”) are essential for the prolongation and convenience of humanity (Daily, 1997; De Groot et al,. 2002; Assessment, 2005). Instant of services are energy, flood anticipation, and entertaining activities (De Groot, 2006). The methodical system of services, e.g., the explanation and the demarcation from functions and processes have been under formation and dispute since the term was first used in the literature (Bastian et al., 2006; Wallace, 2007). For the time being, we use the succeeding move up, based on our human ecological analysis of the landscape. “Functions” can be construed into “services” when they are esteemed by people; one function can advocate quite a lot of services. In theory, the costs of generating and preserving vegetation strips can be got back from the money saved on restoring damage. Converts in goods and services also pressure human wellbeing (Daily, 1997; De Groot et al., 2002; Assessment, 2005).

1.2 Justification of the Title

Maritime vicinities are the largely delicate, active and productive ecosystem and are reasonably often under heaviness from both anthropogenic performance and natural processes. It supports a great quantity of floral and faunal biodiversity.

Maritime region is bestow with a extremely extensive range of surroundings such as mangroves, sea grasses, sand dunes, vegetated strung, mud flats, salt marshes, estuaries and lagoons etc., which are considered by different biotic and abiotic processes. Typically, an amalgamation of remoteness to coast and altitudinal data is used for considering the arrangement, function and adaptation of the land. So, Landscape ecological advance for the learning of composition and construction of landscapes with the organization of ecological connectivity to appropriate territories, amalgamation of balancing resources is very much required for resent studies.

Ecological preparation then may be definite as the employ of biophysical and socio-cultural information to recommend prospects and restraints for decision making about the use of landscape (Steiner, 1991).

1.3 Background of the Research

Landscape ecology conventionally has been inadequate to the lessons of terrestrial systems; however, the queries and techniques defining the science are uniformly applicable for maritime and coastal sub systems. The mutual association between spatial outline and ecological procedure and the overarching consequence of scale on this connection was being investigated in some maritime settings as the common discipline of landscape ecology was growing all the way through the latter two decades of the last century. As with all mechanism of the biosphere, a considerate of these associations is decisive for successful supervision of marine and coastal sub systems. However, comparatively current progress in Geographic Information Systems, Remote Sensing and computer technologies have commence to deal with these issues and are now authorizing appraisal of pattern and process in oceans. The intention of this present work is to emphasize research that is adapting the apparatus of landscape ecology to respond ecological questions within coastal sub-systems, to deal with the exclusive challenges countenance in these landscapes, and to motivate an exchange of thoughts and elucidation to universal problems.

Considering above the potentialities of environmental issues as well as human use of natural resources the present coastal area is selected for the study with the use of geospatial technology.

1.4 Research Problems and Research Gap

As per the Millennium Ecosystem Assessment (MEA) 2005, 40% of the world inhabitants survive within 100 kilometres of the seashore, as a result animated sprain on coastal resources and causative to the speedy ecological modifications that have been occurrence in these bionetworks in the last few decades.

The consequence of coastal zones is associated to the elevated stature and protective province of the biomes embraces by the sensitivity; to the multiplicity of ecosystem meanings, goods and services bestow with coastal schemes; to the amount and massive extent of various economic presentation reliant on these areas; and to the variety and consequence of environmental confronts hesitated upon (European Commission, 2000).

Economic demeanours approaching fisheries (fish farming), residential housing, transport, tourism and leisure, industrial manufacturing, power generation all are crops up in maritime vicinities and depend on the goods and services presented by them. Coastal systems meet the expense of direct and indirect goods and services.

One of the leading descriptions of maritime systems is the well built connections among it's disconnect sub systems, with water as a mediator ingredient. When these sub system vicinities are exaggerated by anthropogenic or even "natural" factors, fisheries as well as the vegetation species outside of the nursery area can also be considerably exaggerated. How individuals exploit the land and their socio-economic activity taking place are the most important reasons of the alteration taking place in land cover and thus, affecting environment in greatly at a global level.

1.5 Objectives of the Study

The following objectives are incorporated with the present study:

- ❖ To construct the foundation of research on landscape ecological studies of sensitive alluvium coastal environment for improving the resilience capacity against the hazards.
- ❖ To evaluate the chronological development of coastal landscapes dominated by chenier plain topography.
- ❖ To assess the spatial diversity of coastal habitats with special reference to the community of plant species.
- ❖ To estimate the ecosystem valuation of landscape ecological units for scientific resource management.

1.6 Systematic Review and Meta-Synthesis of Evidence-Based Practice

Landscape ecology contracts on the examination of spatial pattern and its relationship to ecological successions, at a diversity of scales (Wu, 2006). Landscapes can be definite as parts that are spatially heterogeneous and accordingly landscape ecology approaches can potentially be useful at an assortment of scales to a extensive variety of various environments, including terrestrial, aquatic and marine systems (Turner, 2005; Wu and Hobbs, 2007). Most significant research principle in landscape ecology encompass the reasons and consequences of spatial pattern in landscapes, the special possessions of commotion, ecological flows in landscape mosaics, land use and land cover modification and landscape conservation and sustainable management (Forman, 1995; Turner et al., 2001; Wu and Hobbs, 2002; Turner, 2005; Wu and Hobbs, 2007). As a research scheme, landscape ecology has developed speedily in modern decades (Wu, 2007), propped up by the development of specialist journals (e.g., *Landscape Ecology*) and academic institutions (e.g., the International Association for Landscape Ecology), Research work concerning the landscape ecology recurrently take up remote sensing data together with field measurements and inaugurate geospatial analyses (using GIS) or simulation modeling (Turner, 2005). The relevance of remote sensing in landscape ecology is becoming more extensive (Greegor, 1986; Hall et al., 1988; Nellis and Briggs, 1989; Hobbs, 1990; Goossens et al., 1991; Turner and Gardner, 1991; Haines-Young, 1992; Haines-Young et al., 1994; Iverson et al., 1994; Moody and Woodcock, 1995; Metzger and Muller, 1996). The impending of Thermal Infrared (TIR) remote sensing data for given that momentous new information in the assessment and modeling of landscape ecological experiences is high (Graetz, 1990; Luvall and Holbo, 1991; Quattrochi and Pelletier, 1991; Norman et al., 1995; Lo et al., 1997; Quattrochi and Ridd, 1998). Recording information on the geographic surroundings of species (Wadsworth and Treweek, 1999), landscape ecology is concerned in the results of location and spatial relations in ecology. These communications, such as the distribution of species in relation to other species or to the natural environment, which had been formerly unnoticed or oversimplified, achieved significance with the implementation of GIS (Johnston, 1998). Even though principally a tool used in landscape ecology (Haines-Young et al., 1993; Johnston, 1998), GIS is now utilized for a widespread multiplicity of significance for answering questions on the ecology and allocation of species individually and communities also (Scott et al., 2002). Present study deals with multifunctional surveillance of landscape and amalgamate both natural and cultural features, for the reason that, this view assists consideration of the landscape as the physical basis for sustainable landscape extension. In this view, landscapes are spatial human ecological systems that dispense a broader multiplicity of functions that are or can be valued by humans because of economic, socio-cultural and ecological reasons (Chee, 2004; DeFries et al., 2004; De Groot, 2006), for example food production, climate regulation and education (De Groot, 2006).

As Risser et al. (1984) make a memorandum of the flows and reassigns among spatial workings between and amongst landscape patterns are predominantly noteworthy in considering the inter connections of landscape patterns and processes. A widespread clarification of thermal infrared remotely sensed data can be obtained from (Anderson and Wilson, 1984; Estes et al., 1986; Lillesandet al., 1987; Davis and Lettington, 1988; Price, 1989); Also, superior intuition of how multispectral remote sensing, together with the use of thermal infra red data, can be affianced to better understand the land surface heat balance are given in Choudhury (1991) and Sellers et al. (1995). Remotely sensed data makes available an effective tool for landscape pattern study, though it is only in recent years that its credible for landscape describe has commenced to be fully utilized (Forman, 1995).

The succession of landscape ecology as a discipline has been principally encouraged by technological enhancements in remote sensing and GIS; in fact its origins lie down in the perfection of aerial photography (Groom et al., 2006). As with a lot of areas in physical geography and interconnected fields, Remote Sensing is a key expertise for computing landscape patterns and developments in the twenty first century. The Remote Sensing society has developed a wealthy and mottled set of analytical tools that go glowing ahead of conventional cartographic products. However, it is not coherent how far these pioneering techniques and products have been included within landscape ecology. In a contemporary assessment of the situation of the science, for example, Turner (2005) concurrences remote sensing little more than an ephemeral divulge. Although Frohn and Lopez (2017) afforded a consciousness of the exercise of remote sensing data in landscape ecology, the elucidation focused basically on the multiplication of landscape pattern metrics. In recent times, Groom et al. (2006) tinted the prospective significance of contemporary technological developments together with multi-angle performance, hyper spectral sensing and radar, to European landscape ecology, but did not scrutinize the exposure to which these advances have been approved by researchers. It is applicable to reflect on the modern and possible function of remote sensing in landscape ecology. Successive measurements have renowned an augmented utilize of quantitative statistical study and modeling approaches, but little enhancement in development of theory (Hobbs, 1997; Andersen, 2008). In her current review of landscape ecology science, Turner (2005) failed to talk about the apprehension of theory in general. Here, we consider the disputation that quantitative study of remote sensing data in incorporation with field data can reinforce the scientific rigidity of landscape ecology, by underneath the testing of hypotheses beached in applicable ecological theory. In the early 1980s landscape ecology attained origin as a junction of numerous fields working on diverse theories. In 1984, landscape ecology leads the way in the United States defined ethics and route for the field (Risser et al., 1984). Their paper confirmed “Landscape ecology focuses unambiguously upon spatial patterns. Particularly, regards as the development and dynamics of spatial heterogeneity, spatial and temporal relations and exchange transversely heterogeneous landscapes, persuades of spatial heterogeneity on biotic and abiotic processes, and managing of spatial heterogeneity." Early landscape revises in North America have a propensity to attention on pattern elucidation and assessment (Turner, 2005). Wiens (1995) assessed the first five issues of the Landscape Ecology journal and found that the 99 articles were mainly communicative or indefinable, with either no quantitative consequences, or results that were reachable without statistical or mathematical examination. For example, Turner and Ruscher (1988) considered transformations in the spatial patterns of land use in Georgia. Their effort was straightforward and communicative, but very significant at the time. In fact, the authors (Silbernagel et al., 1997) gone behind on this effort to itemize landscape understanding in a northern Great Lakes region. In this way, we incrementally made-up upon the schemes and application developed formerly. Development and testing of landscape metrics was a fundamental juncture, concurrent with progressions in GIS and information technology. Now, more than twenty years after the primary endeavor to describe principles, landscape ecological studies have completed immense advancement in both theory and applications. Practitioners have particularly sharpened methods for enumerating landscape structure, for pertaining remote sensing and GIS tools and for developing spatial models. Landscape ecology has altered into a worldwide science, persuading how ecologists observation and revision the world. Its approaches and perceptions have been extensively embraced both in university curricula and environmental resource management worldwide (Turner, 2005).

The objective of the current study is to demonstrate how coastal zone landscape can be differentiated using remote sensing and empirical model development to the betterment of the resource management community. Landscape ecology has been distinct variously (Risser et al., 1984; Urban et al., 1987; Turner, 1989; Pickett and Cadenasso, 1995; Turner et al., 2001), but mutual among explanations is the precise focus on the significance of spatial heterogeneity for ecological progression. The scale free focal point of landscape ecology on the causes and consequences of spatial heterogeneity is separate from how landscape ecology is sometimes defined (e.g., Zonneveld, 1990; Bastian, 2001; Opdam et al., 2001). Although these two views are not commonly exclusive, the different perceptions have fashioned some perplexity about what comprises landscape ecology. Some researchers also reflect on the global expressions restraining (e.g., Reiners and Driese, 2001), but landscape ecology is useful in terrestrial and also maritime ecosystems (e.g., Steele, 1989; Bell et al., 1997; Teixido et al., 2002; Ward et al., 2002).

The generalization of the landscape perception and its function across an ample assortment of systems and scales has surely given it wider applicability within ecology and studies paid attention on bigger areas have contributed to new consideration of ecological dynamics.

The explanation of coastal dynamics in various forms has concerned lots of early researchers (Cracknell and Hayes, 1991; Huang et al., 1991; Cracknell, 1999; Anthony et al., 2006; Sener et al., 2010). Studies regarding the beach profile gives information on cyclic/seasonal morphological alterations in the coastal area which are important to recognize the erosional and depositional features, which in turn help to appreciate alters in oceanographic processes in the coastal areas (Selby, 1985; Pethick, 1990; Ikeda and Dobson, 1995; Paul, 2002; Bhattacharya et al., 2003; Ramasamy and Kasturirangan, 2005; Anthony et al., 2006; Ganesan and Gaonkar, 2006; Pacheco et al., 2008; Murthy et al., 2008; Masselink et al., 2008; Maiti and Bhattacharya, 2009). To evaluate the dynamic behavior of the coastal province for pre monsoon and Post-Monsoon season it is necessary to bring out seasonal beach profiling.

A land resource record is an essential beginning for environmental setting up or resource management decision making (Lyle, 1999). Remote Sensing affords a quick, precise, inexpensive way to obtain such land resource data (Redfern and Williams, 1996). This land resource data is decisive to support in determining the performance of terrestrial ecosystems (Cihlar et al., 2003).

Ecosystems present a multiplicity of services, a lot of which are of indispensable and significance to human well being, for health, livelihoods and endurance (Costanza et al., 1997; Assessment, 2005; Foundations, 2010). In spite of international reassurance (through among others the Convention on Biological Diversity (CBD)) universal biodiversity carries on to turn down at astonishing rates (TEEB, 2010). Articulating ecosystem service principles in economic units also offers supervision in accepting user fondness and the proportional value present productions situate on ecosystem services. These values support to formulate decisions about dispenses resources between contending uses whereby it should be cherished that economic values that are based on market prices only, usually discount the rights (values) of forthcoming creations (Farley, 2008). In addition, the scope of the extensive multiplicity of ecosystem service flows and their values in financial units or else is a basic step to extend encouragement and fabricate expenditures desirable for their maintenance and sustainable use, such as systems of Payments or Rewards for Ecological Services (Farley and Costanza, 2010; Leimona, 2011). Research on the economic evaluation of ecosystem services dates back to the early1960s but recognized sufficient awareness with the publication of Costanza et al. (1997) and since then there has been a strong expansion in the number of articles and reports on the economic valuation of natural resources, ecosystem services and biodiversity. Ecological models are events that replicate ecological systems and progressions. Ecological modeling combines mathematical modeling, systems investigation and computer techniques with the ecology and direction of the environment and its natural resources (Jørgensen, 2000).

Biodiversity is the diversity of living organisms measured at all levels of involvement, from gene through species, to higher taxonomic levels, as well as the diversity of habitations and ecosystems, in addition with the procedures happening therein. Global Biodiversity Assessment (Heywood and Watson, 1995; Gaston, 2000) guesstimates the whole number of animal and plant variety to be between 13 and 14 million. It further records that so far only 1.75 million species have been demonstrated and deliberated (Heywood and Watson, 1995). Incidentally, a lot of species are being shattered even without being recognized their survival and significance in the ecosystem.

Determining the distribution and circumstance of biodiversity remotely, with airborne or satellite sensors, comes out to be an ideal technique to assemble these important data (Noss, 1990; Menon and Bawa, 1997; Turner et al., 2003; Gross et al., 2009).

Many contemporary data suggested, however, that augmented N_2O emissions following deforestation may not be as great as first thought (Verchot et al., 1999; Erickson et al., 2001). The participation of subsequent land use to trace gas exchange is even less well understood (Erickson and Keller, 1997; Erickson et al., 2001) though information and considering of trace gas (N_2O and CH_4) fluxes from natural forest systems, pastures in Latin America, paddy rice and a few other cropping systems in the humid tropics has distended significantly over the past 10 years. Fluxes of N_2O from substandard forests are similar to or less than those of primary or old expansion forests (Keller and Reiners, 1994; Verchot et al., 1999). Modern data from a chronological sequence in Para, Brazil established less important forests of 10 years or less with fluxes one tenth that of the conventional forest while that of 20 to 70 year old less important forests was about one third that of the of the full-grown forest (Davidson et al., 2001). Pastures in Latin America present a more complicated representation with some studies performing they are potentially a great source of N_2O (Luizao et al., 1989), while others depiction similar or lower N_2O fluxes from pastures distinguished with the forest

(Vitousek et al., 1989; Verchot et al., 1999) or that the great flux from pastures may be temporary, comforting at levels minor than that of the forest system from which they were consequential (Keller et al., 1993; Davidson et al., 2001). Natural systems usually have upper fluxes than the consequential, unfertilized systems and N_2O (+NO) fluxes can be roughly anticipated as 4% of airborn N_2O inputs (Davidson et al., 2000). Additionally, soil type and texture can control N_2O fluxes, with clayier and more productive soils having eminent fluxes (Matson and Vitousek, 1987; Mosier et al., 1996; Verchot et al., 1999). Studies of CH_4 fluxes from miscellaneous land use coordination in the steamy tropics are lesser than for N_2O but delegate that upland, well drained forest soils devour CH_4 (Keller et al., 1986; Keller and Reiners, 1994; Steudler et al., 1996; Verchot et al., 2000). From an financial point of view biodiversity, i.e., “the variety of life at all levels of organization, from the level of genetic variation within and among species to the level of variation within and among ecosystems and biomes” (Tilman, 1997), must be seen as an constructive characteristic, with biodiversity supervision as an endeavor and the disregard of fortification to be presumed as a disinvestment, which directs to a diminish of exclusive services and, in rotate, to economic costs. Therefore, the economic establishment of a decision for or alongside the strengthening of biodiversity necessitates the consideration of all costs and benefits associated to it. It is well known that the major predicament of counting the multiplicity of biodiversity services in economic selections is that many of these services are not treasured on markets. There is a breach between market valuation and the economic value of biodiversity. In order to fill up these valuation gaps, those services of natural properties that are not valued on markets, but ought to nonetheless be considered valuable, must first be documented and then – as far as potential – monetization. Only in 1967 were subsistence values recognized as a possible profit of natural belongings. They were in general anonymous before that date (Krutilla, 1967).

Anybody who becomes anxious in conservation application quickly comprehend that it is an essentially multidisciplinary commotion. So that a project concerning hazard fuels diminution programs has focused on development of a Cost Effectiveness Analysis (CEA) system for U.S. Department of Interior (USDI) (Omi et al., 1999). Fortunately, technological proceeds do offer apparent tools to maintain in decision making for continuing sustainability of our earth. Resource administrators should, however, confidentially observe as present potentialities, and restrictions, of these tools for acquiring geospatial data enviable to sustain GIS and ecological models. Continuing studies of our varied environments and the supervising of challenging convincing of environment and man are decisive for decision makers to have information facilitating them to make informed judgments (Cooke and Doomkamp, 1990; Cihlar et al., 2000; Slater and Brown, 2000).

1.7 Research Design

Connectivity across the seascape is expected to have attentive consequences for the performance, expansion, endurance and spatial distribution of maritime species. A landscape ecology study proposes enormous efficiency for learning ecological connectivity in tropical coastal system. Landscape ecology endow with a well developed theoretical and equipped structure for focused on complicated multi-scale questions relating to persuade of spatial outline on ecological procedure. Landscape ecology can propose quantitative and spatially unambiguous information at scales applicable to resource management decision making. While landscape ecology is steadily more being purposeful to tropical marine coastal sub system, present study has dealt clearly with the issue of coastal management strategies through understanding of chronological development of this area, species variation and also land valuation estimation. Herein, we observe the relevance of landscape ecology to better comprehend ecological connectivity in tropical marine ecosystems by: (1) reviewing the existing literature regarding landscape ecology concepts for detecting the research gap and the existing problems to fix the research goal and also aware about the characteristics of the studied coast for better implementation of methodology as well as management strategies, (2) discussing the chronological development history of the study area to understand the geomorphological settings for assessing the morphometric attributes so that study area can be divided into different processes response zone, (3) examining the acquired field data related to the floral species succession, zonation, richness, evenness, (4) reviewing the data regarding the ecological value and economic value of land by which the total studied area can also be divided into different land valuation zone to formulate appropriate management strategies for sustainable development, (5) assessing lessons learned from terrestrial landscape ecology and from marine ecology studies, and discussing the implications of ecological connectivity for resource management and some recommendation have also fabricated for improving our understanding of ecological connectivity and applying results to make more informed decisions for conservation planning.

1.8 Materials and Methods

The concept of ‘landscape’ was defined as ‘a geographically, functionally and historically interconnected complex of ecosystems’. The ecosystem, as a basic landscape element, can be recognized in the field by the homogeneous structure and composition of its vegetation and homogeneous morphometric features of the soil profile. More fundamentally, it is also characterized by its microclimate and by processes which can be described as input, movement, transformation and output of matter and energy.

1.8.1 Data Used for This Study

The present study is incorporated with Survey of India (SOI) Toposheets (Toposheet no. 73O/4, 73O/5, 73O/6, 73O/9, 73O/10 and 73O/13) from Survey of India, Kolkata with a scale of 1: 50,000 and 1: 250,000. Further the study also deals with satellite image of Landsat 5 and Sentinel -2 Multi Spectral Instrument (MSI) from USGS and SCI HUB; several temporal images of Google Earth; meteorological records from India Meteorological Department (IMD), Kolkata; geological map from the Geological Survey of India (GSI) official portal. Soil map from National Bureau of Soil Survey and Land Use Planning (NBSS & LUP) has also been used for the analysis of the soil characters simultaneously repeated field survey has been conducted with pre designed questioners for validation of the research results.

Landsat 5 was commenced on March 1, 1984 at Vandenberg Air Force Base, California on a Delta 3920 National Aeronautics and Space Administration (NASA). The Thematic Mapper (TM) sensor was accepted on Landsat 4 and Landsat 5, and images consist of six spectral bands with a spatial resolution of 30 meters for Bands 1 to 5 and 7, and one thermal band (Band 6). The estimated outlook size is 170 km north-south by 183 km east to west (Table 1.1).

Table 1.1: Landsat 5 (TM) Band Specification (Image acquisition date-21.11.1990; Path 139, Row 45).

	Spectral bands	Wavelength (μ)	Resolution (m)
Mission: Landsat 5 **Sensor: TM**	Band 1 - Blue	0.45-0.52	30
	Band 2 - Green	0.52-0.60	30
	Band 3 - Red	0.63-0.69	30
	Band 4 - Near Infrared (NIR)	0.76-0.90	30
	Band 5 - Shortwave Infrared (SWIR) 1	1.55-1.75	30
	Band 6 - Thermal	10.40-12.50	120* (30)
	Band 7 - Shortwave Infrared (SWIR) 2	2.08-2.35	30

TM Band 6 was acquired at 120-meter resolution, but products are resampled to 30-meter pixels.

Source: United States Geological Survey (USGS)

1.8.2 Dark Object Subtraction (DOS)

The scattering of the ambiance, particularly depends on the wavelength in the perceptible fraction of the electromagnetic spectrum. In this circumstance DOS technique is acknowledged for the reason that it is a relative atmospheric scattering model to predict the haze values for all the spectral bands from a preferred starting band haze value. This complicated technique is employed to regularize the expected haze values for the diverse gain and offset consideration used by the imaging system. The path radiance is particular by the subsequent equation (Sobrino et al., 2004).

$$Lp = L_{min} - L\ DO1\%$$

where, L_{min} = radiance that communicates to a digital count up value for which the amount of all the pixels with digital counts inferior or equivalent to this value and it is equivalent to the 0.01% of all the pixels from the image measured (Sobrino et al., 1993), consequently the radiance acquired with that digital count value (DN_{min})

LDO1% = radiance of Dark Object, assumed to have a reflectance value of 0.01.

1.8.3 Conversion from Digital Number to Spectral Radiance

Spectral radiance scaling technique has been exploited for the radiance adaptation of TM data. The Digital Number (DN) of individual bands are transformed to space attainment radiance or Top of Atmospheric (TOA) Spectral Radiance (L_λ) of the sensor's opening. Multispectral band of the TM sensor's (Landsat 5) data can be rehabilitated to TOA spectral radiance for standardizing the data (Markham and Baker 1986).

$$L_\lambda = \{(L_{max} - L_{min} / Qcal_{max} - Qcal_{min}) \times (Qcal - Qcal_{min}) + L_{min}\}$$

where,

L_λ = Spectral radiance at the sensor aperture in watts/ (meter^2 *ster* μ m)

Qcal = Quantized calibrated pixel value in DN

L_{min} = Spectral radiance that is scaled to $Qcal_{min}$ in watts/(meter^2 *ster* μ m)

L_{max} = Spectral radiance that is scaled to $Qcal_{max}$ in watts/ (m^2*ster*μm)

$Qcal_{min}$ = Minimum quantized calibrated pixel value (corresponding to L_{min}) in DN

$Qcal_{max}$ = Maximum quantized calibrated pixel value (corresponding to L_{max}) in DN

L_{max} and L_{min} = Spectral radiances for each band at digital number 1 and 255 (i.e., $Qcal_{min}$, $Qcal_{max}$) respectively.

1.8.4 Conversion to Top of Atmospheric (TOA) Spectral Reflectance

Different multispectral bands of the TM sensor's can also be transformed to TOA planetary reflectance by means of reflectance rescaling coefficient factor which are supplied from the product metadata file. The subsequent equation is used (NASA, 2016) to exchange spectral radiance to TOA reflectance for TM data.

$$\rho_p = (\pi * L_\lambda * d^2) / (ESUN_\lambda * \cos\theta_s)$$

where,

ρ_p= Unit less planetary reflectance, which is "the ratio of reflected versus total power of energy" (NASA, 2016)

L_λ= Spectral radiance at the sensor's aperture (at-satellite radiance); d= Earth-Sun distance in astronomical units (provided with Landsat 5 metafile, and an excel file is available from USGS website

$ESUN_\lambda$= mean solar exo-atmospheric irradiances

θ_s = Solar zenith angle in degrees, which is equal to ($\theta s = 90° - \theta e$, where θe is the Sun elevation)

ESUN = $(\pi * d^2)$* radiance maximum and reflectance maximum (radiance maximum and reflectance maximum are provided by image metadata).

So the Landsat 5 images are completed accessible with band explicit rescaling factors which permit for the straight conversion from DN to TOA reflectance. Alternatively, the property of the atmosphere (i.e., Disturbance on the reflectance that varies with the wavelength) should be measured in order to compute the reflectance at the position. It is described by the land surface reflectance (ρ) (Moran et al., 1992).

$$\rho = [\pi * (L_\lambda - L_p) * d2] / [T_v * ((ESUN_\lambda * \cos\theta_s * T_z) + E_{down})$$

where,

L_p= The path radiance

T_v= The atmospheric transmittance in the viewing direction

T_z= The atmospheric transmittance in the illumination direction

E_{down}= The down welling diffuse irradiance.

1.8.5 Sentinel- 2 Multi-Spectral Instrument (MSI)

Sentinel- 2 was instigated on June 2015; the fabrication of the Multispectral appliance (MSI) on board Sentinel-2 has been determined by the requisite for great swath high geometrical and spectral performance of the dimensions.

The MSI measures (Level-1C) the Earth's reflected radiance in 13 spectral bands from Visible Infrared (VNIR) to SWIR (Table 1). The Bandwidth (nm) is calculated at Full Width Half Maximum (FWHM). This dispensation move compresses Level-1C imagery using the JPEG2000 algorithm and a GML geographic imagery prearranged header. Level-1C data is generated at the last part of this step. Level-1C product provides orthorectified TOA reflectance, with sub-pixel multispectral registration (Table 1.2). Cloud and land/water masks are incorporated in the product.

1.8.6 Radiometric Calibration Activities

The radiometric calibration actions permit fortitude of the considerations of the radiometric calibration model, which aspires to exchange the electrical signal calculated by the appliance, transformed in digital count, into physical radiance measured at the sensor (ESA, 2017).

Radiometric calibration activities are the set of techniques used to guesstimate the considerations of the Sentinel-2 radiometric model.

Nominal radiometric calibration activities include:

- Dark signal calibration (every 2 weeks)
- Relative gains calibration (every month)
- Absolute radiometric calibration (every month).

Table 1.2: Band characteristics of Sentinel-2 MSI image (Imagery date-16.12.2016 and 16.03.2017).

Band Name	Resolution (m)	Central Wavelength (nm)	Band Width (nm)	Purpose
B 01	60	442.7	21	Aerosol detection
B 02	10	492.4	66	Blue
B 03	10	559.8	36	Green
B 04	10	664.6	31	Red
B 05	20	704.1	15	Vegetation classification
B 06	20	740.5	15	Vegetation classification
B 07	20	782.8	20	Vegetation classification
B 08	10	832.8	106	Near infrared
B 8a	20	864.7	21	Vegetation classification
B 09	60	945.1	20	Water vapour
B 10	60	1373.5	31	Cirrus
B 11	20	1613.7	91	Snow / ice / cloud discrimination
B 12	20	2202.4	175	Snow / ice / cloud discrimination

Source: Sentinel-2 MSI, User Guide, 2017

High resolutions Digital Elevation Model (DEM) have been prepared through incorporate the replication of image calculation procedure for the recognition of micro geomorphological components of the studied area. 2,000 Ground Control Points (GCP) locations were marked on the Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) Global Digital Elevation Model (GDEM) (Version-215 m, 2014), Shuttle Radar Topography Mission (SRTM: 1 arc-second, 30 m, 2014) DEM and Google Earth image to accumulate the altitude of every GCP for the detection of Root Mean Square Error (RMSE), Mean Error (ME) and Absolute Mean Error (AME). These data were calculated through the bootstrapped iterations to beat the inaccuracy. Because the bootstrap iterations offers an advantage for determining the precision statistics stochastically as contrasting to existing practice of deterministic derivation of these statistics (Sharma et al., 2010) and a quantity of principle positions had been selected for the Total Station (TS) survey to integrate and validate the elevation points for the analysis landscape characteristics as well as evolution processes of coastal tract since 1990.

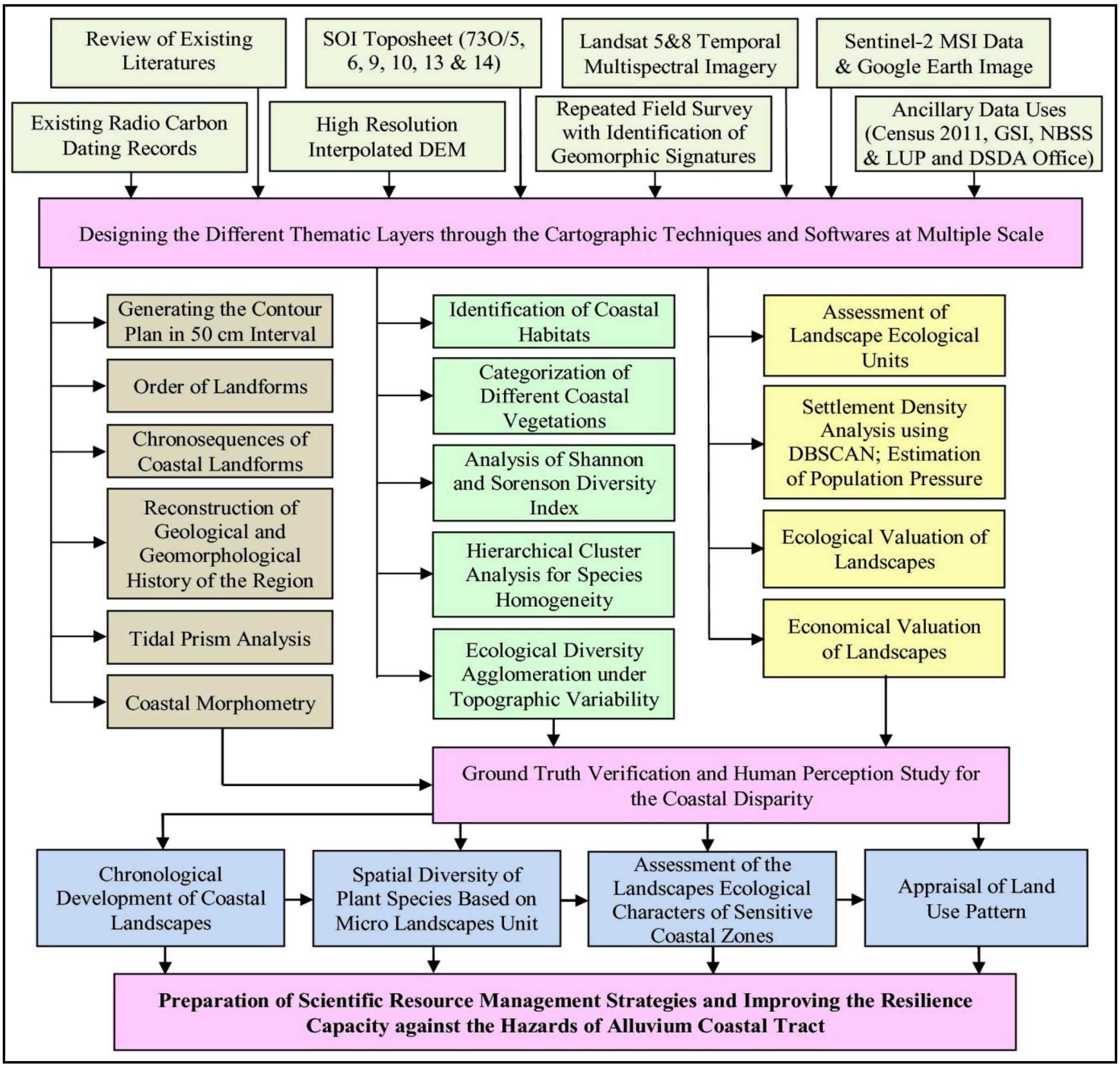

Fig. 1.1: Elementary methodological flow chart showing the developments of landscape ecological study which is the relation among spatial patterns, historical background and ecological processes.

To characterize the landscape units and coastal evolution process supervised image classification along with the detail contour plan has been prepared on the basis of Remote Sensing technology and high resolution interpolated DEM of the study area and existing radio carbon dating record has been used for validation of entire processes of landscape evolution.

Shannon Diversity Index, Sorenson Coefficient, Hierarchical Cluster Analysis techniques are employed to explore the species richness and evenness of the study area and analyze the spatial diversity of coastal habitats.

Several numerical techniques are incorporated to establish the landscape valuation assessment such as, market based techniques, revealed preference techniques, stated preference techniques. Human perception surveys through repeated field survey are also conducted to understand the relation among human intervention (resource uses and alteration of land use / land cover), coastal hazards and coastal morphodynamics. At the same time biological processes have been estimated through the phyto-geomorphological mapping. Finally some Secondary data (climatic data, tide data, census data, hazards data etc.) are also collected and analyzed through some statistical methods to understand the coastal processes and the pressure of uses of coastal resources.

On the basis of these thematic mapping and constant field observation the present study estimates the chronological development of the coastal environment, spatial diversity of plant species and appraise the land use pattern and land valuation so that the present study can helps the society to formulate the further scientific resource management strategies as well as the strategies of reducing the hazard intensity of low lying alluvium coastal tract.

Developments in landscape ecology illustrate the important relationships between spatial patterns and ecological processes. In this present study these developments incorporate quantitative methods that link spatial patterns and ecological processes at broad spatial and temporal scales (Fig. 1.1). This linkage of time, space, and environmental change can assist managers in applying plans to solve environmental problems. Through this work the increased attention in recent years on spatial dynamics has highlighted the need for new quantitative methods that can analyze patterns, determine the importance of spatially explicit processes, and develop reliable models.

Multivariate analysis techniques would be frequently used to examine landscape level vegetation patterns throughout this present work. The present study incorporated with statistical techniques, such as cluster analysis and different statistical models for classifying plant communities of the coastal belt. Climate change is another major component which has been considering in the current research of landscape ecology. Ecotones, as a basic unit in landscape studies, may have significance for management under climate change scenarios, since change effects are likely to be seen at ecotones first because of the unstable nature of a fringe habitat. The study analyzes gradients across space and time between ecosystems of the coastal dune to determine relationships between distribution patterns of animals in their environment. Looking at where animals live and how vegetation shifts over time may provide insight into changes in coastal processes as well as climatic changes over time across the landscape as a whole.

1.9 Improving our Understanding of the State of Ramnagar Coast

The studied coast is a widespread coastal region is on the farthest South West of the state. A part of the district of Purba Medinipur, West Bengal along the Bay of Bengal includes the coastal plain. This rising coastal plain is made up of sand and mud sedimented by fluvial and aeolian process which is also an mid- eastern division of Kanthi Coastal Plain, covers an area of about 29439 hectare or 294.39 km^2 (Fig. 1.2).

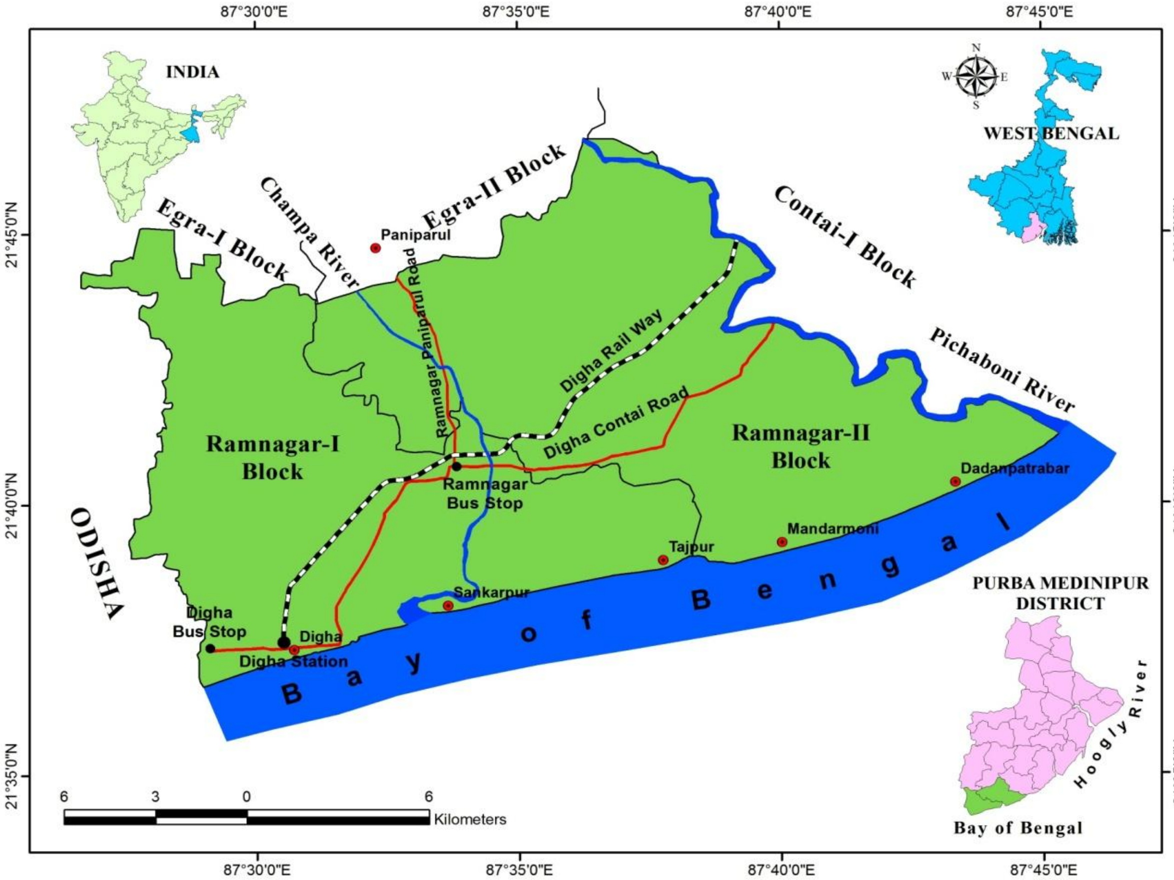

Fig: 1.2: The studied coast, a widespread rising coastal plain made up of sand and mud sedimented by fluvial and aeolian process at mid-eastern division of Kanthi Coastal plain, stretching between 21°36'33.07"N to 21°46'47.03"N and 87°26' 42.86" E to 87°45' 22.15" E is the part of district of Purba Medinipur, West Bengal along the Bay of Bengal coast.

Geologically, the area is characterized by ordinary alluvium deposits of Holocene to recent origin that were brought down by the Subarnarekha and Ganges River system. Presence of colonies of sand dunes and marshy areas are in parallel way to the shoreline is mostly frequent in nature of this geomorphic part. The dune of this vicinity lies adjacent and parallel to the Bay of Bengal (Fig. 1.3). In some regions dunes arises are at a distance of 5 - 6 km from the coast and 11 m - 12 m high. The state has a shoreline of 210 km.

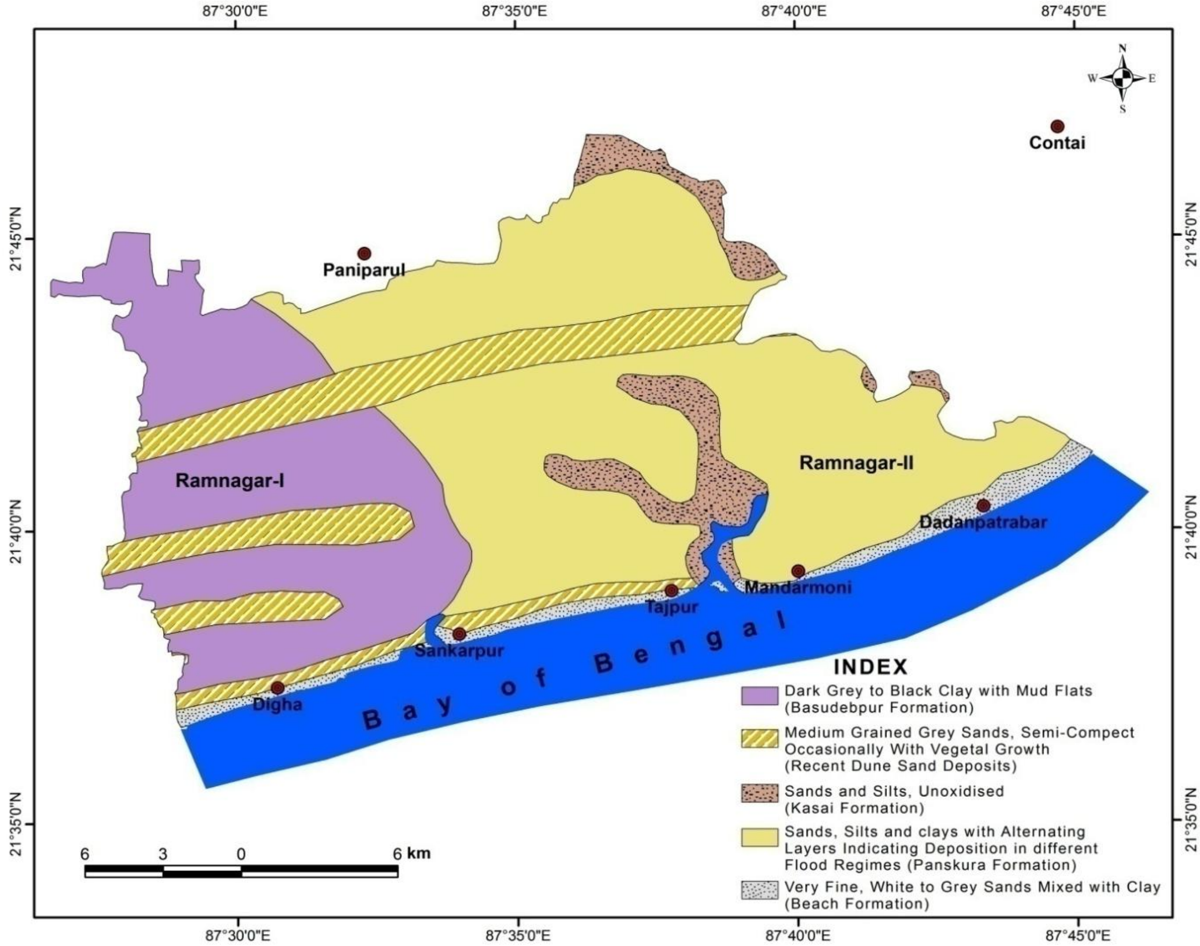

Fig. 1.3: Geological structure of the study area.

Table 1.3: Description of the soil taxonomic classess**.**

ID No.	Map symbol	Description	Taxonomic name
4	W073	Very deep, moderately well drained, sandy soils occurring on gently sloping dunes in coastal plain with sandy surface, severe erosion and salinity.	Aquic Ustipsamments
2	W074	Very deep, well drained, sandy soils occurring on moderately sloping coastal plain with sandy surface, severe erosion and slight salinity.	Typic Ustipsamments
3	W076	Very deep, poorly/ imperfectly drained, fine soils occurring on level to nearly level marshes in coastal plain with clayey surface and moderate flooding and salinity associated with deep, well drained sandy soils.	Fine Aeric Haplaquepts Typic Ustipsamments

1	W077	Very deep, poorly drained, fine soils occurring on nearly level to gently sloping coastal plain with clayey surface, and moderate flooding and slight to moderate salinity (limited extent) associated with very deep, poorly drained, fine cracking soils.	Fine Typic Haplaquepts Fine Vertic Haplaquepts
7	W078	Very deep, poorly drained, fine cracking soils occurring on nearly level to very gently sloping coastal plain with clayey surface, moderate flooding and moderate salinity (moderate extent) associated with deep, poorly drained, fine soils.	Fine Vertic Haplaquepts Fine Typic Haplaquepts
6	W038	Very deep, very poorly drained, fine cracking soils occurring on level to nearly level low lying alluvial plain with clayey surface, associated with very deep, poorly drained, fine soils.	Very fine Vertic Haplaquepts Fine Typic Haplaquepts
5	W075	Very deep, poorly/ imperfectly drained, fine soils occurring on level to nearly level marshes in coastal plain with clayey surface, and moderate flooding and salinity ssociated with very deep, well drained sandy soils.	Fine Aeric Haplaquepts Typic Ustipsamments

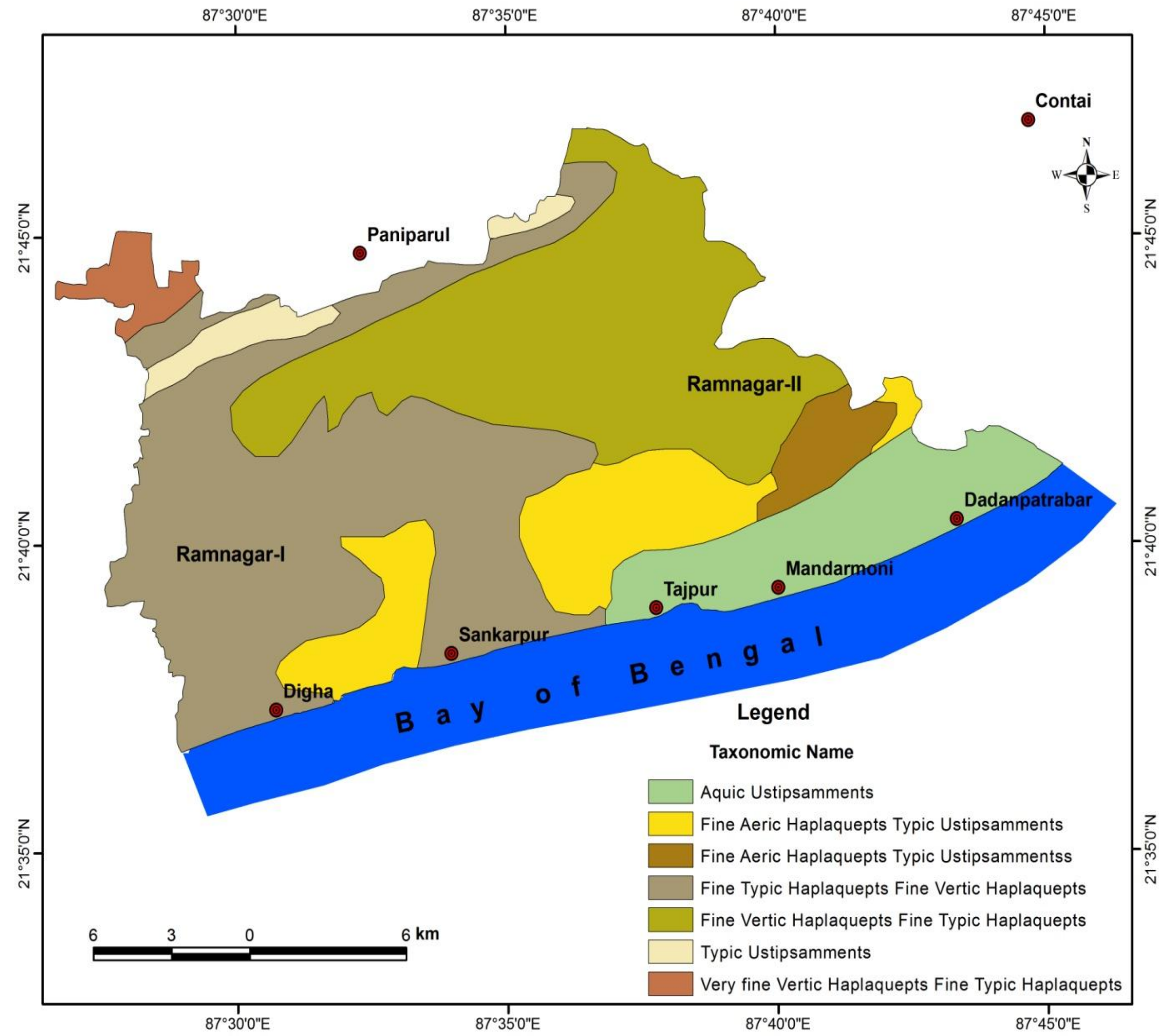

Fig. 1.4: Spatial distribution of the soil taxonomic classes.

Purba Medinipur coastal tract is characterized by sand dunes, long shore currents, major river emancipations, less turbid but high saline sea water influence, cuspate delta of the Jaldha river and neo-tectonic depressions in the north which covered mostly by sandy clay and silty loam soils that developed under a brackish environment and this type of soil has a high water retaining capacity (Table 1.3; Fig. 1.4).

Bankiput and Tajpur Mangroves in Purba Medinipur district has a complicated coastline, bunches of early growing deltas with interlinked tidal creeks and estuary. Deltaic expanses are generally clayey due to high deposit of sediments through the Subarnarekha system in right and also through the Ganges system in left. A clayey bedspread covering gravels of sandstone, siltstone and quartz designate quaternary era of the area. Consequently, West Bengal does not acquire the fertile alluvium as before and the topography is not desalinated by river floods. The wide beaches and intensive network of inlets and creeks, mangrove swamps, mudflats, frequent coastal dunes and sand flats are the major characteristics of this coastal region.

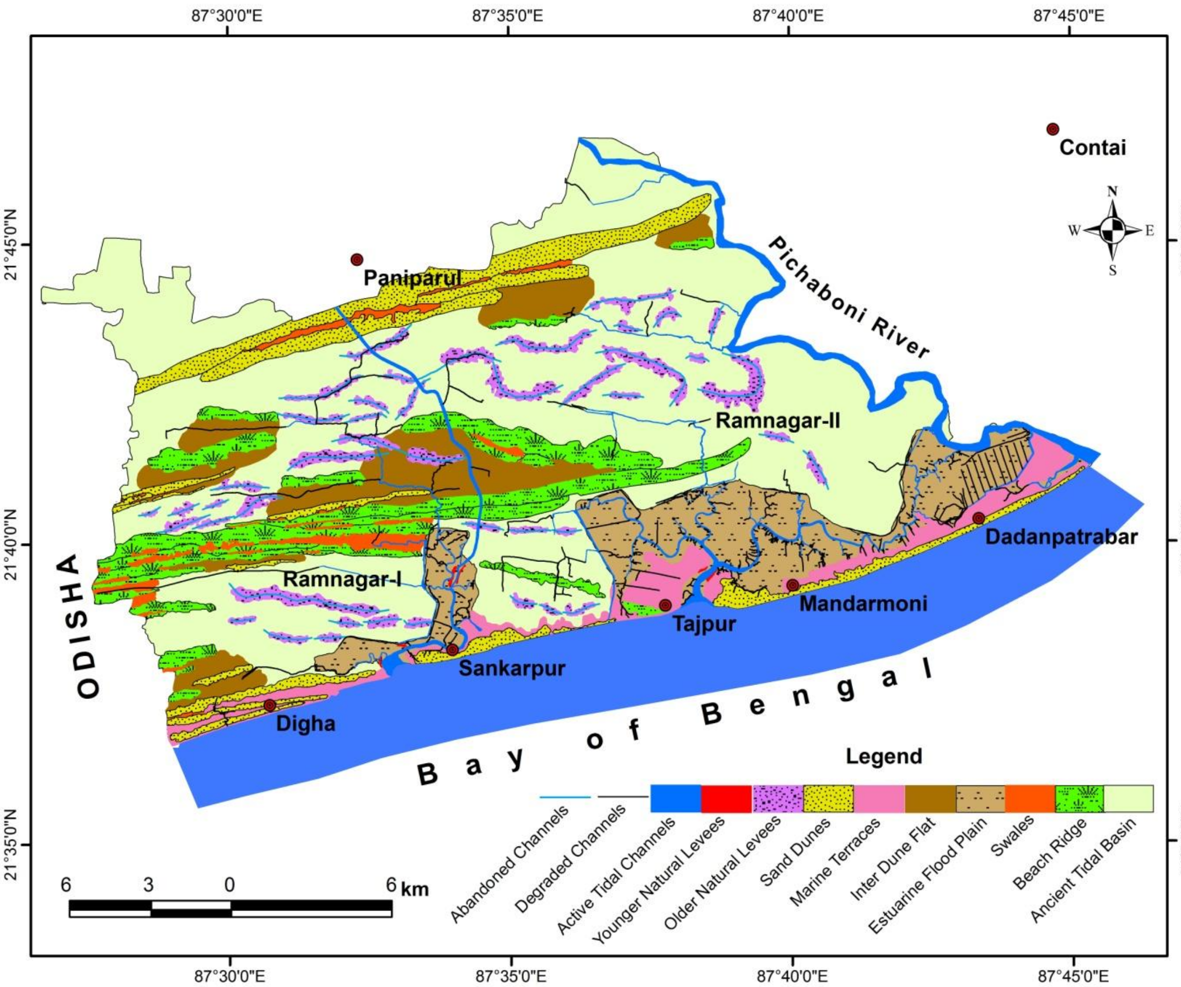

Fig. 1.5: Micro geomorphological units of the studied coast.

Geomorphological mapping technique has been executed for concerning a century and ever since that instance has developed extensively, accumulation larger aspects and intricacy or has pursued a themed, holistic advance.

The progress of a diversity of mapping come up to reproduces the requisite scale of procedure and the diverse regions of relevance: for instance resource development, hazard mapping, nationwide mapping and ecological preparation. By the 1970s, there had been a huge intercontinental endeavor to discover widespread principles for mapping landforms. In recent times the beginning of remote sensing and GIS has unfastened a lot of potentials for the additional expansion and specialties of geomorphological mapping.

The present attempt is also incorporated with twelve (12) consecutive classes like abandoned channels, degraded channels active tidal channels younger natural levees, older natural levees, sand dunes, marine terraces, inter dune flat, estuarine flood plain, swales, beach ridge and ancient tidal basin according to their topographic characteristics (Fig. 1.5).

Climatic variations of the study area are more significant between Monsoon and Pre-Monsoon seasons. The temperature varies from a minimum of 9°C in winter to a maximum of 38°C in summer. Relative humidity ranges between 90%–96% in most months. Low atmospheric pressure is often present during the summer and Monsoon period. Wind dominantly blows in from offshore areas. There is no extensive forestland in the study area, and natural vegetation primarily consists of grasses (*e.g.*, *Sesuvium portolacrustum* and *Ipomoea bioloba)* and herbs (*e.g.*, *Lantana camara*, *Acanthaceae* sp, and *Calotropis gigantea*). Trees like casuarinas, eucalyptus and Acacia *auriculiformis* have been planted in this area, while coconut, banana, bamboo and mango are indigenous floral species.

1.10 Consequence

Landscapes are spatially varied geographic vicinity categorized by an assortment of interacting patches or ecosystems, sorting from comparatively natural terrestrial and marine ecosystem such as forests, grasslands and dune to human subjugated environments together with agricultural and urban environment. The most appropriate description of landscape ecology is its eminence on the association among pattern, process, scale and its focus on broad scale ecological and environmental concerns. These require the combination between biophysical and socioeconomic sciences. So the ultimate research theme in landscape ecology contain ecological flows in landscape mosaics, land use / land cover (LU/LC) change, scaling, describing landscape pattern analysis with ecological progressions and landscape safeguarding and sustainability.

Another most important perception in landscape ecology is scale. Scale communicates to the real world as converted onto a map, recounting distance on a map depiction and the subsequent distance on earth. Scale is also the spatial or temporal determine of an entity or a procedure or amount of spatial resolution. Components of the scale comprise with composition, structure and function, which are all very significant ecological concepts. Applied to landscape ecology, composition refers to the amount of patch types denoted on a landscape and their comparative abundance. Structure is unwavering by the composition, the arrangement and the amount of different patches diagonally the landscape, while function refers to how each component in the landscape act together based on its life cycle events. Pattern is the term for the contents and inner order of a heterogeneous area of land.

A landscape with structure and pattern involves that it has spatial heterogeneity or the irregular allotment of substance across the landscape. Heterogeneity is a key component of landscape ecology that taken apart this discipline from other branches of ecology.