Detrimental Consequences of Unethical Anthropogenic Interventions upon the Ecosystem of Teknaf Peninsula, Chattogram, Bangladesh

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Abstract: The eastern coastal zone of Bangladesh is endowed with dynamic Terrestrial ecosystem. The wide river estuaries, the uninterrupted Teknaf coast, and the rich biodiversity of the study area provide ample opportunities for socio-economic development. Nevertheless, the terrestrial ecosystem of the east coast has been deteriorating in an accelerated rate owing to unethical anthropogenic interventions. Few studies regarding ethical attitudes of local communities to conserve the coast were conducted earlier. The main theme of the study was to identify the detrimental consequences of unethical anthropogenic intervention upon the terrestrial ecosystem of Teknaf Peninsula, Chattogram. The objectives were (i) to measure the heavy metal concentration and (ii) the physio-chemical quality of soil, and (iii) to analyze the depletion of vegetation coverage at the study area. Five heavy metals like- Cadmium, Copper, Iron, Lead, and Zinc; and three physio-chemical parameters such as, the pH, Electrical Conductivity, and Temperature of sample soil were measured. The average concentration of Pb in soil (0.25 mg/g) is 10 times higher than world average (0.03 mg/g), while the concentration of Fe at Himchari area (S 03) soil is 1.54 mg/g more than world average (3.4 mg/g). The physio-chemical parameters are within standard range. Unethical discharge of toxic effluents from shrimp hatcheries, and municipal garbage dumping are main sources of pollution, which ensue into degradation of the terrestrial and coastal and marine ecosystems. Further, the vegetation coverage has depleted manifolds. Hence, the Department of Environment (DoE), Bangladesh [1] declared the area as an 'Ecologically Critical Area' (ECA). The concerned stakeholders, like- CPP volunteers and officials, Forest Division, Fisheries Research Institute, Bangladesh Water Development Board, Union Chairman and Journalists of Cox's Bazar recommended insertion of moral ethics among local stakeholders through trainings, motivational lectures, demonstrations and dramas, as well as, incorporation of lessons about consequences of unethical and unscrupulous activities upon geo-environment into text books. Though least practice has been found regarding the practice of moral values and ethics during the survey, the present research advocates in developing 'Knowledge pool' about coastal environment, creating awareness, and developing moral ethics among the local, regional and national stakeholders.

Keywords: Bio-diversity, Ecologically Critical Area, Ethics, Knowledge Pool, Moral Values, Terrestrial ecosystem.

Introduction: The Teknaf coast, one of the significant 'Ecologically Critical Areas' (ECA) of the country was selected as the study area. The coast lies within the 'Bio-Ecological Zone 8a', which consists of the i) Coastal Plain, and iii) Sandy Beach/Sand Dunes [2] (Map 1). The study focuses upon the detrimental consequences of unethical anthropogenic intervention upon the Terrestrial ecosystem of the study

area. Three indicators, such as (i) the concentration of heavy metals and (iii) physio-chemical quality of soil and (iii) vegetation coverage of the study areas were selected to measure the detrimental impacts of unethical anthropogenic activities upon the study area. Collected soil samples were measured to find out the concentration of five heavy metals and quality of four physio-chemical parameters.

The literatures regarding the heavy metal concentration in soil revealed the seasonal distribution of heavy metal (Cd, Pb, Zn, Cu, Mn and Fe) concentration in the littoral sediments of the Bay of Bengal coast[3]. The study mentioned the river, industrial region, and uncontrolled domestic wastewater discharge areas as the hotspots of pollution. The researchers stated that, the concentration of Cd, Pb, Zn and Fe were high at Matamuhuri, Moheshkhali and Bakkhali Rivers and had affected the aquatic ecosystem.

According to the DoE (2014) declared that, the Cox's Bazar municipality received around twelve tones of household wastes into the water bodies daily of which more than half of them end up in the Bakkhali River. The level of dissolved oxygen (DO), total dissolved solids (TDS) and biological oxygen demand (BOD) in the Cox's Bazar Municipality area varied greatly in comparison to the standard values. Further, the DoE declared that, in 2013 the level of TDS was 9,110 ppm (standard value below 2,100 ppm) in the river's middle wharf area, which accentuates the gradual contamination of the river water [4].

Rashid and his colleagues focused on the adverse effects of toxicity due to the escalation heavy metal concentration in saline sea water, sea sediment, sea shells, and on oyster along the east coast of the Bay of Bengal[5].

Raknuzzaman and coauthors aimed to provide baseline information on the toxic trace metal concentration in different coastal environment of Bangladesh[6]. Seven trace metal concentration, such as, Cr, Ni, Cu, Zn, As, Cd and Pb was determined in water and sediment samples collected from four coastal sites of Bangladesh, namely Bakkhali river estuary, Cox's Bazar, Karnaphuli river, Chattogram, Meghna Estuary and Sunderbans. The study confirmed that, a wide range of metal concentration was observed among the sampling sites.

The soil of the No.6 Fishery Ghat at Bakkhali River was detected as the main source point of pollution.

The heavy metal contamination in sediment in recent years along Karnaphuli River estuary by measuring the depth-distribution of core sediment composition, grain-size parameters, TOC content and Pb radioactivity of the Karnaphuli River estuary sediment[7]. The variations of all core sediment properties showed an abnormal sediment layer (8–20 cm) below the surface and the surface sediment of Karnaphuli River estuary was contaminated with Cr and Pb. Further, the researchers stated that, the catastrophic events, such as, landslides, cyclones, and heavy rainfall, between 2007 and 2008, led to the changes in source materials and depositional environment of estuary, and

thus altered metal accumulation in sediments. The heavy metal increase at Karnaphuli River estuary sediment was associated with accelerated urban and industrial growth in recent 30 years, including catastrophic events in the area.

The surface sediments along the Bay of Bengal coast has high concentrations of major (Si, Al, Ca, Fe, and K) and minor (Cd, Mn, Ni, Pb, U, Zn, Co, Cr, As, Cu, Rb, Sr, and Zr) heavy metals[8].

The Mangrove for the Future (MFF) is a regional initiative which promotes investment in coastal ecosystem conservation for sustainable development. Bangladesh is one of the countries where MFF focuses on healthy and well managed ecosystems to ensure ecosystem based resilience coastal communities[9]. The 'Coastal vegetation improvement for community resilience in Sabrang union of Teknaf peninsula' (2016-2017) is one of the MFF projects, which aimed to improve lives and livelihoods of community people by reducing poverty and to ensure sustainable management in the Sabrang union of Teknaf. The project distributed 33,000 saplings and 150 Bondhu chulas with a aim to reduce use of fire wood by the community. The project achieved success in reduced rate of tree cutting for domestic and other uses, increased plantation at homesteads and refrain from cutting down the road side trees [10].

The mangroves as highly productive wetlands and vital coastal resource for the socio-economic development[11]. The researchers mentioned productivity and physical structure of the mangroves as two key variables, which provides suitable habitat for nursery, growth, and migration of floral and faunal species by recycling wastes and nutrients at the coastal areas. The study also mentioned that, 13 mangrove user communities are highly dependent upon the mangroves. For instance, the small-scale fishing, like the catch of fin fishes, shrimps and prawns, crabs, mollusks are done from the mangrove areas along the coastal areas. Realizing the importance of the mangroves, about 1,469 ha of euryhaline mangroves were reported to be planted by different management regimes[11].

Though the literatures investigated into the concentration of heavy metals at the coastal area sediments, there were lesser studies regarding the heavy metal concentration at the source points of pollution in the soil of the Teknaf peninsula. Hence, the study selected the major point sources of pollution along the study area as the sample areas and collected soil samples from the most polluted soil of the sample areas. Moreover, little has been studied regarding the pattern of vegetation coverage of the study area, though the vegetation coverage of the area has been declining in a rapid pace.

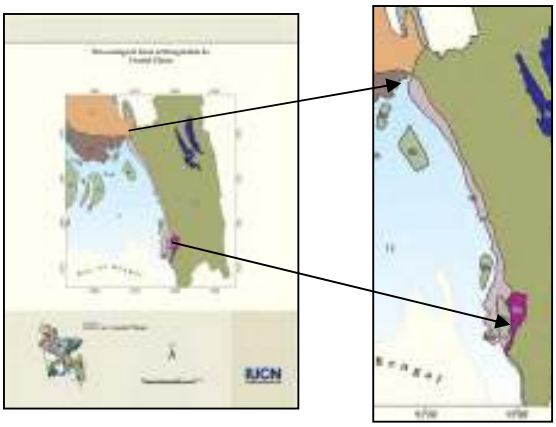
Main Theme and Objectives: The main theme of the study was to identify the detrimental consequences of unethical anthropogenic intervention upon the terrestrial ecosystem of Teknaf Peninsula, Chattogram. To achieve the theme, three objectives were selected, such as (i) detection of heavy metal concentration level in soil, (ii) identify the physio-chemical quality of soil, and (iii) analyze

the vegetation coverage status of the Teknaf coast.

Justification: Lack of awareness, knowledge and ethical values of the local stakeholders are the vital driving forces causing detrimental changes and destruction of the Terrestrial ecosystem of the coastal zone in Bangladesh. The most vital component of terrestrial ecosystem is the soil, while vegetation functions as the 'Producer' of the ecosystem food chain. Hence, the study focused upon anthropogenic invention induced soil quality deterioration, which ensue depletion of floral bio-diversity of the Teknaf coast. The present research found that, creating awareness about the impacts of unscrupulous activities of local and national stakeholders at the east coast ecosystems must be ensured through proper in-depth knowledge about diverse sectors of the coastal zone.

Methodology: Selection of Study Area and Sample Areas: The study area was selected after a reconnaissance survey, as well as thorough literature survey and analysis of the satellite imageries of the last twenty-five (1990-2015) years. The sample areas were selected on the basis of presence of three distinct environmental features, such as the (i) source points of heavy metal concentration, (ii) areas of significant vegetation coverage depletion, and (iii) areas of substantial ecological criticality. Selection of Environmental Indicators: The Cd, Cr, Cu, Hg, Ni, Pb, and Zn are the eight most common pollutant heavy metals [12 a,b]. Among these, the present study measured the concentration of four heavy metals such as the Cd, Cu, Pb, and Zn; and the concentration of heavy metal Fe was measured for its significance as a nutrient for the terrestrial organisms[13].

Further, three physio-chemical parameters, such as the pH, Temperature, and Electric Conductivity (EC) were selected as the physio-chemical parameters to measure the soil quality and thus, identify the state of terrestrial ecosystem of the Teknaf coast.



Map 1: Bio-Ecological Zone of the Study area [2]

Research Approach: The research was conducted in both Quantitative and Qualitative Research approach.

Primary sources of data: (i) The soil samples were collected from the point sources of pollution to measure the heavy metal concentration and physio-chemical quality of soil and (ii) The vegetation coverage was derived from the analysis of the six Temporal Landsat Images (1990-2015).

Secondary sources of data: (i) National and international reports, and (ii) Published and unpublished academic journals and books.

Sample Collection: The soil samples were collected by 'Point Sampling' method from three source points of pollution at the study area. Toxic water drained directly from the shrimp hatcheries and fish processing industries into the beach soil at the Sonarpara and Himchari shrimp hatchery area; and the polluted beach soil due to garbage disposal by the tourist markets, hotels and visitors at the Inani beach 'Tourist Spot' area were collected.

Methods of Sample Analysis: The level of concentration of five major heavy metals in the soil samples were analyzed in the Environment laboratories of the department of Geography and Environment, department of Soil, Water and Environment, and CARS, D.U. The soil samples were collected during the dry weather (pre-monsoon), from 16th -20th March, 2016.

(i) Analysis of Heavy Metal Concentration in Soil samples: The heavy metals were analyzed to measure the concentration level in soil samples by 'Atomic Absorption Spectroscopy (AAS-7000)' method. The soil samples were collected from a depth of six to eight inches at the point sources of pollution by 'Point Sampling' method. The samples were grinded and digested by 'Nitric-hydrochloric Acid Digestion' method and then filtered into clear bottles. The digested samples were submitted at the Centre for Advanced Research in Science (CARS), University of Dhaka to measure the concentration level of the analytes like-Iron, Zinc, Copper, Lead, and Cadmium in soil samples. The sample had to be diluted many folds to keep the results in the analytical range.

(ii) Analysis of Non-Metal or Nutrient Concentration in Soil samples: The content of the two major non-metals or nutrients, such as Phosphorous and Sulphur was measured by HNO3 digestion method (combination of Nitric-Perchloric acids).

(iii) Analysis of Physio-Chemical Parameters in Soil samples. Three physio-chemical parameters, such as the pH, Electric Conductivity (EC), and Temperature of soil was measured with the pH Meter, calibrated by pH 7.0 buffer solution (distilled water) to analyze the environmental quality of the study area. The samples were measured and analyzed in the Environmental Laboratories of the Department of Geography and Environment and the Department of Soil, Water and Environment, University of Dhaka.

(iv) Analysis of Landsat Images for Vegetation Coverage:Six 'Radiometrically Corrected Temporal Landsat Images' were analyzed and maps were created with Arc/GIS and ERDAS Imagine software to measure the 'Vegetation coverage'. The 'Normalized Difference Vegetation Index (NDVI)' method was used to reveal the vegetation coverage pattern in the study area (Map 2). The scale of NDVI ranges from -1.0 to + 1.0[14]. The NDVI index separates green vegetation from other surfaces as the chlorophyll of green vegetation absorbs red light for photosynthesis and reflects the near-infrared (NIR) wavelengths. Hence, the areas with strong infra-red wave length reflectance show healthy green dense vegetation, which is represented with index value from 0.6 to +1 [15]. Further, the index value from 0.2 to 0.4 indicates

sparse vegetation, and values from 0.4 to 0.6 indicate moderate vegetation. On the other hand, the index value below 0.2 represents water bodies and areas without vegetation, while bare soil, rocks, water bodies, snow, and clouds have around zero reflectance[15]. Table 1.1 illustrates the pattern of physiographic features within the NDVI range.

NDVI Range	Feature
-1 - 0	Bare Soil, Rock, Water, Snow, Cloud
0 - 0.2	Barren land / built up /rock
0.2 - 0.4	Sparse Vegetation
0.4 - 0.6	Moderate Vegetation

Table 1.1: NDVI Classification Ranges Ref No

Data Presentation: The attributed data were presented with Tables, Graphs, and Maps.

Results of the Study:

Heavy Metal Concentration in Soil: The concentration of five heavy metals in soil samples, such as Cadmium (Cd), Copper (Cu), Iron (Fe), Lead (Pb), and Zinc (Zn) of three sample areas of the Teknaf coast has been shown in Table 1.2.

Cd Concentration in the Soil: The Cd concentration of the soil samples at three source points of the study area is below detection level (BDL) (Table 1.1).

Cu Concentration in Soil: The concentration of Cu ranges from 0.08 mg/g to 0.15 mg/g, while the average (n=3) was 0.12 mg/g (Table 1.1, Fig. 1.1) in the study area. The soil sample, collected from a drain pouring toxic waste water directly to the soil and water from several hatcheries had the highest content of Cu (S 02). The Cu content of the sample areas were quite lower than the world average (0.9 mg/g).

Fe Concentration in Soil: The Fe concentration ranges from 2.09 mg/g to 4.94 mg/g, with an average (n=3) of 4.20 mg/g (Table 1.1, Fig.1.2). The highest content of Fe is at Himchari Shrimp hatchery area (S 03), which is 1.54 mg/g more than the world average (3.4 mg/g).

Pb Concentration in Soil: The Pb concentration of S 01 and S 02 is 0.24 mg/g and 0.26 mg/g, while the average (n=2) is 0.25 mg/g (Table 1.1, Fig. 1.3). The Pb concentration of S 03 is below detection level (BDL). However, the average concentration of Pb in the soil of sample areas is 10 times higher than the world standard average concentration (0.03 mg/g).

Zn Concentration in Soil: The Zn concentration ranges from 0.71 mg/g to 0.86 mg/g, while the average (n=3) was 0.78 mg/g (Table 1.1, Fig. 1.4). The highest content of Zn is at Himchari Shrimp hatchery area (S 03).The concentration of Zn in the soil of the sample areas is quite lower than the world average concentration (5.0 mg/g).

Physio-Chemical Quality of Soil: Three (pH), (ii) Electric Conductivity (EC), and (iii) Temperature was taken to measure the physio-chemical quality of soil (Table 1.3).

(i) Potential of Hydrogen (pH) of Soil**:** The pH level of the three source points of the Teknaf coast varies from 5.8 to 7.6. This shows that, the soil of both S 02 and S 03

Sample ID	Cd-content	World Standard of Cd	Cu-content	World Standard of Cu	Fe-content	World Standard of Fe	Pb-content	World Standard of Pb	Zn content	World Standard of Zn
Soil Sample	mg/g	mg/g	mg/g	mg/g	mg/g	mg/g	mg/g	mg/g	mg/g	mg/g
Sample 01 Inani Beach, Marine Drive	BDL	0.11	0.13	0.9	2.58	3.4	0.24	0.03	0.77	5.0
Sample 02 Sonarpara, Marine Drive	BDL	0.11	0.15	0.9	2.09	3.4	0.26	0.03	0.71	5.0
Sample 03 Himchari, Marine Drive	BDL	0.11	0.08	0.9	4.94	3.4	BDL	0.03	0.86	5.0
Average	---		0.12		3.20		0.25		0.78	

Table 1.2: Heavy Metal Concentration in Soil of Teknaf Coast

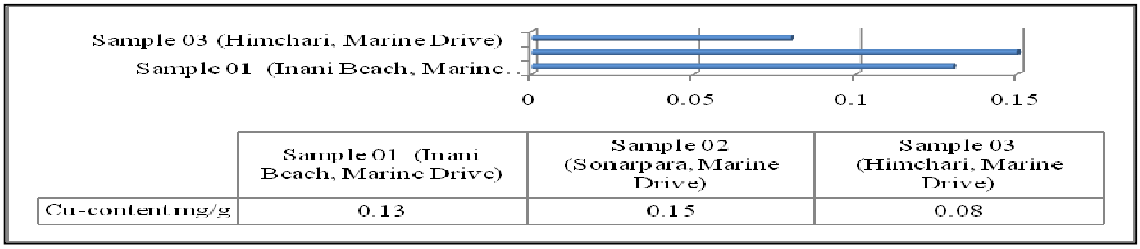


Fig. 1.1: Concentration of Cu in Soil

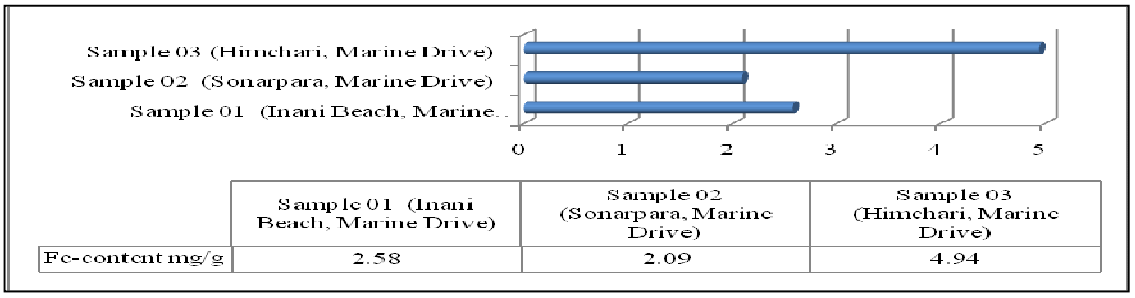


Fig. 1.2: Concentration of Fe in Soil

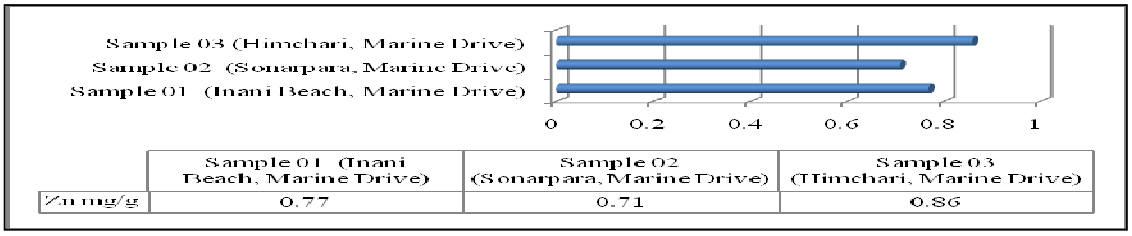


Fig. 1.3: Concentration of Pb in Soil

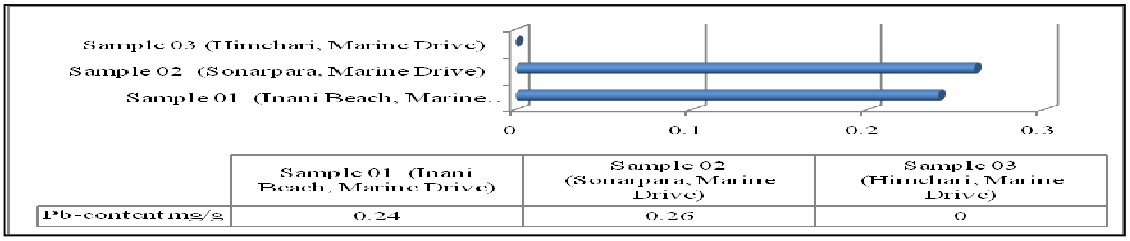


Fig. 1.4: Concentration of Zn in Soil.

were 'Slightly Alkaline' type. The soil quality at Inani beach tourist spot area (S 01), as well as, the average soil condition of the sample areas is 'Moderately Acidic' in nature (Table 1.3, Fig.1.5).

(ii)Electrical Conductivity of Soil: The EC of the soil ranges from 1.22 mS/Cm to 6.37 mS/Cm in the sample areas, with an average EC of 4.21 mS/Cm (Table 1.3, Fig.1.6).

(iii)The Temperature of Soil: The temperature of the sample area varies from 26.4 to 26.5 °C, and the average temperature was 26.5°C (Table 1.3, Fig.1.7).

Findings and Discussion: The east coast of Bangladesh is a dynamic coast with diverse opportunities and vulnerabilities. The longest uninterrupted coast of the world –the Cox's Bazar coast, the wide river estuaries serving as the breeding ground and nursery of diverse flora and fauna, the rich terrestrial ecosystem endowed with the mangrove and many other indigenous trees, the largest tourist spots of the country like the Cox's Bazar and Inani beach, the hills bordered by the narrow coastal plains, the wide and shallow continental shelf offers diverse physiographic and socio-economic opportunities of sustainable development. Nevertheless, all these opportunities have been facing deterioration owing to unethical and unscrupulous anthropogenic interventions like illegal land grabbing leading to coastline accretion and/ or erosion, destruction of the floral and faunal diversity, soil and water pollution due to huge discharge of untreated toxic heavy metals from the industries and water vehicles, excessive logging of indigenous trees for accommodating land for housing, shrimp cultivation, salt farming, agriculture, mixed and misuse of land properties. Realizing the situation, the present study attempted to analyze the state of major two components of terrestrial ecosystem-the soil and the vegetation coverage of the east coast. Hence, the heavy metal concentration and physio-chemical quality of the soil and the vegetation coverage depletion of the study area were identified in the study. The main sources of heavy metal pollution in soil were the urban traffics, and agrochemical products used in the agricultural land[16]. From the data acquired, the concentration of the heavy metal Fe in soil was detected as the highest (3.2 mg/g), followed by the ZN (0.78 mg/g), Pb (0.35 mg/g), and Cu (0.12 mg/g) concentration (Table 1.1). However, the average concentration of Pb in soil (0.25 mg/g) was 10 times higher than world average (0.03 mg/g). The Lead (Pb) as an extremely stable heavy metal which is a dangerous neurotoxin to human and other animals[17]. Though natural presence of 15 to 40 ppm of lead per kg (mg/kg) of soil is considered as natural, pollution might increase the level to several thousand ppm. The densely populated and industrial areas where weathering, chipping, scraping, sanding, and sand –blasting of structures bearing lead-based paints generally are the major sources of high Pb concentration. The concentration of Fe at Himchari area (S 03) soil was 0.54 mg/g more than world average (3.4 mg/g). The Fe is an essential plant micronutrient occurring naturally. Deficiency of Fe in plants lessens the chlorophyll of the leaves[18].

However, Fe itself is not toxic, but this heavy metal interacts with other toxic

Soil Sample	pH	EC (mS/Centimeter)	Temperature (°C)
Sample area 01 (Inani Beach, Marine Drive)	5.8	6.37	26.5
Sample area 02 (Sonarpara, Marine Drive)	7.6	2.04	26.5
Sample area 03 (Himchari, Marine Drive)	7.6	1.22	26.4
Average	7.0	3.21	26.5

Table 1.3: Physio-Chemical Quality of Soil. Source: Present Study, Field Survey, March, 2016

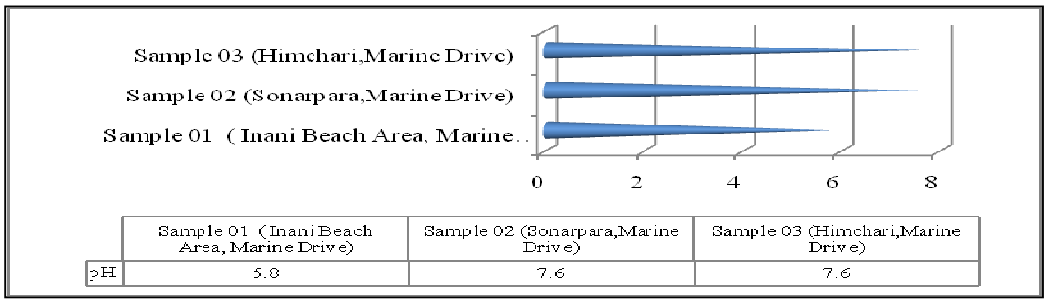


Fig. 1.5: Potential of Hydrogen (pH) of Soil

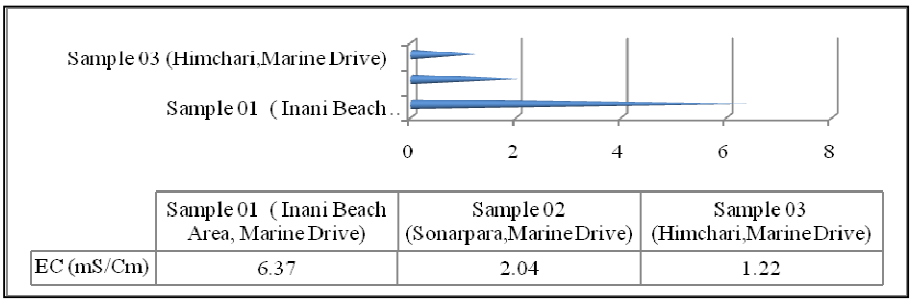


Fig. 1.5: Potential of Hydrogen (pH) of Soil

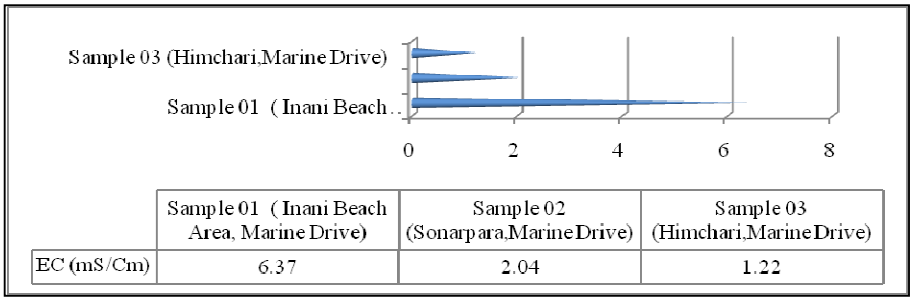


Fig. 1.6: Electrical Conductivity of Soil

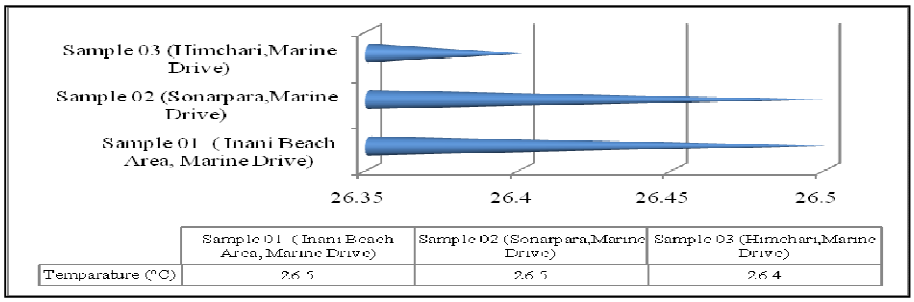


Fig. 1.7: Temperatures of Soil

metals. The anthropogenic sources, such as airborne dust during copper metallurgy are a major source of Cu, Pb and Cd[18]. Copper (Cu) is an essential heavy metal for plant growth available in soil[19]. Wide and continuous use of fertilizers in agricultural sector causes Cu contamination. A wide variety of copper products produced in Bangladesh, such as copper foil, bars and rods, sheets and plates, tubes and pipes, wire, unwrought, and many other products[20].

The concentration of Pb in the Chattogram city area was around 7.33 mg/kg, while the concentration of Cd was around 2.43 mg/kg during the summer season. The municipal wastes from rapidly growing urbanized areas, industrial effluents, chemical fertilizers or agricultural land, and as the major causes of metal and metalloid pollution in Bangladesh which has been posing substantial threat to the local people[21]. The agricultural land and vegetables in sewage-irrigated areas are highly contaminated with Cd, Pb, and Chromium (Cr). Cd might cause serious deleterious effects both in plants and mammalian consumers[22]. The main source of Cd in soil is the emissions from industries. According the researchers, Cd has high phytoaccumulation mobility from soil to plant and hence, might enter the food chain.

The Zn concentration at S 01 (0.13 mg/g) and S 02 (0.15 mg/g) exceeded the world average (0.9mg/g). The shrimp hatchery areas at Cox's Bazar contain the highest levels of Zn, Cu and Pb due to huge discharge of different salts and chemicals from hatcheries to the beach soil[23].

The soil remediation consists of actions such as removal, control, containment, or reduction of contaminants in soil to a safe level for biological entities[24]. The paper mentioned that, the remediation of copper contaminated soil can be done by the phytoremediation process as this method is economical and eco-friendly. The soils naturally contain 2 to 100 ppm (average 30 ppm) of Cu which is essential for plant growth. On the other hand, excessive Cu concentration might cause toxicity leading to decrease in plant growth and seed germination.

The physio-chemical parameters, such as the pH, EC and Temperature of the soil samples were measured (Table 1.1 and 1.2). The pH in the soil of S 02 and S 03 (pH 7.6) contained higher pH than the Neutral pH level (pH 7.0). Excess presence of pH in soil change the Slightly Alkaline soil into Moderately Alkaline; and decrease of per unit of pH increases the Zn fivefold in soil[25].

The soil EC is an indicator of salinity of soil, which indicates the nutrient availability and loss, soil texture, and available water capacity[26a]. Hence the crop yields and activity of soil micro-organisms, such as emission of greenhouse gases are regulated by the EC [26b]. The soil EC in the sample areas ranged from 1.22 to 6.37 mS/Cm in the study area. The average was 3.21 mS/Cm, while the highest EC was at S 01 (6.37mS/Cm). The soil temperature plays a vital role in the physical, hydrological, and biological processes[27]. The soil temperature regulates the transformation and uptakes of nutrients by plant roots and agricultural crops[28].

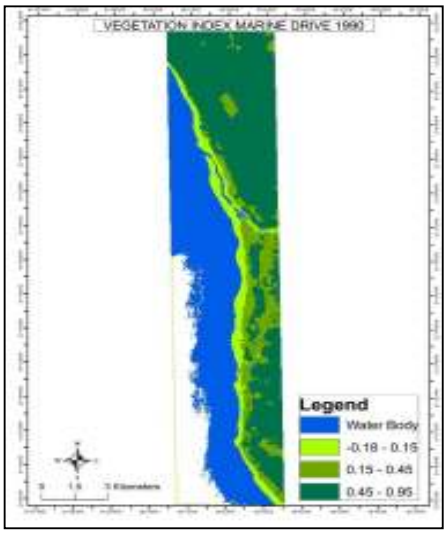
The soil might show high spatio-temporal variability[29].

Vegetation Coverage: The vegetation coverage at the Teknaf coast has depleted at a great extent, showing a decline in index value from + 0.21 (1990) to + 0.02 (2015) (Fig.1.8, Map 2 a & b). According to the Vegetation ranges, the study area has 'Sparse Vegetation'[14 & 15]. In 1990, the value of the vegetation index at the study area ranged from -0.18 to 0.95, which might be categorized as 'Sparsely vegetated area' (Map 2 a). However, in 2015 the value in the vegetation index ranged from 0.007 to 0.56, which indicates acute decline in vegetation coverage in the study area (Map 2 b).

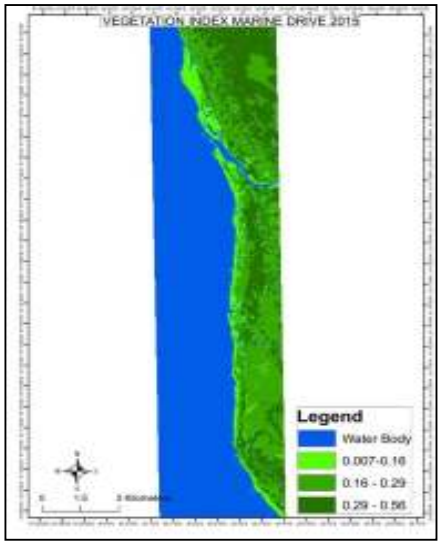
The study observed that, besides the physiographic cause, such as shoreline erosion, excessive cutting down of trees for domestic fire woods, logging and other purposes were the major causes of vegetation depletion. The Cd has high phytoaccumulation mobility from soil to plant and hence, might enter the food chain[29]. Hence, higher concentration of Cd in plants might cause toxicity leading to decreasing nutrient uptake, inhibiting photosynthesis, and plant growth.

The declined vegetation coverage of the study area ensued enhanced soil erosion and causing massive shoreline erosion[30].Moreover, the climate change induced hazards like cyclone and storm surge, tidal inundation, and wave cut erosion has increased in the study area due to decreasing vegetation coverage.

Conclusion and Recommendations: The deterioration of the terrestrial ecosystem of the east coast is the consequence of municipal garbage dumping, industrial waste discharge, plantation of exotic and non-native plant species, lack of public awareness and knowledge about the ecosystem conservation, conflict of multiple, as well as unplanned land use, illegal and unscrupulous land



Map a



Map b

Map 2 (a & b): Vegetation Coverage of Teknaf Peninsula, Cox's Bazar: 1990 & 2015

encroachment by local stakeholders, shrimp cultivation, and over exploitation of floral and faunal species for consuming and trading. The present research advocates to minimize the discharge of toxic industrial and municipal effluents from the point sources by implementing advanced 'Waste Treatment Plant' and ensuring close regular monitoring. Nevertheless, besides the application of modern waste treatment mechanisms, strong emphasis has to be given upon creating awareness at local and national level through developing knowledge pool regarding the conservation, as well as protection of the coastal zone terrestrial ecosystem. Regular trainings, demonstrations, rallies, and dramas should be held among the national and local stakeholders about the detrimental impacts of anthropogenic interventions in the terrestrial ecosystem of the east coast of Bangladesh. National level initiatives have to be taken for incorporating knowledge about the sustainable management of the coastal terrestrial ecosystem into the text books of all levels. Proper and adequate knowledge about the terrestrial ecosystem, awareness enriched with trainings, moral values and ethics regarding the conservation of the terrestrial ecosystem management has to be ensured for achieving the sustainable development goal.

Limitations:

1) The management of the shrimp hatcheries and fish processing factories were not available for KIIs,

2) The local stakeholders were unaware and ignorant about the detrimental impacts of deterioration of ecosystems,

3) The government stakeholders mentioned about lack of proper and fully-functional infrastructural and law enforcing procedures to protect the terrestrial and coastal and marine ecosystems of the east coast, and

4) Majority of the tourists were unaware and uninformed about their unscrupulous activities like throwing garbage at the coastal beach.

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