# CHAPTER ONE

# INTRODUCTION

## 1.1 Background of this study

The Bay of Bengal shares diverse characteristics of the Indian Ocean, has many unique features such as shallow continental shelf region (<200 m), thickest sediment deposits, freshwater runoff, mixing properties, natural land reclamation process, hotspot for tropical cyclones, seasonal reversal of oceanic currents (southwest and northeast monsoon dominated), semidiurnal tides, rich biodiversity and abundance in fisheries resources (Rahman and Mizan, 2006). The oceanaires of Government of the Peoples' Republic of Bangladesh has already set up the context for inclusive socio-economic growth for the challenge of 21st century. This section aims to introduce the basic concept and background study related to land sea interactions in the framework of Maritime Spatial Planning.

## 1.2 Concept of Maritime spatial planning

Maritime spatial planning (MSP) is a modern tool of planning spatially that is emerging at the intersection of the growing demands for the economic use of marine space and growing issues about marine environments (Zaucha, 2019). Maritime Spatial Planning (MSP) is generally concerned with the control of human distribution, space and time initiatives to realize geological, economic and social urgencies and goals performance. According to the Directive 2014/89 (Beetham and Lord, 2014) of the European Union (EU), MSP is the most appropriate way to ensure the accurate assessment of marine resources and the viable use of any marine or coastal resource (Beetham and Lord, 2014).The purpose of MSP is to provide an consistent structure of authority for the fair allocation of activities, while at the same time protecting marine surroundings. This planning is a vigorous task which is similar to, but also relevant to, onshore spatial planning distinctions (Union, 2013). The sea is a highly complex ecological, economic and social zone, so it is possible that the strategies and methodologies used for classical land-use planning vary. The management of the coastal region, which is the relationship between the land and the sea, is important for both nature and social. Maritime spatial planning has been the focus of widespread international planning over the past few decades (Beetham and Lord, 2014).

Bangladesh needs to develop the maritime spatial planning strategy for the vast ocean space. The Government has already developed and prepared a background paper entitled as "Strategy for ocean and river resources management" for the Seventh Five Year Plan (2016-2020) to ensure the development blue economy. The contribution of ideas and knowledge in this sector are greatly helpful for this nation as well as to the human beings. Recent maritime dispute settlement with neighboring states has opened a new sphere of blue economy in Bangladesh.

### 1.3 Concept of Land Sea Interactions (LSIs)

The concept 'land-sea interactions' (LSI) is commonly used in the way of marine and coastal area planning and management. Interactions between terrestrial and marine environments may include, for example, the disposal of pollutants from a terrestrial farming field into a freshwater body that is in contact with coastal waters, as well as the development of a submarine cable in an inter-tidal zone connected a sea wind farm to the public-force matrix (Chang, 2011). LSI is a dynamic phenomenon involving all regular cycles across the interface of the land-ocean and the interrelationships in this field between human exercises. A significant amount of the important topics for sea administration are strongly related to LSI.

Environmental LSI includes coastal impacts combined with the removal of seaward saline solution, seaside base impacts and water stream effects (in and out). Hydro-realistic conditions can be affected by the foundations. The social-economic LSI includes the effect of seaward energy initiatives on nearby wages and jobs, impacts on obstruction of dry weather and water supply levels of contamination. Technical LSI includes achieving effective seaward and inland resources accessibility (mains water supply). The importance of the individual LSI is depending on the nature of fishing (e.g., target species, gear used), resource and area of the fishery. Through management initiatives (such as geographical constraints, specialized (gear) controls, standards), possible environmental benefits can be effectively aggravated. Even though fisheries forecasts will usually be managed by executive measures through the Common Fisheries Policy or the Public Fisheries Policy, arranging marine measures will allow both maritime planning and terrestrial planning to resolve future interactions with planned partnerships with other marine exercises and help to identify nearby financial advantages. Socio-economic impacts of LSI for recreational eco-tourism and spatial rivalry with hydroponics, seaward electricity, mining in various

areas are greatly beneficial for national economy. Socio-economic benefits associated with local profits and jobs. Socio-economic benefits from adjacent beach front fishing to the tourism sector. Technological LSI involves the landing and planning arrangement of offices and transport connections (Brian *et al.*, 2018).

### 1.4 Relationship between the MSP and Land Sea Interaction

The fruitful transmission of MSP and good administration on the coast is central to learning and compromising LSI. The MSP Directive (2014/89/EU) (Beetham and Lord, 2014) expressly includes the analysis of LSI by EU Members. The Directive indicates that Member States can use other formal or informal cycles, such as integrated beach front administration, if LSI may not structure a piece of the MSP process indirectly (Integrated Coastal management) (Papageorgiou, 2016). In their oceanic spatial plans, portion states will represent the impacts.

Specific States should advance the comprehension of maritime spatial plans with other relevant cycles by MSP. One approach to maintaining soundness of any cycle is tending towards LSI.

### 1.5 Role of Integrated Coastal Management in delivering LSIs

Land-ocean interface control has been progressed by the ICM cycle or Integrated Coastal Zone Management cycle (ICZM). ICM is a coastal administration cycle which utilizes a coordinated response to actively pursue sustainability with consideration to all aspects of the beach front region, including geographical and political boundaries. In distinguishing statistics, evaluation and LSI managers, the methods built by ICM are critical in ensuring the economic, social and environmental survival of coastal regions (Schernewski *et al*., 2014). The ICM principles are:

- Taking a long-term and broad current perspective.
- Using adaptive management.
- Retain the specificity of the community
- Consider biodiversity' balancing abilities
- Involved in the concept of management
- The participation of related administrative agencies
- Combination at government level of planning and administration.

### 1.6 Important of this research

There is various intensity of interactions among different uses and activities of coastal and land use planning. This research has profound influence for finding conflicts among different categories and making a proper solution to overcome the problem which arises. This research also helps the coast and tourism region through data analysis. It is also shown the LSI by calculating the height between sea and land using digital elevation modeling approach. Digital elevation models (DEMs) are the arrays of regularly spaced elevation measures referenced horizontally either to a Universal Transverse Mercator (UTM) projection or to a geographic coordinate system (GCS).

### 1.7 Objectives of this research

The objective of this study is to integrate the Land-Sea Interactions (LSIs) in the framework of Maritime Spatial Planning. The specific objectives of this research are as followings:

- To evaluate and identify the land-sea conflicts between land uses and coastal activities of Cox's Bazar.
- To determine the elevation model as well as the contour profile to validate LSIs.

# CHAPTER TWO

# REVIEW OF LITERATURE

## 2.1 Defining MSP and LSIs

Maritime spatial planning (MSP) is intended as a process for applying an integrated ecosystem-based approach to the sustainable utilization of marine resources to control the oceans. The need for MSP is to handle transition, intended as complex elements from multiple drivers has been established by many policies and research publications. Practical examples of MSP accepting transition and dynamics however, are scarce, and the integration of system instability, environmental instability and future MSP adjustment remains difficult (Michelie, 2019). Maritime spatial planning (MSP) has been an emerging and promising international instrument for the implementation of integrated ocean management. For public authorities and stakeholders, the MSP provides an effective mechanism to coordinate their activities across sectors and administrative borders and to maximize the use of natural resources (Schaefer, 2011).

In respect to the Baltic Sea Maritime spatial planning is a modern form of spatial planning that is emerging at the intersection of rising demands for the commercial use of marine space and growing concerns about marine environments (Backer, 2011). Many coastal countries across Europe are currently engaged in this area, not only through their national activities, but also through cross-border cooperation, through cross-border dialogue, joint strategies, and even co-operation. Such activities, consisting of the Plan Bothnia pilot making plans of the Bothnian Sea among Sweden and Finland, carry into floor variations in making plans tactics and approaches, perspectives at the environment, incompatibilities of geographical information and the overall complexity of the international-country wide felony framework (Flinkman, 1996). Creativity and transparent, responsible tactics are had to make sure that such projects were each beneficial and legitimate (Backer, 2011).

Appropriate land-sea interaction (LSI) context management should be based on planning approaches that can help coastal growth holistically, such as maritime spatial planning (MSP). Via an exchange of matter (and energy) between the anthropic system, and the natural environment, land-sea interaction dynamics are physiologically regulated (Maragno *et al*., 2020). The fragmentation of existing

databases and information sources, which constitute *the* territorial knowledge system, is one of the key limiting factors for this integration.

According to Asprogerakas *et al*. (2020) the inter action of development processes and strategies for land and sea areas should be taken into account in the management of the LSI. It is necessary to ensure that legal, administrative, consultation and technical consultations are carried out. To avoid needless duplications, discrepancies, disputes, waste of resources, and/or unreasonable demand for the efforts of stakeholders, procedures are organized and ideally linked (Asprogerakas *et al*., 2020).

A DEM can be represented as a raster or a vector-based triangular irregular network (a grid of squares, also known as a height map when representing elevation). DEMs are generally constructed using remote sensing techniques to collect data, but they can also be constructed from land surveys. The increasing use of DEM (Digital Elevation Model), especially in GIS, highlights the balance between two key issues: terrain modeling quality versus handling large volumes of data. Without external knowledge, the relative validation merely regulates the internal DEM coherence (Rognant, 1998).

Digital Elevation Model Networks (DEMON) enable both contributing and dispersal areas to be calculated (Costa-Cabral, 1994). Dewan *et al*. (2004) conducted a study on DEM based Flood Extent Delineation in Dhaka City Bangladesh. The goal of this paper was to use the digital elevation model (DEM), an integral part of the geographic information system, to delineate the flood scale in Dhaka city. Estimation of flood extent was showed by the DEM data. However, to be a spatially explicit flood model, high-resolution DEM was required to model inundation in the region. Hussain *et al.* (2018) was preparing a high-resolution Digital Elevation Modeling of Saint Martin Island, Bangladesh based on open-source Google Earth data, and a comparative evaluation was carried out with SRTM 30, SRTM 90 (Data set) and ASTER 30-meter DEM resolution. DEM was created from the study area of Google Earth by extracting 58540 elevation points.

## 2.2 Laws and regulation related to LSIs

### 2.2.1 International Laws and regulation

Hussain *et al.,* (2018) described different laws and regulations related to ocean and maritime spatial planning. There are a number of international conventions and

declarations which either directly or indirectly provide legal stands for MSP. Such as United Nations Convention on the Law of the Sea (UNCLOS), UN Fish Stock Agreement, 1995, The Ramsar Convention, 1971 and Convention on Biological Diversity, 1992 etc.

### 2.2.2 National laws and regulation

According to Duck (2012), The Territorial Waters and Maritime Zones Act, 1974 is the first and the only instrument to provide for the declaration of zones and bringing areas in the Bay of Bengal within the country's territorial jurisdiction according to the provisions of international agreements and laws. The Act empowers with the legal means of establishing its sovereign, and other rights on respective zones in the sea. The next most important legal basis for a concerted development and management strategy of the maritime areas is the combination of the Coastal Zone Policy, 2005 (CZPo) and the Coastal Development Strategy, 2006 (Alam,2018).

**Water resource management**

For water resources management, there are three principal instruments in Bangladesh. This policy includes the National Water Policy, 1999; National Water Management Plan, 2001 and Bangladesh Water Act, 2013.

**Shipping, trade & commerce**

The Ports Act, 1908 is the primary legislation for functioning and controlling Port handling in Bangladesh. Moreover, The Protection of Ports (Special Measures) Act, 1948 was enacted to add some safety and security measures in operation and maintenance of port activities. Chittagong and Mongla ports, two existing ports, were governed by their respective laws –The Chittagong Port Authority Ordinance, 1976 (amended in1995), and The Mongla Port Authority Ordinance, 1976 (amended in 1995). The Paira Port Authority Act, 2013 has accelerated the establishment of the third port in Bangladesh. In addition, The Bangladesh Shipping Corporation Order, 1972 establishes the Bangladesh Shipping Corporation for operating and developing of maritime transport services. The Bangladesh Merchant Shipping Ordinance, 1983 is a comprehensive law determining and controlling various operational aspects of the maritime transport sector for sea going vessels while Inland Water Transport Authority Ordinance, 1958 provides for the establishment of such a public authority for the development, maintenance and control of inland water transport. Furthermore,

International trade and commerce are regulated by the Imports and Exports (Control) Act, 1950 and subsequent orders released under the purview of this Law. e.g., Import Policy Orders, 2012-2015.

**Table 1 Different laws and regulations related to MSP and LSIs in Bangladesh**

**International Context**

**Legal and Institutional Framework for MSP**

- International Conventions
- United Nations Convention on the Law of the Sea (UNCLOS)
- UN Fish Stock Agreement 1995
- The Ramsar Convention 1971
- Convention on Biological Diversity 1992

**National Context**

**Policies, Acts, Rules and Plans**

**Maritime and Coastal zone**

- The Territorial Waters and Maritime Zones Act, 1974
- Coastal Zone Policy 2005
- Coastal Development Strategy 2006

**7th Fifth year plan (2016-2020) for Ocean and River management**

**Fisheries**

- The protection and Conservation of Fish (Amendment) Ordinance, 1982
- National Fisheries Policy 1998
- Fish Hatchery Act 2010
- Fish Hatchery Rules 2012
- National Shrimp Policy 2014

**Energy and mineral resources**

- The Petroleum Act, 1934
- Regulation of Mines and Oil Fields and Mineral Development (Government Control) Act, 1948
- Bangladesh Petroleum Act, 1974
- National Energy Policy, 2004

**Environmental Protection**

- Bangladesh Environmental Conservation Act 1995/Rules 1997/Amendment Act 200/2002,
- National River Protection Commission Act 2013,
- National Action Plan for Adaptation (NAPA) to climate change, Bangladesh
- National Conservation Strategy 2005

**Hydrographic Management**

- National Water policy 1999
- National Water Management Plan 2001
- Bangladesh Water Act 2013

**Shipping, trade and commerce**

- The Ports Act, 1908
- The Chittagong/Mongla Port Authority Ordinance 1976/ Amendment 1995
- The Paira Port Authority Act 2013
- The Bangladesh Shipping Corporation Order 1972
- The Bangladesh Merchant Shipping Ordinance 1983
- Import Policy Order 2012-2015
- The Bangladesh Parjatan (Tourism) Corporation Order 1972
- The National Tourism Policy 2009
- The Bangladesh Tourism Board Act 2010
- The Bangladesh Tourism Protected Areas and Special Tourism Zone Rules 2011
- The Fisheries Research Institute Ordinance 1984
- The Navy (Amendment) Ordinance 1977
- The Coast Guard Act 1994

**Tourism**

The Bangladesh Parjatan (Tourism) Corporation Order, 1972 is the pioneering instrument to provide for the tourism sector in Bangladesh. The Order empowered to form the Bangladesh Parjatan Corporation for promoting for operation and development of tourism in the country. Moreover, The National Tourism Policy, 2009 is a holistic approach of Bangladesh government to improve the tourism sector with a

view to facilitate new employment for unemployed people. The Bangladesh Tourism Board Act, 2010 was passed in the next year to establish a supervisory board and The Bangladesh Tourism Protected Areas and Special Tourism Zone Act, 2010 along with The Bangladesh Tourism Protected Areas and Special Tourism Zone Rules, 2011 provide for declaring and managing potential areas exclusively for tourism. A detailed rules and regulation of MSP related with LSIs are specified in the following table 1.

**Scientific research**

The Fisheries Research Institute Ordinance, 1984 allowed the establishment of a research institute to coordinate fisheries research in the country. The achievements and practical outcomes from this institute in 30 years of its founding may be brought into question, and critically evaluated, but the necessity of an organization of its kind cannot be undermined (Duck, 2012). Only recently, a national oceanic research organization has been founded for spearheading all kinds of oceanographic research including, biological, physical, chemical, and geological nature. This would be the lead ocean research body of the country (Duck, 2012).

**Defense, and Law enforcement**

Bangladesh Navy was formed to maintain sovereignty and territorial integrity of our oceanic area under The Navy Ordinance, 1961, and by its amendments, e.g., The Navy (Amendment) Ordinance, 1977. The Bangladesh Coast Guard has been recently formed under the provisions of The Coast Guard Act, 1994 to ensure regular patrolling the maritime boundary of Bangladesh.

# CHAPTER THREE

# METHODOLOGY

## 3.1 Study area

### Cox's Bazar

Cox's Bazar is recognized as one of the best tourism destinations in the world. Cox's Bazar has profound influence on different coastal and maritime uses and activities such as tourism and coastal recreation, para sailing, scuba diving, cultural heritage etc. The beach in Cox's Bazar has a gentle slope and is often referred to as the world's "longest natural unbroken sea beach" with an unbroken stretch of 155 km (96 mi) (Jamil and Siddique, 2013). The southeastern region extending from big Feni River to Badar Mokam, the southern tip of the main land. This part is more or less unbroken, characterized by muddy flat and sandy beaches a degraded natural mangrove forest in the estuarine zone of the Matamuhuri River. Karnafulli, Sangu, Matamuhuri, Bakkhali and Naf Rivers discharge fresh water through the riverine networks (Mahmood *et al.,* 1994).

Depending on geographic features, coastal zone of Bangladesh consists of three parts, (a) The eastern zone, (b) The central zone, (c) Western zone. The coastline is 710 km long which is composed of the interface of various ecological and economic systems, including mangroves, tidal flat, estuaries, sea grass, approximately 70 islands, accreted land, beaches, a peninsula, rural settlements, urban and industrial areas, and port region. Cox's Bazar is situated on coastal plain of southeastern belt which is bordered by the Bakkhali River to the north and east, the Bay of Bengal to the west, and the Jhilwanj Union to the south. This coastal plain appears from above to bulge out into the Bay of Bengal. A large area of sand and dunes is located near the coast. Much of the town is constructed on a lower elevation floodplain, which making it more vulnerable to floods due to cyclones and storm surges. After the sea reached its present level about 6,500 years ago, the Cox's Bazar coastal plain was formed, with the region of the current floodplain originally being a sediment sink that has since been steadily filled by the Bakkhali river and smaller streams coming down from the hills (Alam *et al.,* 2015).

### 3.1.1 Kutubdia Island

Kutubdia is located at 21°49′00″N latitude 91°51′30″E21.8167°N latitude, 91.8583°E. It has total area 215.8 square kilometers (83.3 sq. mi) (Fig. 01a). Climate change and sea level rise threaten to submerge the island in the Bay of Bengal. Kutubdia Island is about 21 kilometers long and 2 to 6 kilometers wide, aligned roughly parallel to the mainland Chakoria separated by approximately 3 kilometers wide tide dominated channel (Chowdhury *et al.,* 2014). Kutubdia is one of many islands of Bangladesh which was affected by increasingly rapid sediment transport, erosion. Some of the fastest recorded sea-level rises in the world were formed at the mouth of a river system consisting of two channels. This vanishing island is shrinking dramatically. Kutubdia has halved in size in 20 years, to about 100 sq. km. At the current rate of erosion Kutubdia will be off the map within 30 years, along with dozens of other coastal islands (Islam *et al*., 2014).

Kutubdia coast was influenced by both natural and anthropogenic factors, and changed severely by the tidal and wave action of the Bay of Bengal and also internal activity of Kutubdia Channel. The natural factors contain changes of tidal estuary and tidal surge, and the anthropogenic factors consist of population pressure, construction and extension of saline, cultivated fields and human activities. It has great significance to monitor coastline change for Bay of Bengal coastal zone protection and utilization. It is also very important to provide scientific and efficient information for decision-making administrations.

### 3.1.2 Moheskali Island

Moheshkhali islands reveals as a substitute complicated geological device at the eastern cliff coast of Bangladesh characterized through hilly topography surrounded through coastal plain exhibiting specific geologic, tectonics and in addition to geomorphologic. The Moheskali Island together with the Materbari and Sonadia lies within 21°20' N to 21°50' N range and 91°45' E to 92°00' E longitude and bordered through Chakoria and Cox’s Bazar in the north, northeastern eastern and southeastern portion throughout the Moheshkhali channel (Fig. 1B). The Kutubdia channel separates Moheshkhali Island from Kutubdia in the northwestern part and excessive western and southwestern portion is open to the Bay of Bengal. The island is split into

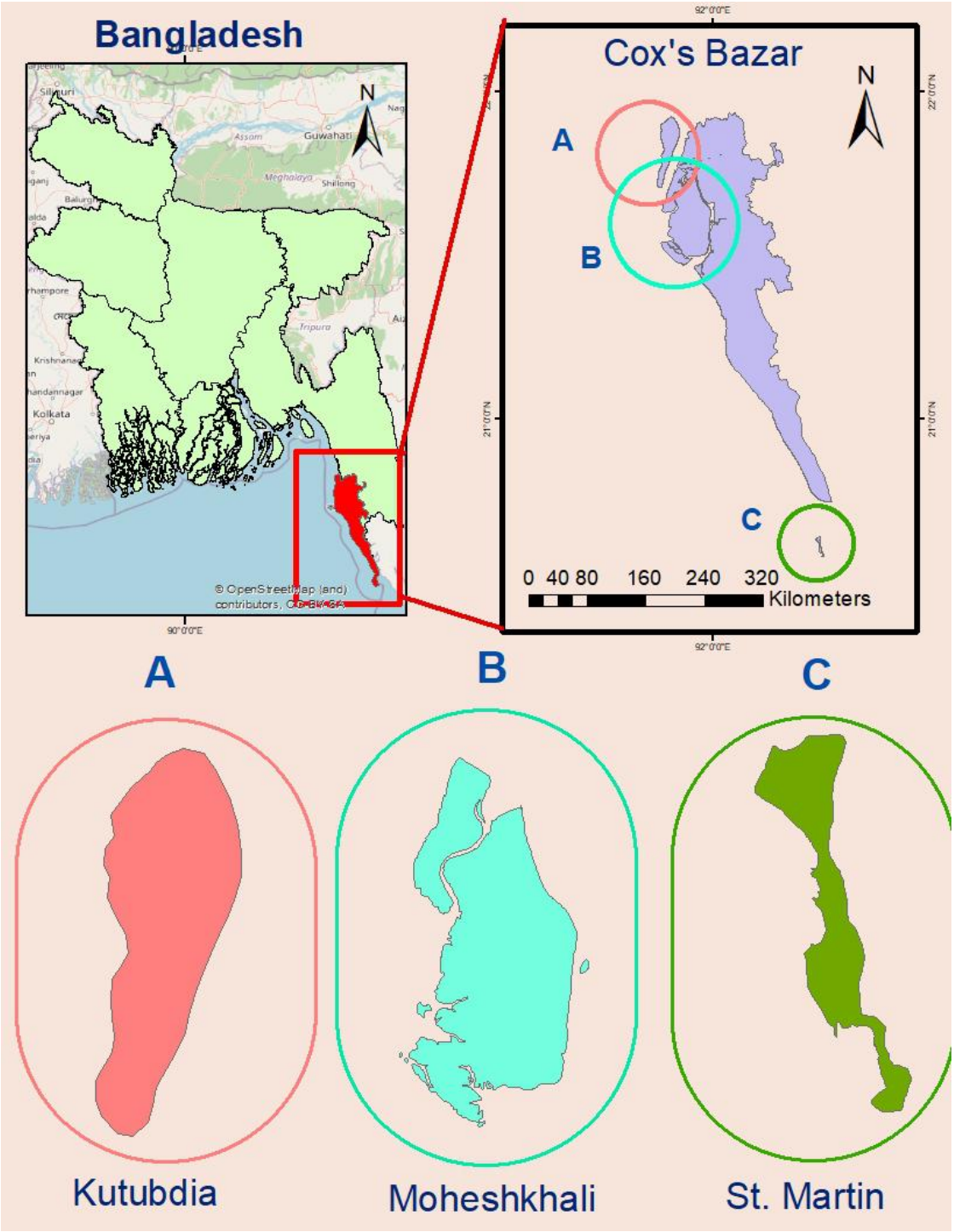


**Figure 1:** Map of Cox's Bazar Study area (A: Kutubdia, B: Moheshkhali, and C: St. Martin island)

four (04) subdivisions. Those are active coastal plain, young coastal plain, old coastal plain and hilly areas with piedmont plain. Landforms are very plenty associated to the geological depositional system. In Moheshkhali Island mainly two different depositional systems take precedent to the semi-closed system in the southern part and

open to the semi-closed system in the northern part (Majlis *et al.,* 2013). According to the scale 1.2 sq. km. Moheshkhali is in the accretion process since 1972 per annual basis (Islam *et al.,* 2011).

### 3.1.3 St. Martin Island

Though St. Martin (Fig. 1C) is a small island in shape and size but the significance of this diverse coral island is indescribable. This unique island is located in the southernmost point of Bangladesh. It is in the northeastern part of Bay of Bengal and like a pearl dot in the Bay of Bengal. It is situated at 9 km south of the Cox's Bazar-Teknaf peninsular tip and about 8 km west of the north-west coast of Myanmar at the mouth of Naaf river (Rashed and Rob, 1997). The total area of this island is about 14 sq. km. including 50 % with the rocky platform extending into the sea (Alam *et al.,* 2015). This island is almost flat and is merely 3.6 meter above sea level. The island is very much ingenious with vast biological variety such as existing fauna and flora mollusk, fish, amphibian, turtle, snail, bird and mammals. Exotic view of the sea, diverse biodiversity including seaweeds, seagrass and coral made this island best exploration spot for scientific community as well as for the tourists.

## 3.2 Geomorphological change

The accretion-erosion process of the islands like Kutubdia, Hatyia, Sandwip and Bhola has indications of strong sedimentary process in the vast Ganges-Brahmaputra-Meghna estuary which constitute about 12800 km2 of in-shore fish habitat (West, 1973). Increase in erosion of the islands in the past few decades is evident. Sandwip has lost over 72 $km^2$ between 1953 and 1982 as compared to the loss of 190 $km^2$ in the last 2 centuries. Hatyia increased to about 1070 $km^2$ from 307 $km^2$ within a period of 166 years (1779-1945) and lost all 700 $km^2$ of accreted land by the year 1979 (within a period of 34 years only) (Mirza and Shahjahan, 1987). Huge rate of accretion in the past indicates an extensive amount of deposit carried down by the rivers, likewise increased erosion in the recent years must be translated at increased transfer of sediments to the sea.

### 3.3 Assessment of present and future uses and activities

Bangladesh is one of the littoral states of the Bay of Bengal region experiencing the challenges of ocean governance ad reviving up the initiatives to garner the benefits of land sea interactions. This Bay region is rigged with the different types of intensities of interactions, including the problems of IUU fishing, marine litter, ineffective marine rules and regulations and maritime communication, safety and security menace. To analyze the present and future land-sea conflicts in the coastal and maritime space this study need to specify the present intensities of the LSI zone as well as potential activities in this area for future planning. There has been growing globally as well as national concerns for preservation and sustainable utilization of coastal and maritime resources by proper planning and management of LSIs. This thesis paper endeavours to analyze how coastal uses and activities shape the coastal environment, integrating the land sea interactions process in the framework of maritime spatial planning. After having revised substantial literature, background documents, position papers and especially the background paper for the preparation of the 7$^{th}$ fifth year plan named "Opportunities and strategies for ocean and river resource management", the present and future land and sea uses and activities are being specified for this southeastern coastal belt of Bangladesh.

### 3.4 Conflict matrix plan

Maritime spatial planning is a big platform to improve the economic status of any coastal country. Maritime spatial planning specially deals with the exploration of sea and ocean resources. There are various uses and activities along the southeastern coastal belt of Bangladesh. So, there are conflicts among these human activities. Conflicts classified as weak or strong or not influential without any conflicts. Without minimizing the conflicts, proper planning in the sea space cannot be imagined. In this section, this study searches the conflicts between the coastal land uses and maritime spatial uses. Conflict resolution in the sea space is a very important issues due to the pressure on maritime region to ensure blue economy in the developing country. There are some uses and activities of the study area are divided into two categories as coastal land uses and maritime spatial uses.(Fig. 6).

### 3.5 DEM Models

Digital elevation model (DEM) is the most fundamental and fascinating geographical data type to create the physical view of land. The digital elevation model is the continuous surface of the ground by a large number of selected points with known coordinates in an arbitrary coordinate field (Garbrecht and Martz, 2000). This technique of data acquisition and processing have been developed and new types of data comes from different source such as coastal agricultural management, flood monitoring and fisheries management etc. DEM can be organized in a raster or random 3D mapping form which provide a correct geo-referencing system in any map. The Shuttle Radar Topography Mission (SRTM) satellite obtained elevation radar data in high resolution digital topographic database of the universe. The single pass SAR interferometry of this satellite gave an interferogram from two-channels measure with slightly different ranges as R1 and R2 for any point on ground. The DEM of the specified area could be computed from this two-dimensional phase field after the $2\pi$ ambiguity of the phase measurement was removed by unwrapping phase. The outputs of the data are available in extension '. hgt' (height) format. The raw file format without the headers and not compressed form of 16-bit signed integers, elevations measured in meters above the sea level using in a specific coordinate reference system.

#### 3.5.1 DEM file collection

DEM file was collected from the Shuttle Radar Topography Mission (SRTM) with the resolution of 30 m. In order to collect DEM data from SRTM, registration and logging process was done through Earthexplorer to access and download relevant DEM data. Then step by step methodology used is as follows: To download the specific data the coordinate's reference system, coordinate values including latitude and longitude at least for four points of the study area were inputted. Then search criteria as well as Data-sets were selected in the specified tab of the website. After that, digital elevation related data-sets selected from the SRTM 1 Arc- Second Global datasets. The results will be appeared according to the objectives of search engine in this website. A list of relevant data-set will then be appeared and need to download using Earth datasets, NOAA websites and Earthexplorer internal site and further processing done by using QGIS or ArcGIS software (Fig. 2).

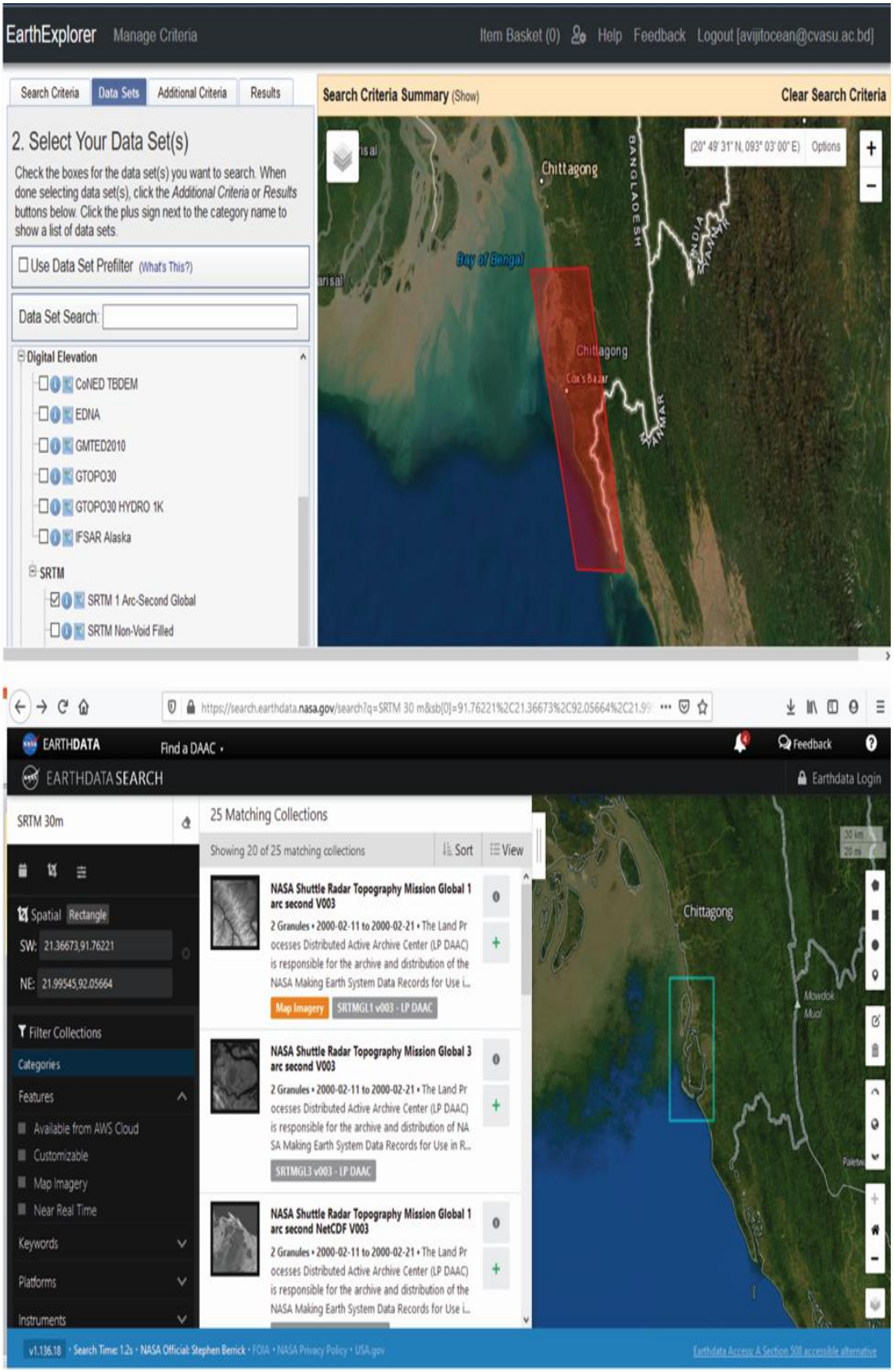


**Figure 2:** Data collection process using USGS Earthexplorer and Earth data from SRTM satellite

### 3.5.2 DEM processing

Here downloaded geotiff file are processed to digital elevation model and contour profile. The DEM and contour were analysis by QGIS software. And finally test with the field validation data with ground trothing.

Whole systems are shown in a diagram as in (fig. 3)

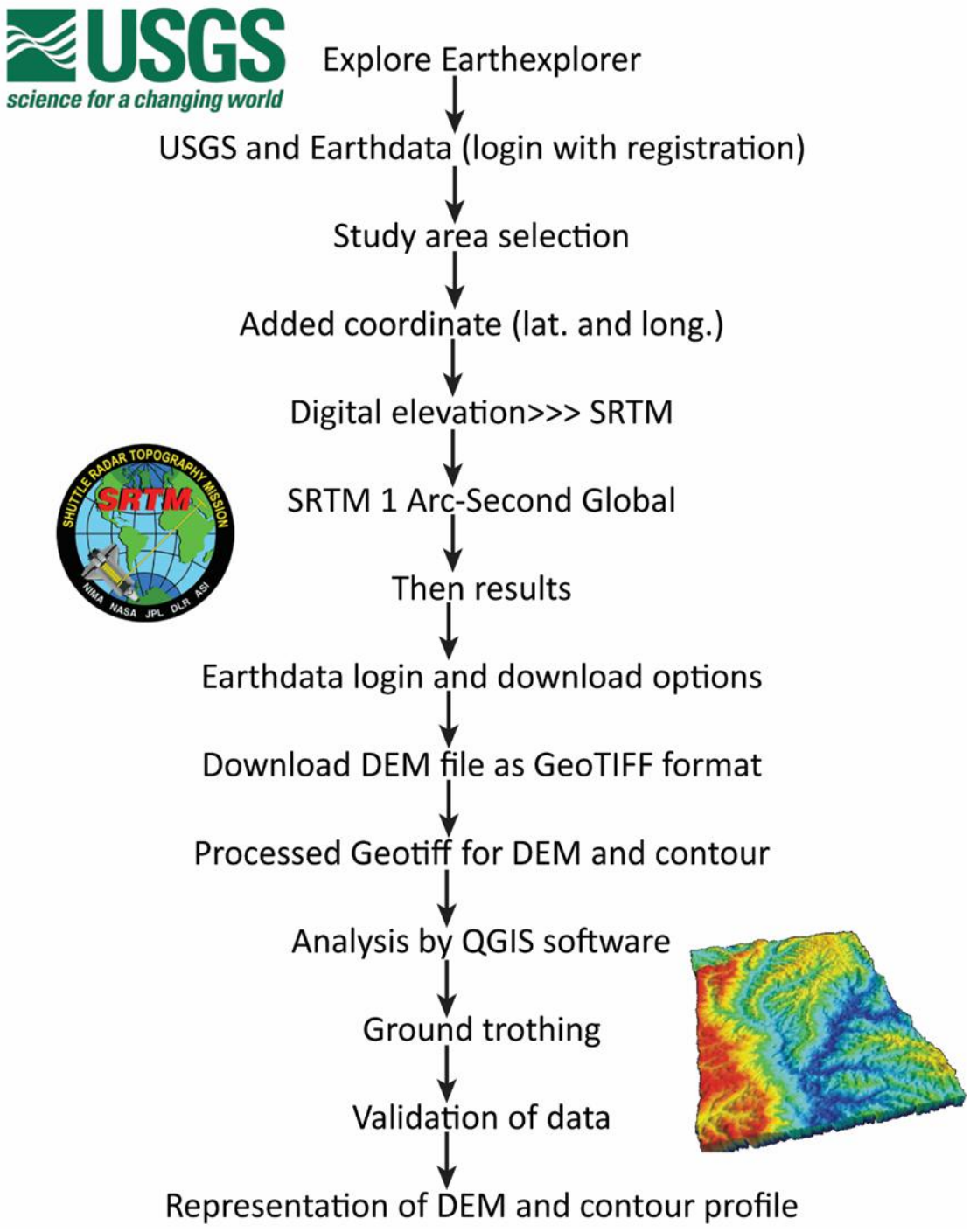


**Figure 3:** DEM processing procedure using SRTM satellite data with 30 m resolution.

### 3.5.3 Software

A wide range of software used for the processing of this DEM modelling which includes

- ArcView 10.6: It is used for creating and using maps, compiling geographic data, analyzing
- ArcMap 10.5: It is most widely used for map creation, but also has broad capabilities for editing and analysis.
- QGIS 3.6.1: QGIS supports both raster and vector layers; vector data is stored as either point, line, or polygon features. In addition to composing and exporting graphical maps.

# CHAPTER FOUR

# RESULT

## 4.1 Defining and analyzing existing conditions

There are interactions of intensities among different uses and activities associated with the coast and maritime space along the coastal belt of Bangladesh. There are graphical representations (Fig.4) of several uses and activities which were closely related with the land sea interactions (LSIs) of this study area .The main uses and activities of the coastal and maritime areas are represented in Table 2.

**Table 2 Uses and activities of land based and sea based coastal area**

| Theme | Uses and activities |
|---|---|
| Energy production | Renewable energy generation, hydrocarbon extraction |
| Extraction of living resources | Fisheries, seaweeds and other sea-based food harvesting, extraction of genetic resources |
| Extraction of non-living resources | Marine mining, dredging, desalination |
| Food production | Aquaculture |
| Land based activities | Industry, agriculture, forestry, urban |
| Man made structure | Land claim, coastal defense, port operations, placement and operation of offshore structures, submarine cable and pipeline operations |
| Military | Defense operations, dumping of unwanted munitions |
| Recreation | Tourism and recreation |
| Research and survey | Marine research, survey, educational activities |
| Transport | Shipping |
| Waste disposal | Solid waste disposal, storage of gases |

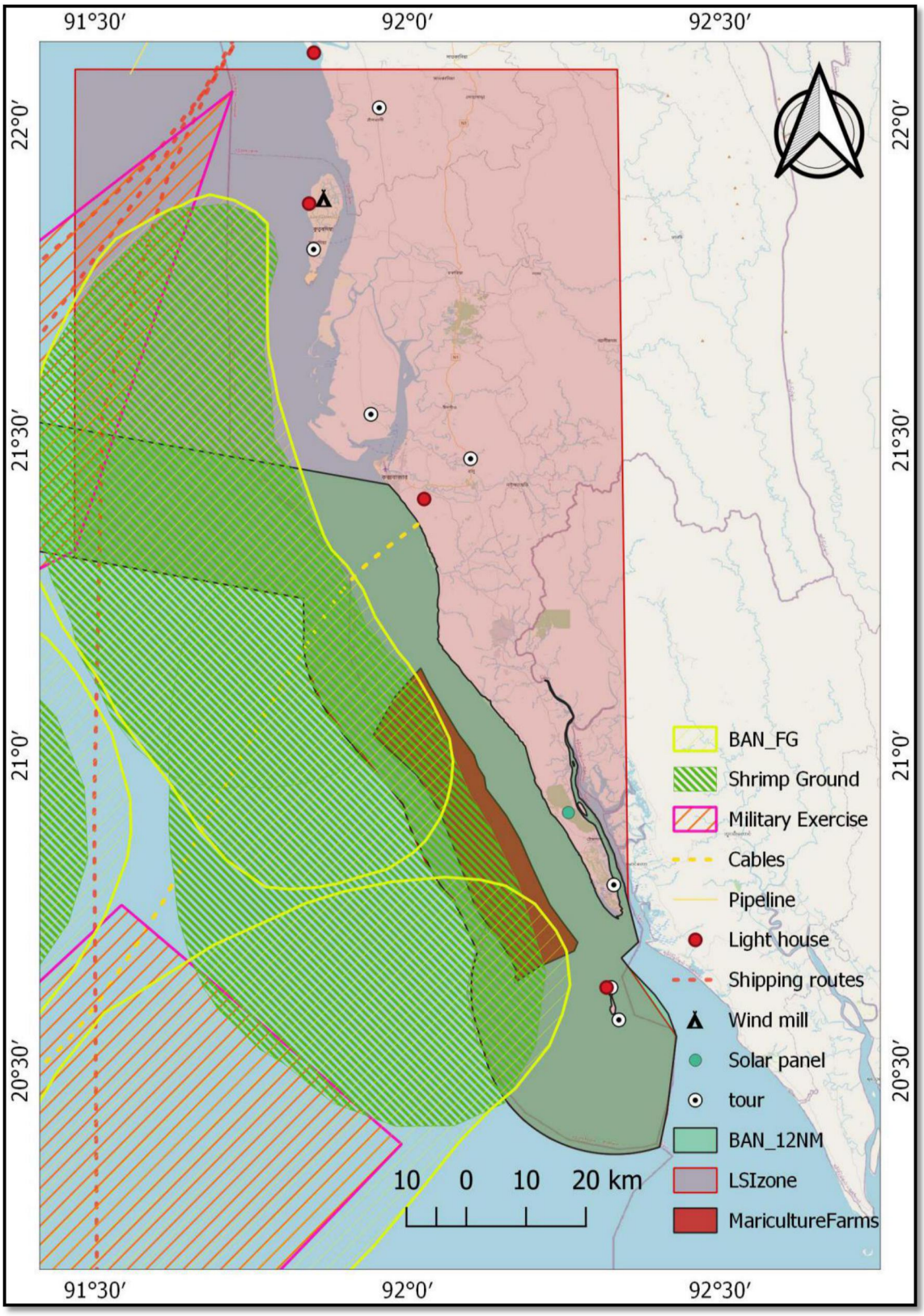


**Figure 4**: Present use and activities of Cox's Bazar area using QGIS software (FG= Fishing ground, LSI= Land Sea Interaction, NM= Nautical mile).

Cox's Bazar is the best districts in the Bangladesh of her beautyness. There are different kinds of use and activities are held in this area. There are 8 sub-districts under this district. My study area lies on Kutubdia, Moheskali, Teknaf (St. Martin) basically. In this area, 12 nm miles from the coast are used for many present use and activities which are related with the land sea interaction such as:

**Fishing Ground:** The Bay of Bengal is the largest Bay in the world which has unique biodiversity with diverse number of endangered and vulnerable species. There are generally four major commercial fishing grounds found in the Bay such as South patches, South of south patches, Middle ground and Swatch of no ground (Huq *et. al.,* 1995). In this study, two industrial fishing ground are touches within the 12 nm miles limit of LSIs as South patches, South of south patches.

**Tourism:** Cox's Bazar is the famous holiday spot for the beauty seeker. There are some tourist spots in Cox's Bazar including its sea beach, Inani sea beach, Kutubdia island, Moheskali temple, St. Martin island, Kutubdia wind mill, etc. There is a huge opportunity to create and develop the tourism system.

**Light house:** This navigational lighthouse is a tower, building, or another type of structure designed to emit light from a system of lamps and lenses and to serve as a navigational aid for maritime pilots at sea or on inland waterways. There are about three lighthouses in the Cox's Bazar district such as Kutubdia Lighthouse, St. Martin island lighthouse and Cox's Bazar lighthouse.

**Military exercise:** Military exercise is generally held in the exclusive economic zone region. For ensuring the national security, total 4/5 military exercise area are designed in the maritime space of Bangladesh. These contributed areas are managed and in the maritime space of Bangladesh. These contributed areas are managed and maintained by the Military department especially Bangladesh Navy which act as the defense barrier of nation.

**Wind mill:** Ensuring the electricity supply is the main target of any developing country. It is the main factor for an agricultural nation like Bangladesh. In Bangladesh, power demand is increasing day by day, but the energy sources are not increasing in satisfactory level. Fossil fuels or petroleum derivates energy are getting diminished day by day. In this LSI research, there are two wind mills are available in Kutubdia and Moheskhali, but not in function.

**Existing solar panel:** Solar panel is another good source of power in local and remote areas of Bangladesh. Bangladesh has the right climate to breed the solar panel power system. In recent study, there are three solar panels area available in the coastal belt of Bangladesh as Teknaf, Cox's Bazar.

**Shipping routes:** Shipping routes are very important for carrying goods and also important for fishing. There are several fishing routes in the Bay of Bengal connecting the ports of Chittagong and Mongla. Newly developed Paira port also in function with the maritime transport.

**Cables network:** Cables are very important for communicating network system. Bangladesh maritime space has one cable network near the southeaster Chattogram coastal belt.

**Port region extension:** Port extension region or area is used in mainly port and maritime traffic related activities. Vessels with goods and passenger stay and parking in different area of port assigned and maintained by the port management authority.

### 4.2 Conflict Analysis

In the study area, conflicts found between the coastal land uses and maritime spatial uses. The results are shown in a conflict matrix where the green color represents the interaction with no conflict between the users; yellow color indicates the interaction with weak conflicts; red color designates the interaction with strong conflict.There are about 225 interaction issues were found during this matrix analysis. In where, land-sea interactions were characterized without conflicts as 79, weak conflicts as61, and found interaction with strong conflicts as 60. There was about 25 interaction not known in the study area. In this study, areas found no interaction between beaches and dunes (coastal land uses) and military practice area (maritime spatial uses) as well as parasailing (coastal land uses) and shipping routes and navigation, research monitoring station (maritime spatial uses). The largest number of interactions were identified in the maritime spatial uses as coastal fishing, open sea fishing, underwater cables, shipping routes and navigation, dumping sites, military practices area, intake waters, wastewater discharges, bottom trawling, protected areas, and coastal land uses were identified scuba diving, wastewater discharges, natural gas pipelines, fish boats, and shipping routes are strongly connected to the users.

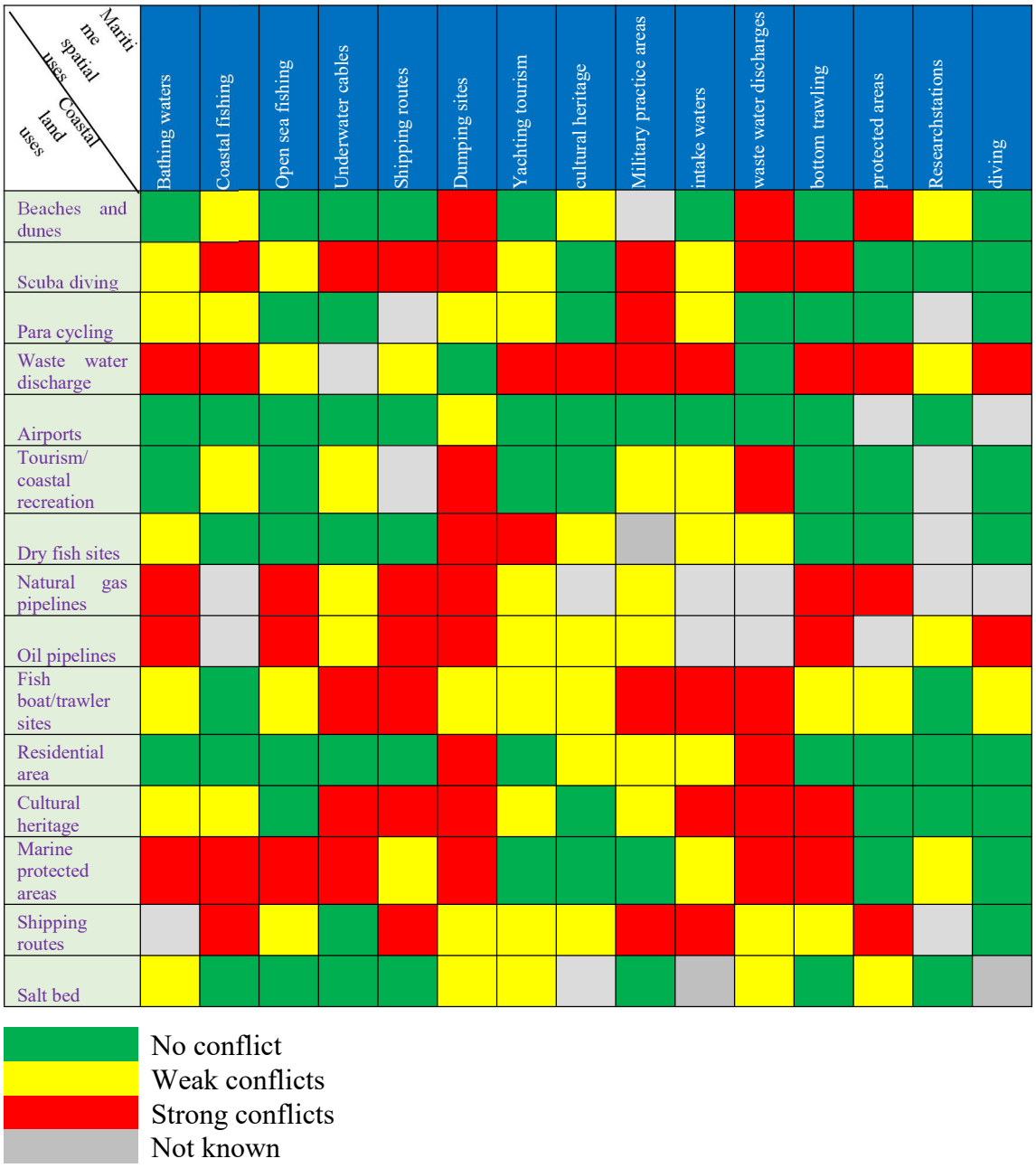


**Figure 5**: Land sea interactions conflicts matrix in Cox's Bazar study area prepared by following their uses and activities.

Beaches and dunes are strongly conflicted with the wastewater discharges whereasno interaction with the military practice area. Wastewater discharges are directly polluted sea waters. Wastewater discharges are the highest conflict among the users. Airports are slightly conflicted to the bathing water, coastal fishing, underwater cables, shipping routes and navigation, yachting tourism, cultural heritage, military practice area, intake waters, wastewater discharges, bottom trawling, and research monitoring station. Dumping sites were found in weak conflict and no interaction between the

protected areas and diving. Marine protected area is very essential for endemic fish and protects the species which are emerging in the future. Interaction between marine protected areas and maritime spatial land uses were found strong conflicts. Oil pipelines and shipping routes and navigation, dumping sites are strongly conflicted with interaction in the study area. The coastal tourism industry can be harmed by the direct impact of oil spills to beaches and waterfront properties and the negative impact on biodiversity (Fig. 5).

Bangladesh is characterized by tropical climate and huge amount of annual rainfall. It supports for diverse coastal waters with high diverse and abundant of marine biodiversity. The marine biological resource includes fishes, mussels, seaweeds, seagrass, coral reefs, mangroves etc. The soft substrate ecosystems abundant along most part of coast of Bangladesh. The high elevation and depth contours between northwest and southeast part of the coastal belt almost gentle, this enables for deposited sediment environments and favorable for the expansion of seagrass and seaweeds beds. The potential environmental pressures are discussed on the Table 3.

### 4.3 DEM Models

In this study, Cox's Bazar area mainly discussed with the three Islands as Kutubdia, Moheshkhali, and Teknaf. (Fig. 6) shown that's the difference between the normal situation and reclassified DEM. Study area labeled 0-5 m showing the highest elevation range while, 200-260 m label shows the lowest elevation in this study area.

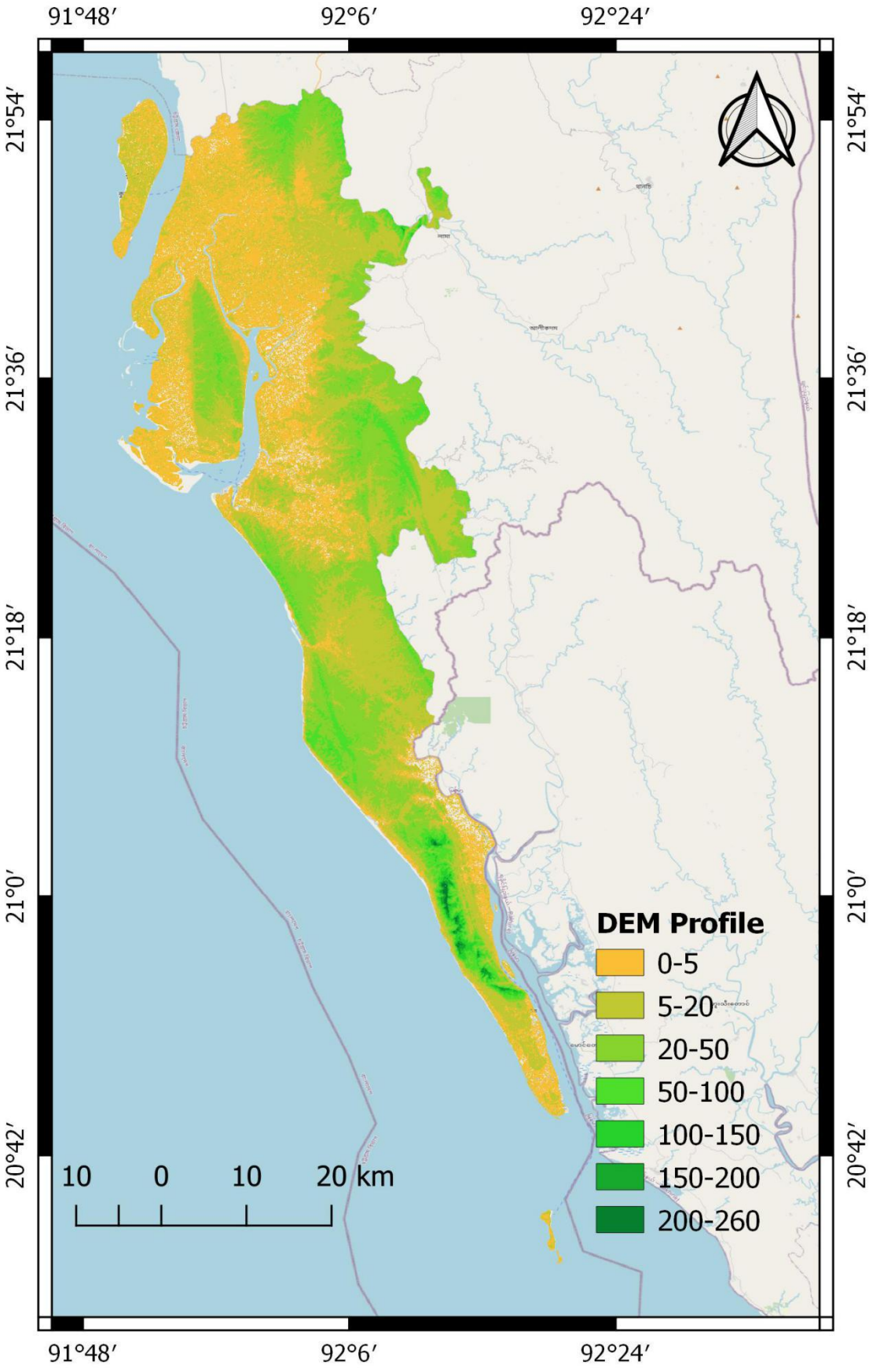


**Figure 6:** DEM profile of Cox's Bazar district which showed the elevation relative to the base line

### 4.3.1 Kutubdia Island

The representation of DEM of Kutubdia Island is shown in the following (fig. 7) which is generally known for its sandy beaches. The highest elevation found in the range of G (25m-28m) (0.004%) and it covered the minimum area of the total area of Island, whereas the lowest elevation was 3 m above the mean sea level within the range of A (0m-3m) (24.96%) of the total Island. A maximum area of 47.80% was covered by the elevation of C (5m-10m) in Kutubdia (Fig. 8).

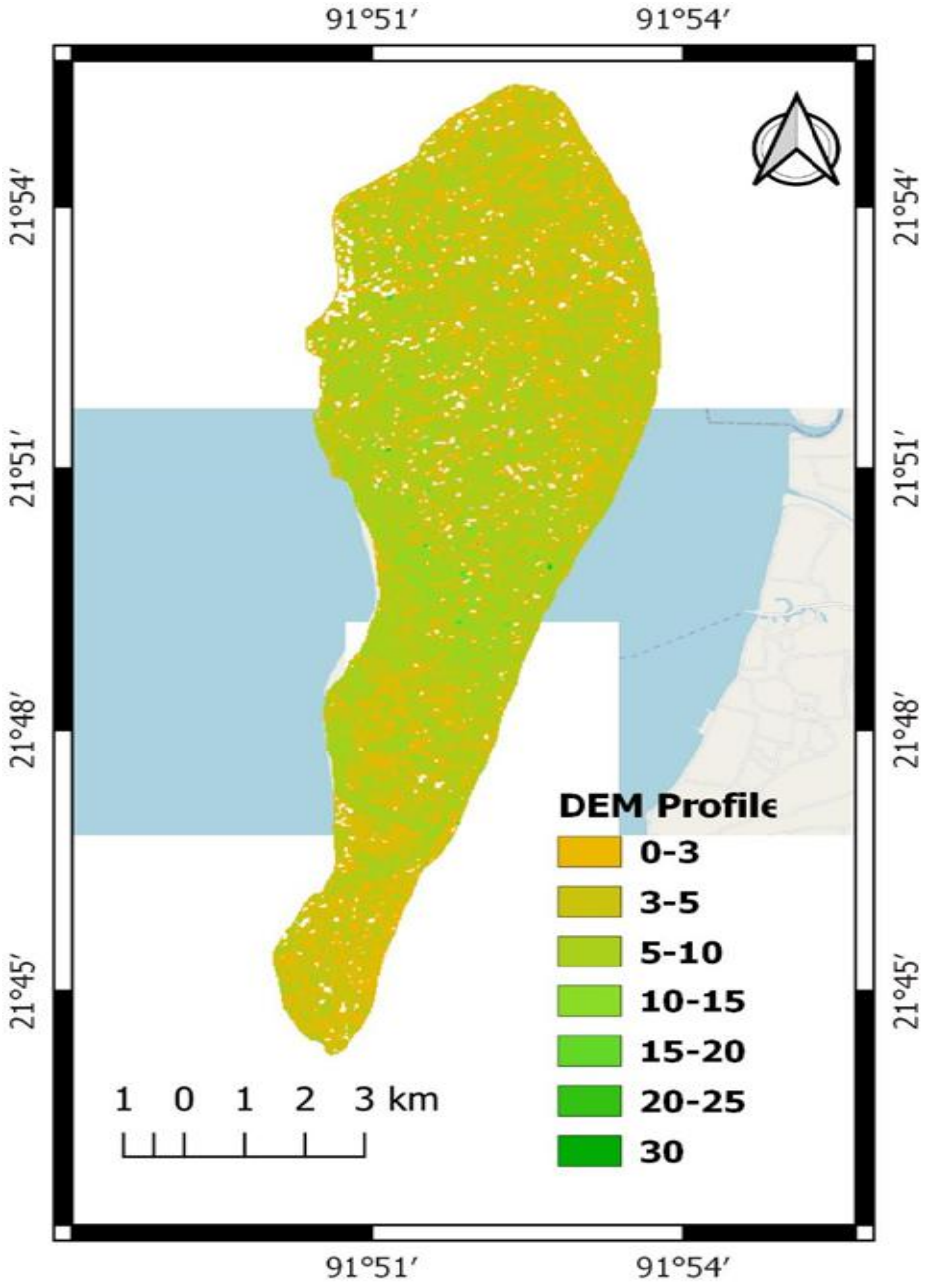


**Figure 7:** DEM profile of Kutubdia study area

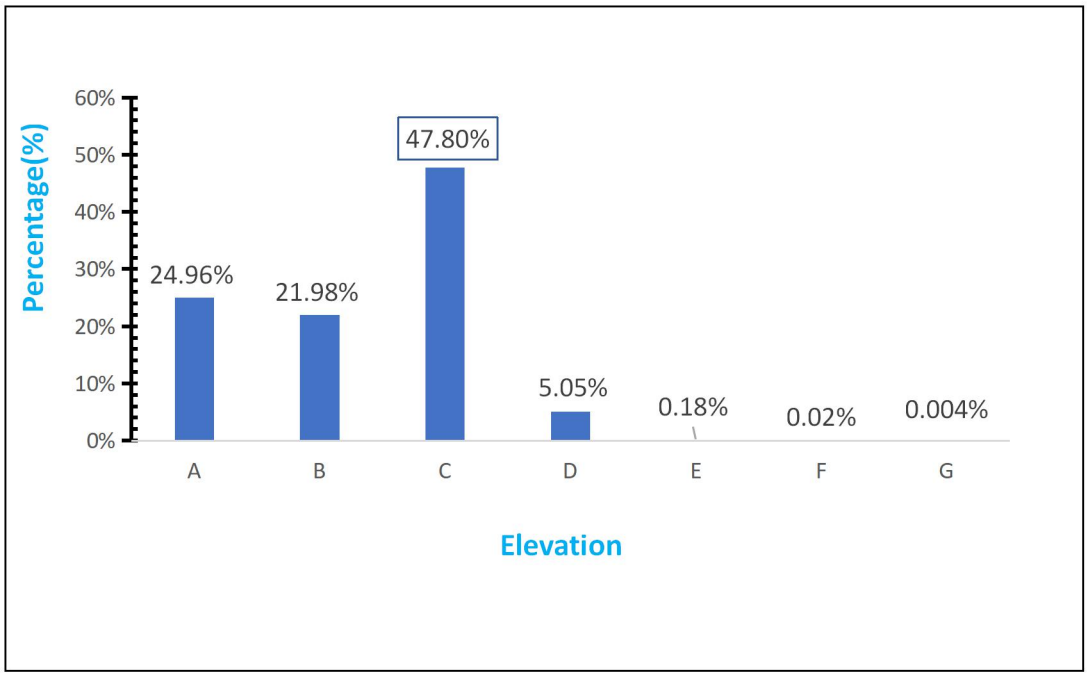


**Figure 8:** Elevation of the Kutubdia Island showing different heigth range*[Here, Elevation value A= (0-3) m, B= (3-5) m, C= (5-10) m, D= (10-15) m, E= (15-20) m, F= (20-25) m, G= (25-28) m]*

### 4.3.2 Moheshkhali island

This unique muddy Island Moheshkhali is characterized by hilly region and the relevant DEM structure represented in the following (fig. 9).In this Island, the highest elevation ranged (60m-82m) was covered by only 0.2% (Fig. 10) of the total area (Moheshkhali Island). On the other hand, the lowest elevation(0m-5m) was covered 53.58% of the total area which is the largest portion of Moheshkhali.

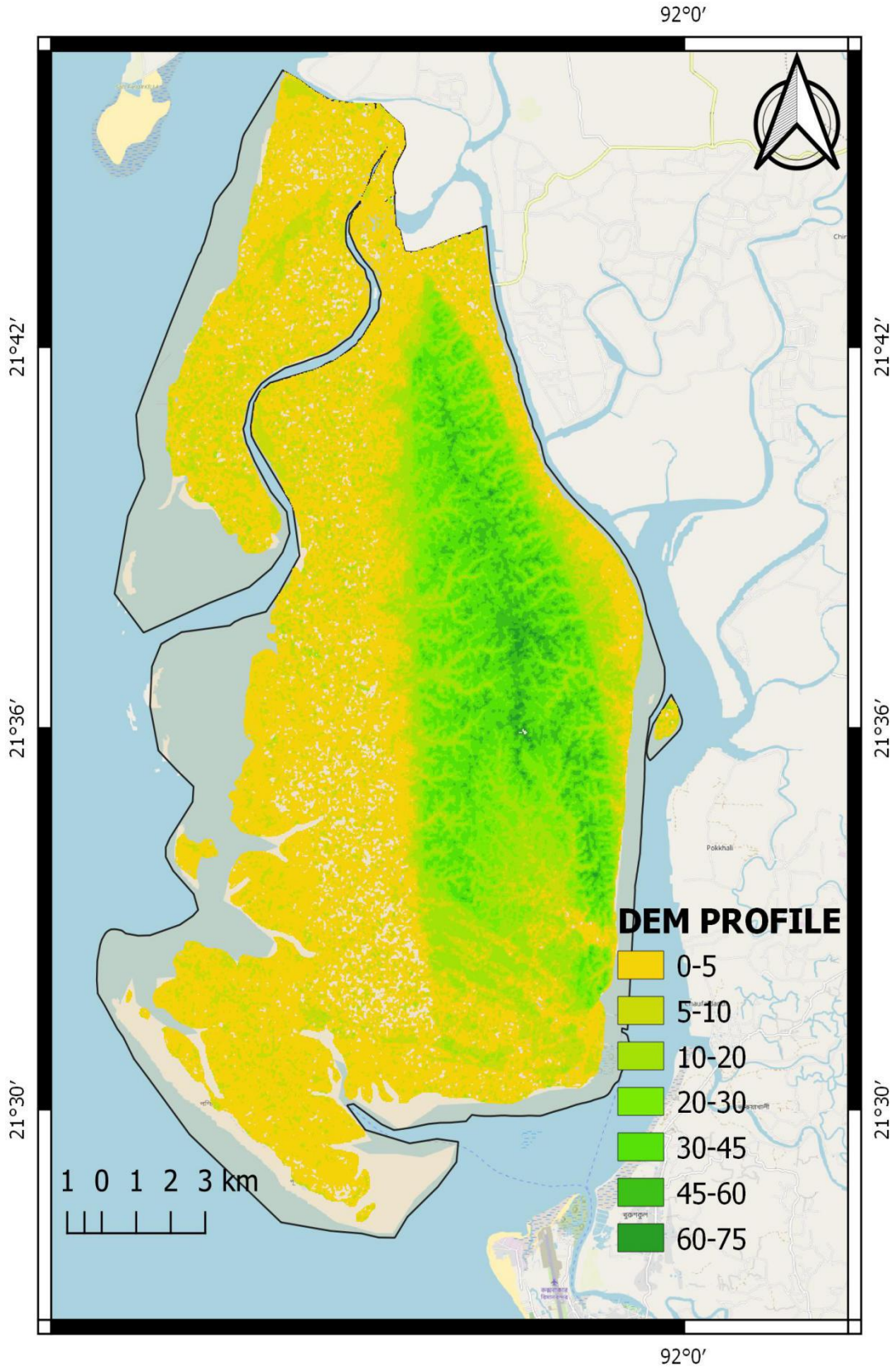


**Figure 9:** DEM profile of Moheshkhali study area

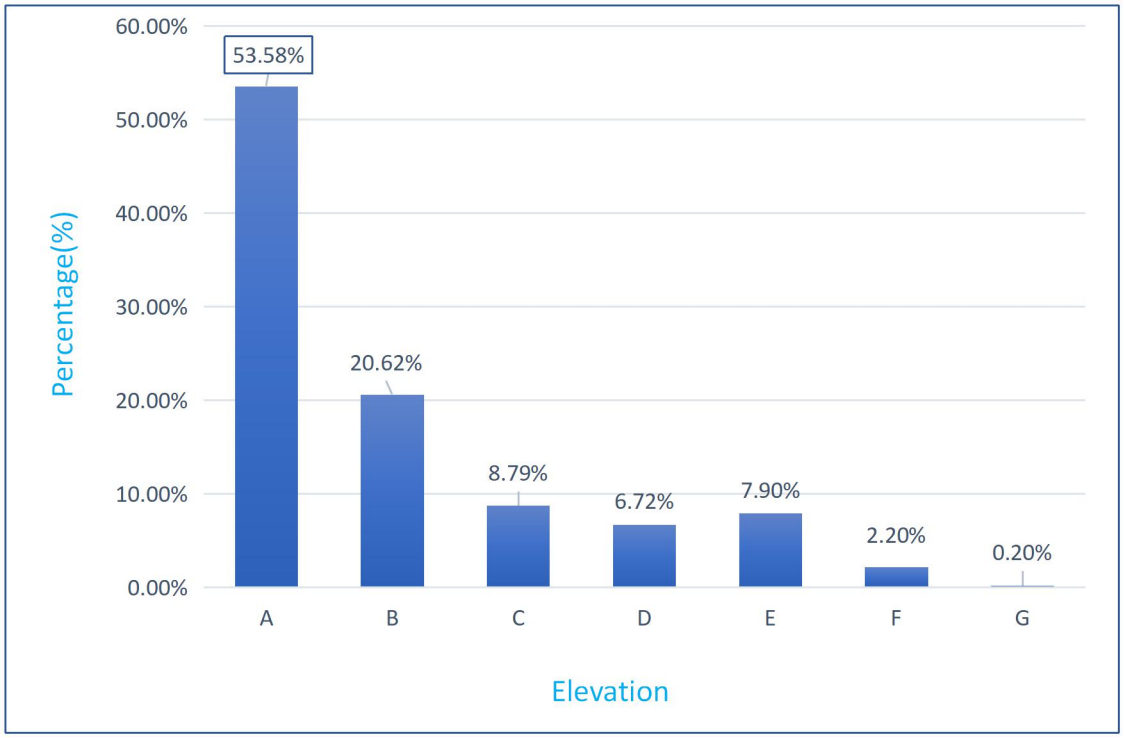


**Figure 10:** Elevation of the Moheshkhali Island showing different heigth range. *Here, Elevation value A= (0-5) m, B= (5-10) m, C= (10-20) m, D= (20-30) m, E= (30-45) m, F= (45-60) m, G= (60-82) m.*

### 4.3.3 Saint Martin Island

The Digital elevation modelling of the coral Island Saint Martin are presented in the (fig. 12) In this Island the maximum elevation was 14 m within the range of 13m-14m which covered approximately 0.36% area of the total Island. In contrast, the lowest elevation A (0m-3m) occupied 26.73% of the total area (Fig. 11). Among the elevation range, the most area covered within the elevation of B category as 3m-5m(30.85%) (Fig. 11)

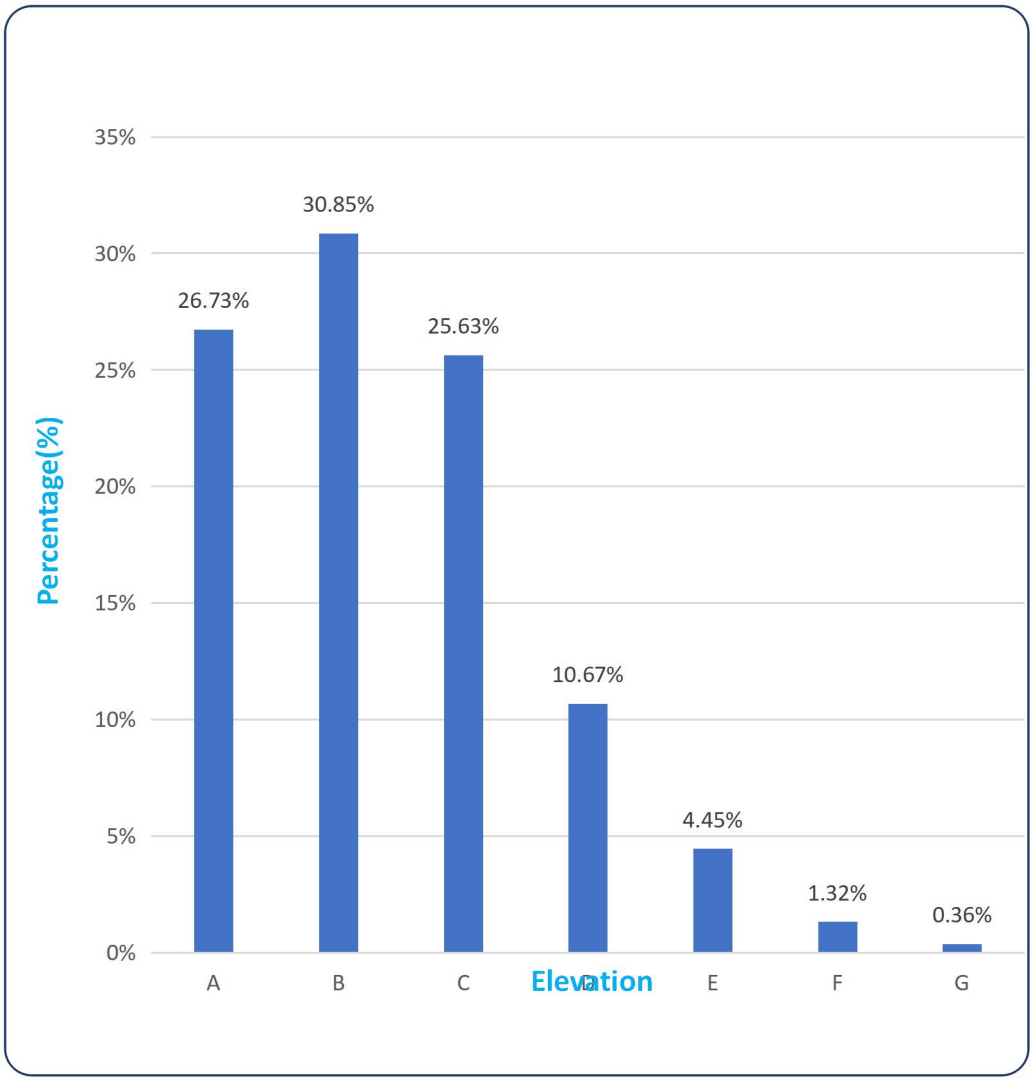


**Figure 11: Elevation of the Saint Martin Island showing different height range**

*Here, Elevation value A= (0-3) m, B= (3-5) m, C= (5-7) m, D= (7-9) m, E= (9-11) m, F= (11-13) m, G= (13-14) m*

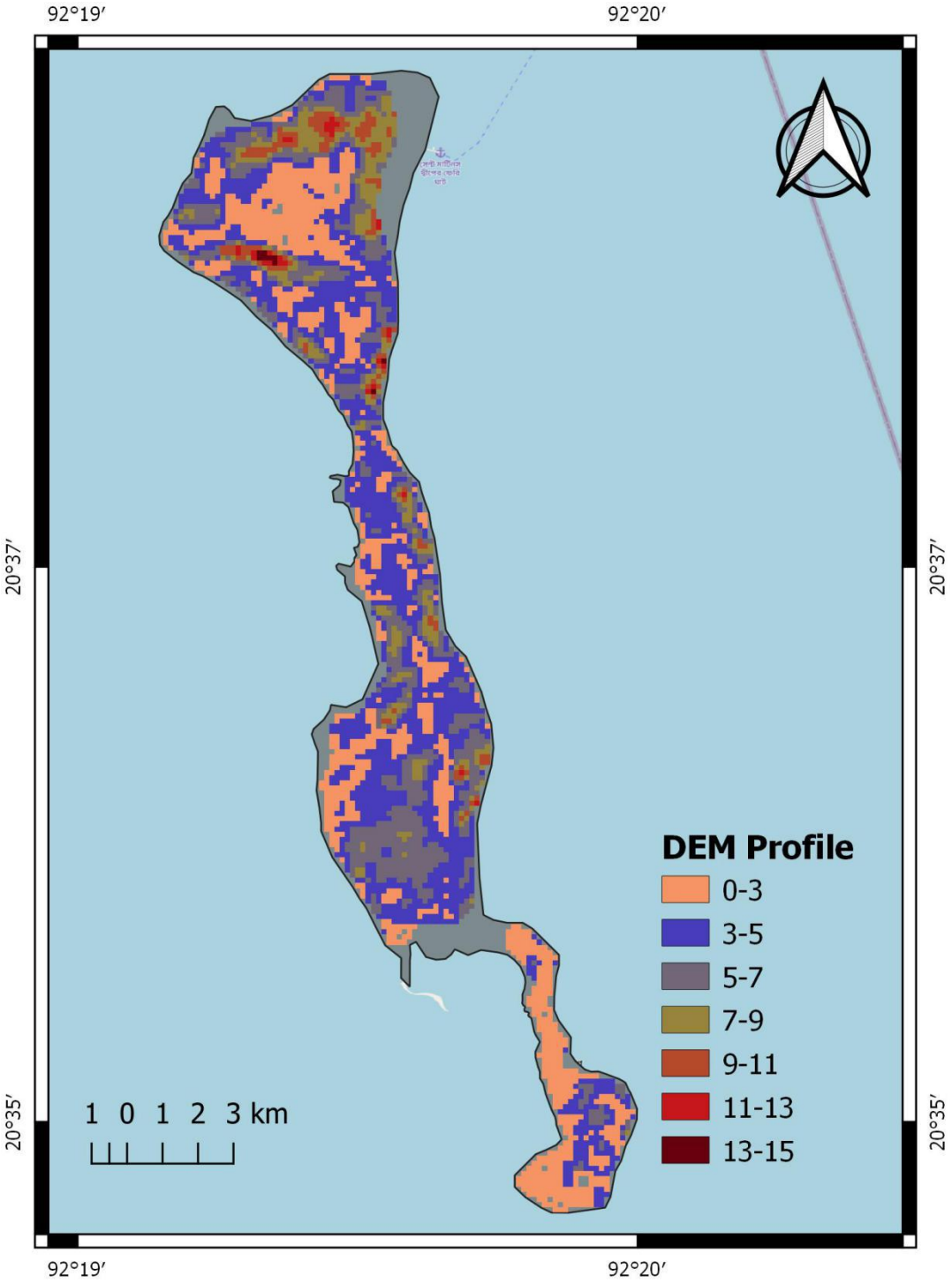


**Figure 12:**DEM profile of Saint Martin study area

### 4.3.4 Contour analysis

The contour lines of Cox's Bazar along with the important islands are presented in the figure 13 to figure 16. The elevation of Cox's Bazar coastal area varied from 0 to 260 m. In this study area, this study generates the contour line and found different count cells, unique values, mode median etc. Following table.3 are the different categories were found in the study area.

**Table 3: Contour profile of the study areas.**

| Contour | Cox's Bazar | Kutubdia | Moheskhali | Saint Martin |
|---|---|---|---|---|
| **Count cell** | 54130 | 1102 | 5399 | 100 |
| **Unique values** | 26 | 3 | 10 | 3 |
| **Minimum value** | 10 | 10 | 7 | 5 |
| **Maximum value** | 260 | 30 | 70 | 15 |
| **Range** | 250.0 | 20 | 60 | 10 |
| **Sum** | 1707310. | 11540.0 | 106830.0 | 650.0 |
| **Mean value** | 31.5 | 10.5 | 19.8 | 6.5 |
| **Median value** | 20.0 | 10 | 10 | 5 |
| **Standard deviation** | 27.7 | 2.2 | 16 | 2.6 |
| **Coefficient of Variation** | 0.9 | 0.2 | 0.8 | 0.4 |
| **Minority (rarest occurring value)** | 210.0 | 30.0 | 70.0 | 15 |
| **Majority (most frequently occurring value)** | 20 | 10 | 10 | 5 |
| **First quartile** | 10 | 10 | 10 | 5 |
| **Third quartile** | 40 | 10 | 20 | 10 |
| **Interquartile Range (IQR** | 30 | 0 | 10 | 5 |

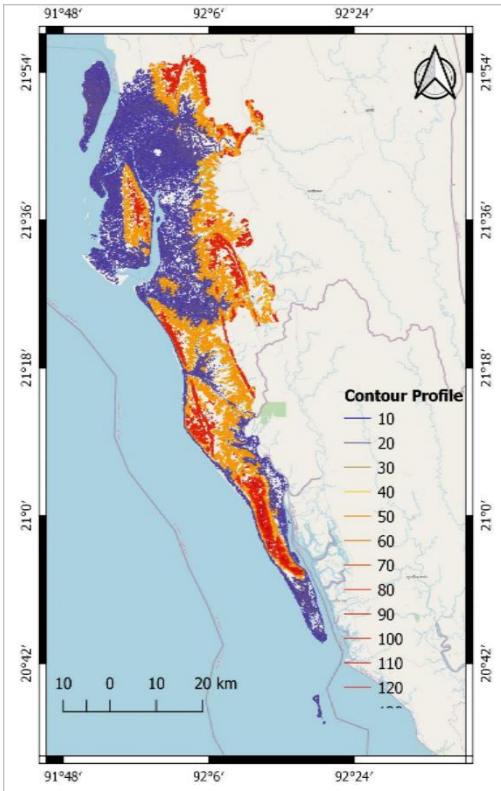


**Figure 13: Contour profile of Cox's Bazar area**

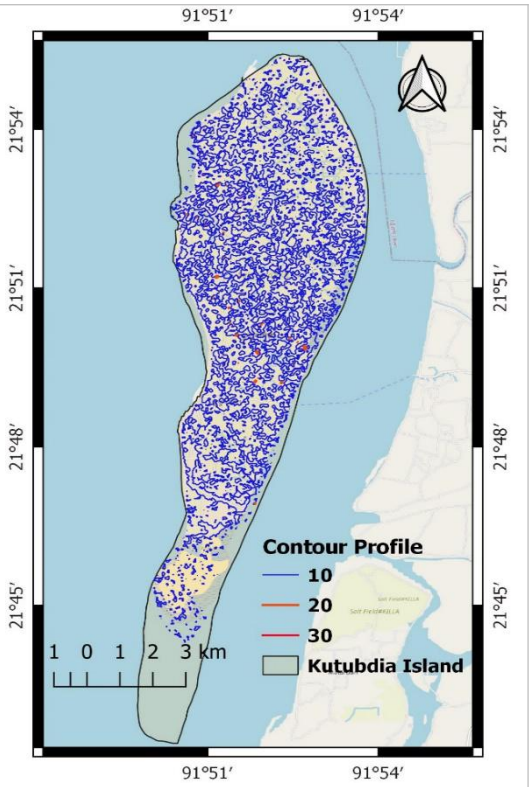


**Figure 14:**Contour profile of Kutubdia area

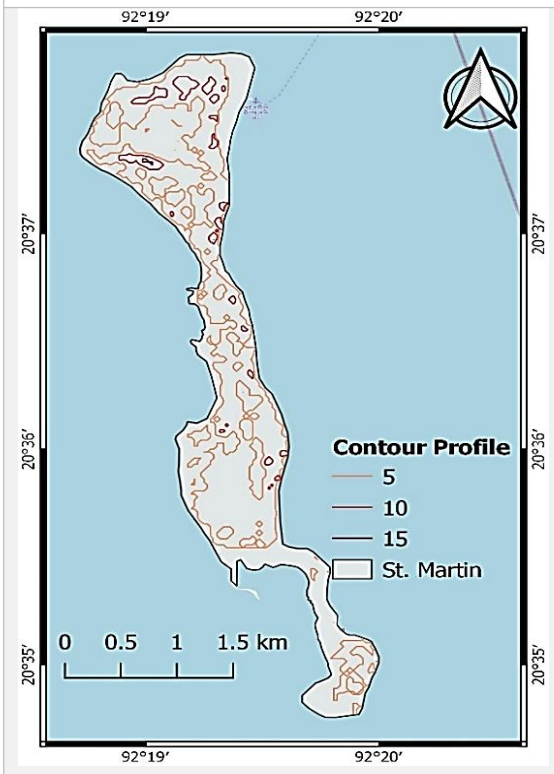


**Figure 15**: Contour profile of Saint Martin area

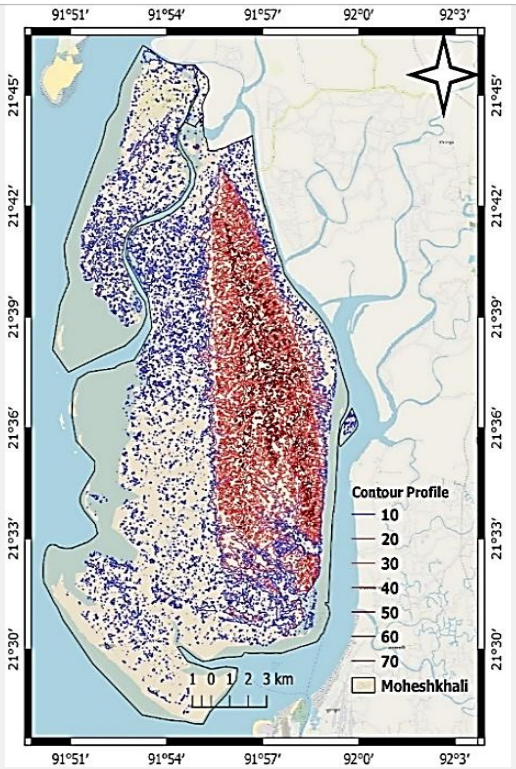


**Figure 16:**Contour profile of Moheshkhali area

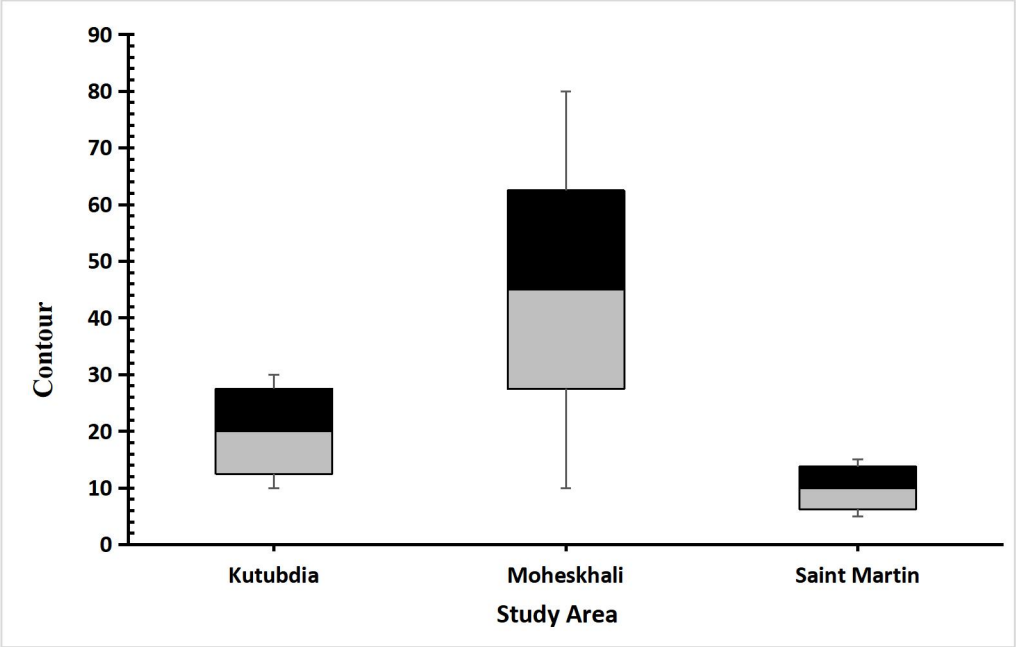


**Figure 17:**Contour analysis of the study area

### 4.4 Future uses and activities for ensuring LSIs

The potential conflicts among various interactions are weighted against each other according to subjective judgements, interactions and sensitivity matrices. Planning process help to address conflicts and promote synergies which need consultation and guidance to reduce conflicts.Cox's Bazar is the best place for tourism and other activities. Developing and planning the district to accomplish the use and activities to highlight the city in the world. So, there are huge opportunities to develop the activities and uses the future perspective. There are some proposed uses and activities in this study area LSI zones 12 nm miles away from the coastline such as:

**Relocation of fishing ground,** proper placing of cable network, pipeline connection and port extension process are important to ensure economic growth of any countries.

**New trawling area** are very crucial for catching fish within the fishing grounds as well as in the shrimp ground. A safe and free hazardous area is beneficial to fishermen. Some areas were proposed for the trawling area(fig.18)Shipping routes were very important for the transportation of any kind of goods. Cox's Bazar coast area is busy with different commercial activities. For the minimization of the overload of the shipping terminal, here proposed few shipping routes.Some lighthouse was proposed

in the study area to develop the sector and contribute to the economy of our country. Establishment of the aquatic sanctuary is one of the best techniques for preserving fish stock, maintaining biodiversity, and growing fish production. So, stock and protect the desirable species proposed some sanctuary area in the study area.

Coral reefs have the best natural intricacy and biodiversity among marine environments and are important monetary and sporting assets. Nonetheless, the strength of coral reefs is undermined by various human-incited and characteristic anxieties including land-based wellsprings of contamination, environmental change (expanded ocean surface temperatures bring about coral blanching), over-reaping of significant reef fish and coral species, and tempests. In this study area proposed coral research center in the Saint Martin island to explore the coral resources in this island.Tourism is the best source of developing the socio-economic condition of a local area. This study proposed five tour spots in Cox's Bazar regions. To minimize poverty in the local area developing a tourism system is a must. In the context of land sea interactions (LSIs) tourism development have profound influence to ensure blue economy in this country.

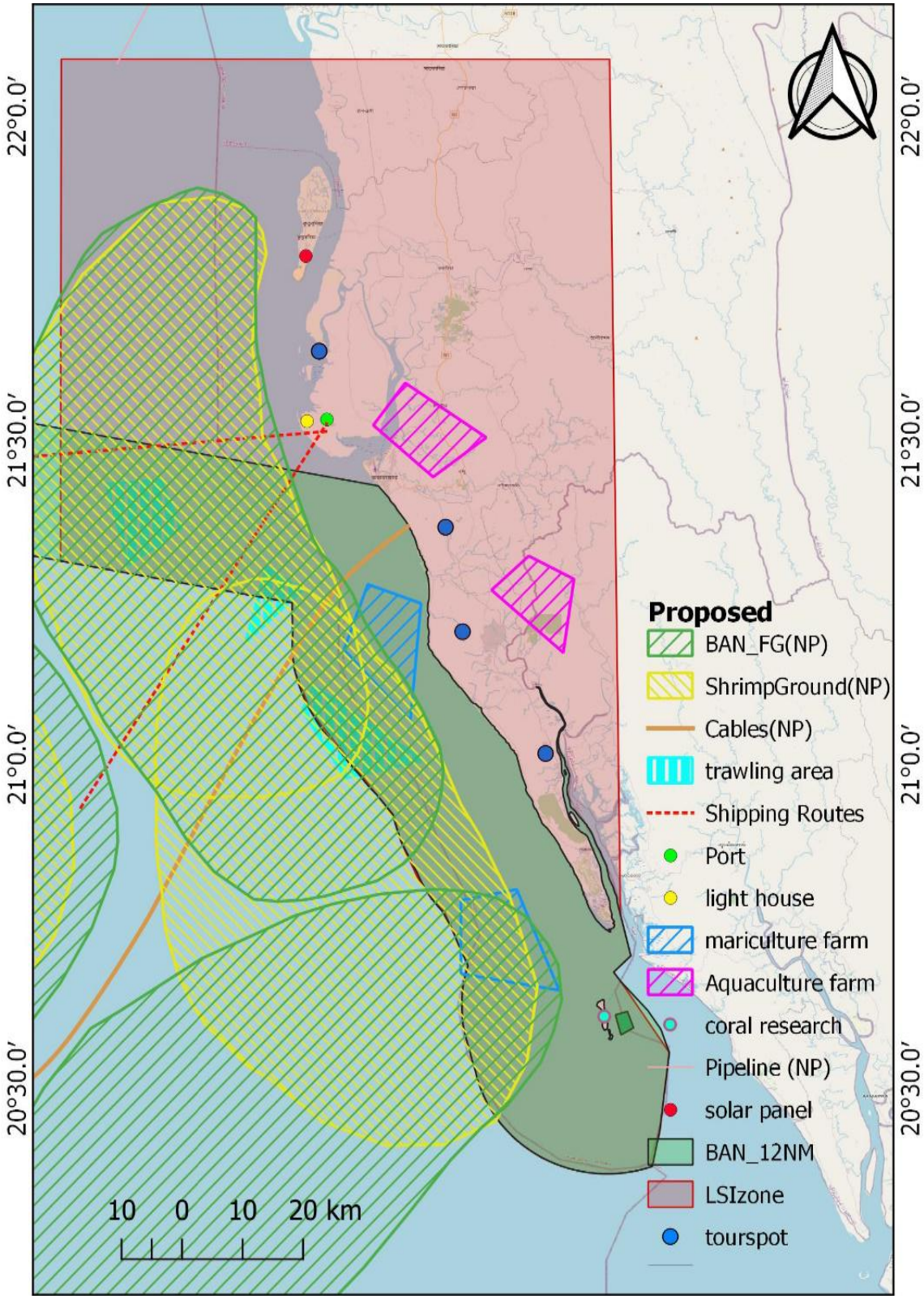


**Figure 18:** Potential uses and activities of the study area.(BAN_FG= Bangladesh Fishing ground, NP= Not Proposed, LSI= Land Sea Interaction, 12NM= Territorial sea)

### 4.4.1 Data Validation and Field validation

The methodic knowledge revalidated with a step-by-step process and checked for error step-down. For the sector validation, Kutubdia was visited for recheck with the satellite information. Auxiliary information like information points obtained by hand-held GPS, maps and pictures and visual analysis were combined with the classification result to boost the exactitude of land use mapping. Ground truth information was obtained by hand-held international Positioning Systems (GPS) (GERMIN e Trex 10) in Feb 2021. With the coordinate of elevation, ground trothing information was matched that justify the importance of the study.

Results were checked by exploitation GPS points of ground truth obtained by hand-held GPS. Land use forms in Google Earth are digitized and kept as GPX files. All GPX files were inputted into ArcGIS software and were created shape file of those way points (Fig. 19) .Then GPX files were projected into the projection of the WGS 1984 World Gerhard Kremer.


**Figure 19:** Ground trothing of Kutubdia Island.

# CHAPTER FIVE
# DISCUSSION

The coastal nations are more concerned about the utmost uses and activities related with Land-sea interactions. Land sea interactions have profound influence on maritime planning that can help coastal growth rapidly as well as ensure blue economy. Maritime spatial planning is the main planning of these to explore the blue economy. The digital elevation model is the process to represents the satellite image in the best way to know contour profiling of any region. The digital elevation model (DEM) is the most fundamental and fascinating geographical data type. DEM model is one of the best ways to provide a correct geo-referencing system on any map. This section represents the interpretation of results section with analytical view of previous research of the same trends.

## 5.1 Present uses and activities of the study

The important uses and activities of the study area were found among the 12 nm away from the coastline. The important uses and activities were fishing ground, tourism, light house, military exercise, wind mill, existing solar panel, shipping routes, cables network, and port region extension, etc. This study area mainly focused on the land-sea users among the 12 nm coastline away from the land. According to Stancheva *et. al.* (2017), different uses and activities in the Black Sea region include fishing, tourism, military exercise, swimming. etc. on Burgus city. In this research, the important use and activities were found in their land-sea uses and maritime spatial uses. The present status of Burgas city in the black sea area showed varieties of activities such as snorkeling, sailing, Gil netting, coral reef community, sea grass region, trap fishing which arethe major activities related to land sea interactions (Tuda *et al.,* 2014). With the comparison with those two studies, it is noticeable that the activities varied from region to region due to geographical location and economical involvement and the specification of 12 nm in this study.

## 5.2 Potential uses and activities of the study

Oil Terminal, building materialscompany, shipyard, factory constructions, Port Burgas West and Andela AD were proposed as the potential activities in Burgas city

area (Tuda *et al,* 2014). This study mainly discussed future perspectives use and activities. According to this study potential activities can be started in this region as trawling area, shipping routes, mariculture farms, port, lighthouse, aquaculture, sanctuary, coral research center, solar panel, tour spots, etc.

### 5.3 Conflicts analysis

As this study was conducted for the assessment and identification of conflicts between the coastal land uses and Maritime Spatial Uses along the 12 nautical miles of a selected area of Bangladesh, so there were found 3 major conflicts (No conflict, weak conflict and strong conflict) and some other were not identified. This study was recorded about 225 interaction issues where land-sea interaction without conflicts was 79, weak conflicts were 61, and strong conflicts were 60. There were about 25 interactions that were not identified in the study area. According to Stancheva *et al.,* (2017) for the Black sea Burgas's study area in total 16 different coastal land uses and 22 sea uses were identified where land-sea interactions without conflict were 44, weak conflicts were 100, 16 strong conflicts were identified and 192 no interactions between land and sea uses were indicated.With the comparison of Stancheva *et al.,* (2017) the number ofweak conflicts was higher in this study and the number of strong conflicts was lower. The most possible reason was fewer activities in this study area than the Burgus city area on the Black sea coast due to geographical condition and environmental features.

Another study showed Tuda *et al.,* (2013) spatial conflicts from the 5 levels of criticality is classified from the lowest to the highest. The venues of the 5 degrees of conflict in order to evaluate the spatial dimensions and human behaviors that led to conflicts in the respective conflict locations, GIS operations were assessed.

#### 5.3.1 Mitigation of conflicts

Mitigation of specific conflicts along the coastal region varies from place to place. According to Stancheva *et al.,* (2017), stake holders should be identified by providing an overview of relevant institutions with information on their responsibilities, interests, and respective contact person in a transparent way. They also give priority to more research to propose the most relevant decision on planning and managing land-sea interactions. Closer collaboration between government and municipalities is

needed to promote sustainable and ecologically effective uses on the land and at sea, especially for those with implications across the land-sea boundary in Riga Bay.

In this study, possible mitigation of conflicts has been identified to resolve the conflicts along the coastal belt of Cox's Bazar. The main focus should give on increasing of consciousness of local people. Coastal pollution is being promoted in that area within 12 nm due to high pressure of man-made activities and influence of industrialization process. The first initiative should be to increase their consciousness level about the bad impact on the environment. Secondly uses of chemicals in dry fish industries harmfully alter the normal quality of adjacent water body which has a long adverse effect on the ecosystem. So, instead of inorganic chemicals they should make understand to use an organic chemical to preserve their products.

### 5.4 DEM

This study was conducted to see the elevation of the selected area as cox's Bazar region (Kutubdia, Moheshkhali, and Saint Martin) through the digital elevation model (DEM). This research described the elevation of those selected areas and measured in meter-scale above from the sea level. The lowest elevation found in the sea level that studied area. The maximum elevation of Kutubdia Island was found as 28 m whereas the Moheshkhali and Saint Martin Island were as 75 m and 14 m respectively. Among the studied areas, found the higher elevation was in Moheshkhali, and the lowest elevation found in Saint Martin. According to Shafiuzzaman *et al.,* (2006) was found that at 30 m in height, the coast side of Kutubdia should be sustainable for small turbines. This study found 28 m height in the highest elevation.

### 5.5 Contour

According to MacMillan (2000) due to digitalization and fast improvement of series strategies for elevation data, the emphasis of users' wishes for elevation contours has moved from desires of accurate elevation evaluation in the direction of wishes of the notion of landforms. A layout method that considers the modified need, and an answer for thus producing contours for topographic maps from digital elevation models (DEMs). This research studied the three different types of islands as sandy island Kutubdia, muddy island Moheshkhali and rocky island Saint Martin. The main role of contour is to check and validate the accuracy of elevation in those study areas.

In this study, the control interval was 10 for Kutubdia and Moheshkhali and 5 m contour used for Saint Martin Island.

# CHAPTER SIX

# CONCLUSION

The development activities along the coastal and maritime environment have an onshore implication. The marine and coastal planning have profound influence on LSIs and should be achieved through consistency of different policies, plans and decision-making process. Land sea interaction is characterized by land-based natural phenomena or human activities which have an influence on the coastal as well as marine environment. Maritime spatial planning (MSP) is supposed as a system for making proper planning and effective use of an incorporated ecosystem. It is primarily based on the spatial planning and sustainable usage of marine resources to manipulate the oceans. Digital elevation model is graphically represented the total elevation and contour profile shows the difference of the elevation height. This study mainly focused on the land-sea interaction, maritime spatial planning, and elevation of the study area of Kutubdia, Moheshkhali and Saint Martin islands. This research is very helpful to other conducting research in the future on this aspect to develop and contribute in maritime sector. This study is also conducting to identify the present and potential use and activities within the 12 nm coastal territorial region. Conflict matrix is showing between the coastal land use and maritime spatial uses which are identifying their interactions of different use and activities. The mitigation of conflicts among the uses are prime need to gain sustainable development and ensure blue economy in the future.

# CHAPTER SEVEN

## RECOMMENDATIONS AND FUTURE PERSPECTIVES

The thesis provides an overview of land-sea interactions (LSI) across land and coastal governance arrangements at National level and shows shortcomings considering LSI in the MSP, with a focus on the Northeastern Island of the Bay of Bengal. Land sea interaction plays an essential role in considering the great economic value of coastal ecosystems. Recommendation of this present research is to:

- Study findings can be used to minimizing conflicts among the users of multisectoral activities in land and sea-based area.
- New marine protected areas proposed in this study should be established for marine life protection. Govt., non-govt organization should take initial steps to improve sustainable development and protection of marine environment.
- Land sea interactions plays a significant role in maritime spatial planning, management
- Digital elevation model at local, regional and national levels will help to moderate the coastal land use planning.
- Further research related with LSI in coastal area will be benefited from this study.
- Implementation of the policies and programs needed for development of integrated coastal zone management. The Oceanaire vision of Government of the Peoples' Republic of Bangladesh has already set up the context for ensuring blue economy.

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## APPENDICES

## A. PHOTO GALLERY

Ground truthing

## Brief Biography

Md. Nazmul Hasan Forhad passed the Secondary School Certificate Examination in 2011 from Bheola Manik Char High School, Chakaria, Cox's Bazar followed by Higher Secondary Certificate Examination in 2013 from Govt. Haji. Md. Mohsin College, Chattogram.He completed his graduation degree on B.Sc. in Fisheries (Hons.) in 2018 from Chattogram Veterinary and Animal Sciences University (CVASU), Bangladesh. Now, he is a candidate for the degree of MS under the Department of Marine Bioresource Science under Faculty of Fisheries, CVASU. He has immense interest to work in GIS.