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Potential aftermath of Tropical Cyclonic Disasters on the Physico-chemical Characteristics of Soil in Satkhira, Bangladesh

Arafat Rahman*, Md Shiful Islam, A.S.M. Mohiuddin, Ishrat Jahanara and M.J. Uddin

Corresponding author: Dr. Rahman A, Department of Soil, Water and Environment, University of Dhaka, Dhaka-1000, Tel: +8801672006862; E-mail:Arafat.du.edu@gmail.com

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Abstract

On account of evaluating some selected physico-chemical attributes of soil and detecting the changes in soil health over a period of the last 20 years due to colossal storms like Aila and Mora, befallen in coastal areas, an investigation was carried out at Shyamnagar Upazila of Satkhira district, Bangladesh. The amount of sand was less than the silt and clay fractions in the studied sites. Silt contents were significantly augmented in study sites over 20 years. Consequently, siltation has been taken place in these sites for the last few years. In the area of investigation, soil salinity was associated with the development of silt texture, altered from clay loam texture. The field moisture contents were observed to be increased (52%) which attributed to the increase of clay content with depth. The investigated soil samples revealed a very slow to moderate permeability class along with permeability rates ranging from <0.13 to 6.3 cm/hr. In 1996, only 4.55% of soil samples were moderate basic whereas it was elevated up to 27.27% in the present study. Concurrently, an incremental trend of pH was noticed in the present study in relation to the study in 1996. The soils were extremely saline in nature with a range of EC from 12.25 to 46.40 mS/cm. In comparison to 1996, organic carbon content was gradually decreased. The intrusion of saline water from the Bay of Bengal, resultant of the catastrophic cyclone Aila and Mora, might play a pivotal role in these changes in the examined physico-chemical properties of the soil. These impacts could be aggravated in the topsoil by inundation or by capillary movement. Possibly due to the extended nature of salinity, soil drainage was restricted, soil health was deteriorated and crop production was impeded in the study sites. This situation might become worsened in the near future. Moreover, the adoption of crop residue management, incentivizing increases in water-use efficiency, application of soil amendments, adequate groundwater application, proper drainage system, etc. might be effective countermeasures in post-Aila and Mora affected soil to alleviate the soil salinity, improve soil health and thereby deal with a more variable climate.

Keywords: Cyclone Aila and Mora; physico-chemical properties of soil; soil health

Introduction

In pursuance of ADB, some predominant factors like climate change and global warming are considered as having massive and disastrous consequences for Bangladesh which makes it one of the most vulnerable countries whose 28% of the population lives in the coastal area [1]. Coastal areas, especially heavily populated mega delta regions in South, East, and South-East Asia, will be at greatest risk due to increased flooding from the sea as well as citing a trend since the mid-1970s toward longer duration and greater intensity of storms [2]. The IPCC suggests that by 2080, sea-level rise could convert as much as 33 percent of the world's coastal wetlands to open water figured out that homogenous 10% future intensification over the next 100 years increases the potential inundation zone to 25.7% of the coastal territory, taking into account sea-level rise. This translatesto potential inundation for an additional 52 million people, 29164 km2 of agricultural area, 14991 km 2 of the urban area, 9% of coastal Gross Domestic Product (GDP), and 7% of wetlands [3], resulting in threatens coastal ecosystems severely. Thus, it is crucial to bring out the dynamic risks and inversion of degraded environmental components in coastal areas. The trend of tropical cyclones hitting the Bangladesh coast is not steady. The result will likely be more devastating coastal storm events, combined with ongoing elevated coastal erosion [4] and flooding, gradual inundation of low-lying lands, and, in many areas, the salinization of groundwater. Most of the casualties from cyclones in Bangladesh, as in other parts of the world, are generated by storm surges as climate change will enhance the height of storm surges, leading to greater coastal flooding.

The southwest area lies between 21°30´ and 23°15´ north latitude, and 89°00´ and 90°00´ east longitude and includes the world's largest mangrove forest [5]. Satkhira, the south-western coastal district of Bangladesh, is thought to be the most disaster-prone region in consequence of frequent natural calamities and higher vulnerability to the effects of global warming, climate change, and sea-level rise. This area is the hub of all types of silent disasters like cyclone Sidr in 2007, Aila in 2009 and Mora in 2018, tidal surges, floods, drought, salinity intrusions, repeated water-logging, and land subsidence. Devastating cyclonic storms and their consequent tidal surges enhanced the unfitted salinity level in this locality, arousing affect water resources, productive soils, crops, etc. Approximately, 85% of the people of this territory depend on agriculture. Being exacerbated by climate change and rising sea levels, the agricultural lands in those regions may be experiencing extended salinity levels. Salinity in Satkhira assumes form of a serious problem if the monsoon rain is inadequate or delayed or if embankments are damaged. Most of the areas remain fallow during the dry season owing to high salinity and lack of suitable irrigation water. About 2.85 million hectares of land in Bangladesh bordering the northern apex of the Bay of Bengal and constituting the coastal off-shore lands. Out of it, 1.06 million ha of arable lands are affected by varying degrees of salinity.

The devastating Aila and Mora cyclones might cause not only salinity intrusion but also to aggravate soil quality deterioration that has already posed a serious impediment to the economic development of the southwestern coast of Bangladesh. Considering the above facts, the present investigation has been undertaken with a view to investigate the changes of physicochemical properties of soil, in addition, to reveal their relationship in the selected Aila and Mora affected study sites in comparison to the data sets of soil resources development institute, SRDI and to make a recommendation regarding the soil quality of the study sites.

Materials and Methods

Descriptions of the experimental site, the methods of soil sampling and analyses are given in this section. ArcMap 10.3 software developed by Environmental Systems Research Institute (ESRI) was used to exhibit the sampling location. Finally, the descriptive statistical analyses of all data are given.

Experimental site

Being entangled with severe cataclysms like Sidr, Alia, and Mora, geographically, the coastal Shyamnagar Upazila (22°11′ to 22º24′ N, 89º00′ to 89º19′ E) (Upazilla denotes an administrative subunit of districts which is locally named) which is the largest Upazila (1968.24 sq. km.) of Satkhira district, Bangladesh was chosen for the study purpose. The experimental area belongs to the agro-ecological Zone of AEZ-13 under Ganges Tidal Flood Plain [6]. Generally,it enjoys a sub-tropical monsoon climate including a very flat and low topography except in its southeast and southwest region. It is riparian of Kholpetua river, streaming as one of the largest rivers of the Ganges-Padma system originating from Himalayan mountains. Adjacent to the Bay of Bengal, the experimental area is also littoral on the verge of Sundarbans which is recognized as world’s biggest mangrove forest ecosystem. Major soil resources in the study areaare Fluvaquentic Endoaquepts and Typic Endoaquepts, as reported by Rahman. During sampling, Land and Soil Resource Utilization Guides (LSRUG) of SRDI was used. Soil sampling was done bythe following LSRUG sampling location (Table 1).

Sample No	*GPS value of the sampling points*	*Name of soil series and land type*	*SRDI sampling*
S1	22°20'35.1"N and 89°06'10.8"E	Barisal Mediumhigh land	21
S2	22°20'23.7"N and 89°09'02.1"E	Barisal Mediumhigh land	22
S3	22°22'16.2"N and 89°10'44.9"E	Jhalokathi Medium high land	20
S4	22°21'08.4"N and 89°09'05.9"E	Jhalokathi Medium high land	23
S5	22°19'24.7"N and 89°09'57.9"E	Barisal Medium high land	24
S6	22°21'55.3"N and 89°10'09.1"E	Jhalokathi Medium high land	62
S7	22°19'48.5"N and 89°10'31.9"E	Barisal Medium high land	26
S8	22°14'46.0"N and 89°08'21.9"E	Barisal Mediumhigh land	25
S9	22°29'31.9"N and 89°09'07.7"E	Dacope Medium high land	51
S10	22°21'13.4"N and 89°08'9.1"E	BarisalMedium high land	52
S11	22°17'59.9"N and 89°10'59.0"E	Dacope Medium high land	77
S12	22°21'02.0"N and 89°11'10.6"E	Jhalokathi Medium high land	54
S13	22°21'21.5"N and 89°12'07.5"E	Barisal Medium high land	58
S14	22°19'51.0"N and 89°10'30.9"E	Bajoa Medium high land	76
S15	22°19'31.2"N and 89°11'36.9"E	Jhalokathi Medium high land	108
S16	22°19'21.8"N and 89°11'41.3"E	Barisal Medium high land	111
S17	22°19'11.5"N and 89°12'38.6"E	Jhalokathi Medium high land	61
S18	22°18'49.8"N and 89°05'45.6"E	Jhalokathi Medium high land	59
S19	22°18'05.2"N and 89°05'55.3"E	Barisal Medium high land	60
S20	22°17'30.6"N and 89°07'29.3"E	Jhalokathi Medium high land	70
S21	22°14'44.8"N and 89°08'31.8"E	Barisal Medium high land	113
S22	22°14'57.4"N and 89°10'19.8"E	Barisal Medium high land	114

Table 1. Soil sampling location of the study sites.

Methods of Soil Sampling

Sampling depth of 0cm-30 cm was ascertained because changes in soil quality attributes that took place at this soil depth were most evident. It is also recognized as plough layer of soil in terms of agricultural productivity and concurrently, plant-water-soil relationship.

A total of 22 soil samples were collected from Shyamnagar Upazila using a systematic random composite sampling method for the study purposes (Table 1). Sample coordination (location) was recorded using a global positioning system (GPS, Germin-62s, USA) receiver. The map of thestudied sites was drawn up by using ArcMap 10.3 software developed by Environmental Systems Research Institute (ESRI) exhibited in.

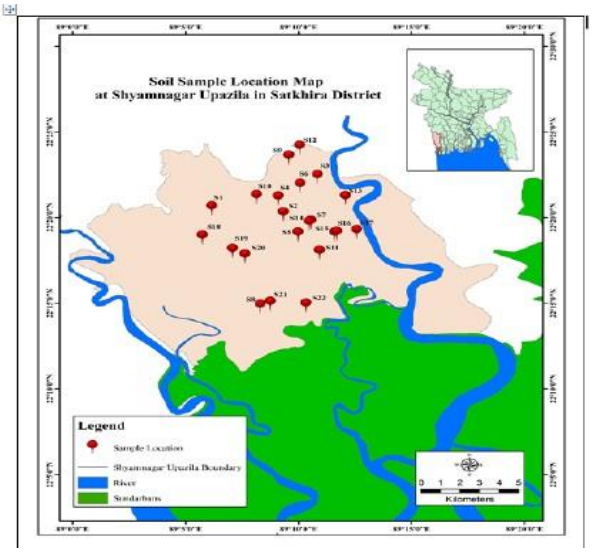

Figure 1: Map of the sampling sites in the Shaymnagar upazila, Satkhira.

Soil Sample Preparation

Using stainless steel soil auger, soil samples from the field were collected in thick double polythene bags. The bags were sealed properly, precluding moisture loss from the sample and transferred as quickly as possible to the laboratory for their processing. Prior to analysis, the representative soil samples were sun-dried, ground, and sieved through a 10 mesh (2mm) sieve for physical analysis and 2.5 mesh (0.5mm) sieves for chemical analysis. The sieved soil was then stored into a plastic container.

Soil Analyses

In order to assess the magnitude of declining soil health in the surveyed area, the present research has emphasized on laboratory experiments of soil collected from several undisturbed spots in December 2018. The field moisture in freshly collected field soil was examined by gravimetric method [7]. For particle size analysis, the soil was dispersed by the method of Jackson. The percentages sand (>50μm), silt (2μm to 50μm), and clay (<2μm) were determined by hydrometer method as described by Day [8]. United States Department of Agriculture (USDA) size fractionation technique was used during determination. The textural class experimented from the triangular co-ordinates as devised by the USDA Staff. The soil reaction (pH) was measured at a saturated paste extract keeping a ratio of 1:1 with deionized water by using a digital glass electrode pH meter (Accumet Model AR15, Fisher Scientific). According to the method by Rhoades, a 1:2 soil to water ratio, allowing to stand overnight under 25°C with the help of Electrical Conductivity (EC) meter (Accumet Model AR30, Fisher Scientific), EC of the soils was analyzed at saturated paste extract. The carbon content of the soil was examined volumetrically by wet-oxidation method of Walkley and Black using normal potassium dichromate and concentrated sulfuric acid mixture and rapid titration with 1N ferrous sulfate solution, and henceforth, the organic matter content of the soil was calculated by multiplying the percentage of organic carbon with conventional Van-Bammelen's factor of 1.724 as narrated by Nelson and Sommers [9].

Statistical Analyses of Data

Descriptive statistics (mean, Standard Deviation (SD), Coefficient Variation (CV), minimum, maximum were used to analyze related soil properties (Sand, silt, clay, field moisture, pH, EC, and org C). Statistical analyses of the data were performed using computer-based statistical program Minitab-19, Grapher, and IBM® SPSS® Statistics 25. The regression analysis ® was obtained by IBM® SPSS® Statistics 25 (IBM, Armonk, New York, U.S.A.). Correlation and Regression analysis, and Box-Whisker plot are applied to evaluate and compare relationships among several parameters.

Results and Discussion

The results and discussion estimates and scrutinizes the distribution and dissimilation in physico-chemical properties as like particle size distribution, textural class, permeability of soil, and moisture content, along with some chemical attributes of the studied soils. Also, it validates the reasons for deteriorating soil health, salinity intrusion, environmental risks, and the downfall of yield capacity. The differences compared to the previous study by SRDI are also pointed out. Moreover, requisite recommendations for protecting the vulnerable coastal area have also been provided.

Particle Size Distribution

The results of the particle size distribution of investigated soils are shown in Table 2 and Figure 2. Among the analyzed soil samples, the sand content is less than 11% except for sample number S1. Higher amounts of sand (39.07%) contained in Barisal soil series at sample number S1. The average sand content in the study sites was around 5%.

Silt is the dominant size fraction in the studied area. Silt contents in the experimental sites were varied from 38.02 to 81.85% (Table 2). Containing the highest amount of silt content, Jhalokathi and Barisal soil series at sample number S15 and S22 (Table 2), respectively is considered to be the most silt dominant site in the experimental area (Figure 2). The lowest silt content was recorded in the sample number S8 (Figure 2). The average silt content of the analyzed soil samples was 54.28% (Table 2). Such a high level of silt content was related to the nature of the siltation in the study sites. Concentrations of clay fraction in the studied sites ranged from 12 to 60%, the average was around 41% (Table 2). The maximum amount of clay (60.58%) was found in the Barisal soil series at S8 sample whereas the minimum amount of clay (12.53%) was analyzed in the Barisal soil series at the sample number of S1 and S22.

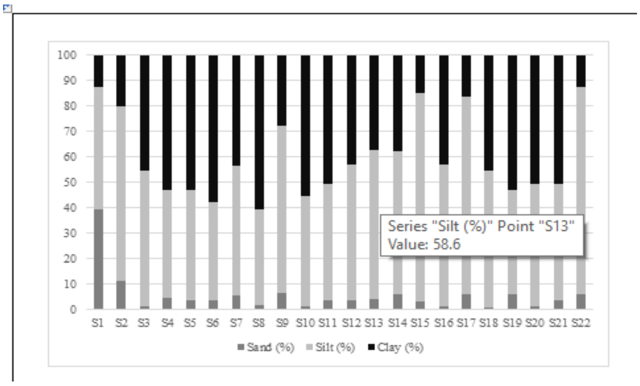

Figure 2: Particle size distribution of the soils of investigated coastal region at different sampling stations.

Most probably, severe sedimentation took place due to the natural disaster Aila and Mora. The amount of sand was less than the silt and clay fraction. Because of the insufficiency of the sand fraction, it might not be able to provide a congenial physical condition to the soil for plant growth. The very low percent of sand fraction in the soils under the present investigation corroborates the general observation of Brammer that the texture of the soil across Bangladesh becomes gradually finer as one moves from north to south. The present study revealed that the studied soils had higher silt and clay fraction than sand. Moreover, it might be said that the siltation has been taken place on this site for the last few years. This finding should be considered when seeking sites for construction of new ponds or farms in the studied area.

Soil Texture

The amount of sand, silt, and clay fractions in the soil determines the soil texture. The result demonstrated that the soils belong to silty loam, silty clay loam, silty clay, silt, clay, and loam texture Among the variation of soil textures, silty clay was the most dominant textural class, representing about 55% soil samples were silty clay whereas almost all the sites of our investigated points were highly clay dominated in the study of 1996

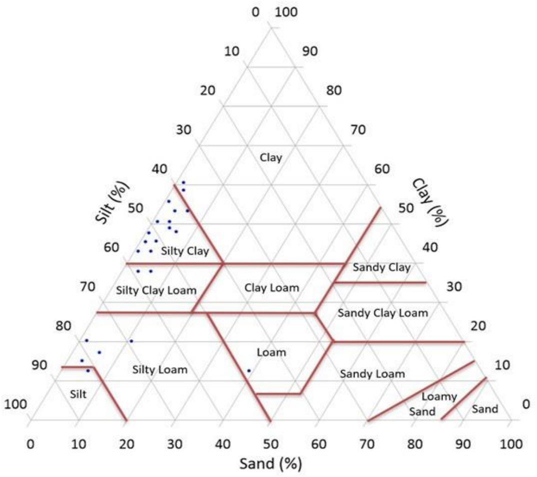

Figure 3: Textural distribution of soils-(plotted on USDA textural triangle) for studied samples.

Sample No.	*Sand (%)*	*Silt (%)*	*Clay (%)*	*Field Moisture (%)*	*Textural class (2018)*	*Textural Class (1996)*
S1	39.07	48.4	12.53	30.21	Loam	Clay loam
S2	10.86	68.97	20.17	32.30	Silty loam	Clay loam
S3	1.02	53.44	45.54	27.23	Silty clay	Clay loam
S4	4.23	42.74	53.03	27.55	Silty clay	Clay loam
S5	3.32	43.37	53.31	38.70	Silty clay	Clay
S6	3.32	38.67	58.01	49.23	Clay	Loam
S7	5.42	51.08	43.50	25.63	Silty clay	Clay
S8	1.40	38.02	60.58	36.93	Clay	Clay loam
S9	6.23	65.74	28.03	12.74	Silt	Clay loam
S10	0.77	43.51	55.72	31.23	Silty clay	Clay
S11	3.44	45.86	50.70	27.88	Silty clay	Clay
S12	3.35	53.55	43.10	24.28	Silty clay	Clay
S13	3.90	58.60	37.50	48.21	Silty clay loam	Clay loam
S14	5.87	56.12	38.01	51.98	Silty clay loam	Clay loam
S15	3.07	81.85	15.08	14.61	Silty loam	Clay loam
S16	0.80	56.10	43.10	31.91	Silty clay	Clay
S17	5.81	77.68	16.51	18.25	Silty loam	Loam
S18	0.64	53.64	45.72	37.68	Silty clay	Clay
S19	5.87	40.82	53.31	26.58	Silty clay	Clay loam
S20	0.90	48.40	50.70	23.64	Silty clay	Clay loam
S21	3.44	45.86	50.70	24.67	Silty clay	Clay loam
S22	5.63	81.84	12.53	28.68	Silty loam	Clay loam
Mean	5.38	54.28	40.33	30.40		
SD*	7.91	13.31	15.71	10.23		
CV**	1.47	0.25	0.39	0.34		

Table 2. Particle size distribution (sand, silt, clay), field moisture and textural class of the studied soils.

Depending on soil texture, salinity holding capacity varies. Generally sandy soils tend to be less saline because sand particles are less coherence to each other and salt leach easily. Peat soils also contribute leaching saline easily because of their surface drainage network. But salts tend to attach to clay particles and clay soils tend to be more saline for longer. Crop production largely depends on soil properties influenced by soil texture include drainage, water-holding capacity, aeration, susceptibility to erosion, organic matter content, cation exchange capacity, pH buffering capacity, and soil tilth. The soil was gradually turned into more saline because clay soils can hold salt for a longer period because of its high-water holding capacity, very slow drainage rate and, poor aeration system. Subsequently, it turned into silty clay textureunder the circumstances of siltation over the last twenty years. It was observed that silt contents were expanded in the study sites over 20 years of time. It was significantly changed after the disaster Aila and Mora. Correspondingly, due to the incremental nature of salinity, soil drainage was restricted and thereby plant growth was confined in the study sites. The elevated salinity was associated with the development of silty texture in the study sites. To account for reining unanticipated topsoil salinity, unintended degradation of soil health as well as optimizing yield capacity, soil texture is relevant to crop choice in agriculture. Silty soils would be suitable for shrubs such as blackberry, beach rose, and raspberry; climbers such as cucumber, hops; cash crops like betel leaf, betel nut and coconut; and grapes; grasses such as rye, wheat, and corn; and perennials such as ginger, strawberry and tomato. Many moisture-loving trees as well as vegetable and fruit crops do well in silty soils that have adequate drainage. Hitherwards, it is also substantive that soil that is best for plant growth is directly related to the type of plants being grown. Having silt clayto loam texture, the studied coastal soils are very fragile under natural conditions. If irrigation facilities could be developed during the dry season the potential of these soils would elevate to a greater extent generating much higher quantities of food grains.

Soil Permeability

To combat with rising soil salinity, relevancy was constructed between soil permeability and textural class pointed out that soilpermeability classes incorporated into the estimation of permeability rates by using the textural class of soil. Alternately, the studied soil samples revealed very slow to moderate permeability class along with permeability rates ranging from <0.13 to 6.3 cm/hr as data reported.

The permeability of soil is largely influenced by its infiltration rate. Clay soils have small pore spaces, are known to have low permeability, resulting in low infiltration rates and poor drainage whereas coarse sand soils have very rapid permeability. Siltation might cause the alteration status of soil permeability in the investigated area. Soil permeability can feasibly increase when soil compaction begins to loose with extended pore spaces, resulting in detrimental impact for agricultural tailored soils as a slightly compacted soil can speed up the rate of seed germination because it promotes good seed-to-soil contact.

Moisture Percentage in the field condition

The percentage of moisture at field condition of the studied soils is presented in Table 2. The field moisture contents were within a range of 12% to 52%. The average field moisture content was 30.40%. The Lowest amount of field moisture was audited in Dacope soil series at sample number of S9 whereas the highest amount was observed inBajoa soil series at sample number S14.

It is known that good water holding capacity represents the good physical condition of soil. The SRDI observed the variation in field moisture percent values with the variation in texture of differentsoils. In particular, they stated that increase of moisture percentageof the soils imposed on the increase of clay content with depth. Decomposition of organic matter is mainly depending on the soil moisture. If water becomes too low, a plant becomes stressed. Water is present in more in soil; it is not available to plants due to a high degree of salinity.

Nature of Soil Reaction (pH)

To measure the degree of soil acidity and alkalinity, soil pH is a very important variable and it helps to know about soil properties chemical, biological, and indirectly physical environment including both nutrients and toxins. The result of the pHs of the investigated sites is shown in Table 4 and Figure 4. The highest pH value was recorded as 7.80, while the lowest pH value was 5.0. In all of the soil samples, soil pH was ranged from 5.0 to 7.80. In the present study sites, most of the soil was found as alkaline (pH>7.5). This pH is suitable for shrimp aquaculture but not for agricultural production

The admissible range of pH in the soil is 6.0 to 6.5 because most of the plants' nutrients become available in this stage. In the year 1996, soil pH in the study sites was not as much elevated as the present and both years showed a significant correlation at 95% confidence level. The highest pH value was 7.60 and the lowest pH value was 3.80 in 1996 (Table 4). In 1996, only 4.55% of soil samples were moderate basic whereas it was elevated up to 27.27% in the present study.

An incremental trend of pH was noted in the present study. It might be due to the influence of disasters like Aila and Mora. The saline water from the Bay of Bengal had a pivotal role in the pH status of the soil. These impacts could be in the groundwater as well as in the topsoil by inundation or by a capillary movement which might be the ultimate resultant of Mora and Aila disaster. From the pH observation, it can be said that the present pH range has motivated the local farmers to the shrimp cultivation in the study sites. Acid sulfate soils constituted uniformly in drowned coastal and estuarine environments can eventually be highly acidic when drained or unearthed. Latterly, it might increase the degree of pH in the investigated area of Shaymnagar, resulting in soil health deterioration. The elevating trend of soil pH is contradictory to the equilibrium between available nutrients in the soil environment, certainly interrupt soil fertility to plant growth. In most cases, pH range of 6.0-7.5 is optimum for the adequate availability of nutrients in the soil.

Electrical Conductivity (EC)

EC is the most convenient method to measure soil or water salinity. In agricultural standards, soils with an EC greater than 4 mS/cm are considered as saline soil. Ranging from 12.25 to 46.40 mS/ cm along with an average value of 24.84 mS/cm in the present study (Table 4 and Figure 4), EC plays regulative role for the comprehensive distribution of unfitted soil salinity in the investigated area. Based on the classification of soil EC of the samples, in conformity with SRDI BARC, Islam Shitangsu and Hassan 72.73% samples in 1996 and 90.91% samples in 2018 had a very high range of EC. The highest and lowest EC was examined in the sample number of S16 (46.40 mS/cm) and S21 (12.25 mS/cm), respectively. Meanwhile, the EC was varied from 7.35 to 43.21 mS/ cm with a mean value of 21.04 mS/cm in 1996 [10]. A significant correlation was marked between the years 2018 and 1996 at 95% confidence level and showed

Out of the total soil samples, 72.73% soil samples in 1996, and 90.91% samples in 2018 had a very high range of EC. An EC value less than 1 indicates that soils are highly suitable for cultivation, between1-3 is injurious to crop growth, between 3 and 4 will definitely cause yield reduction and soils with EC value more than 4 are designated as saline soils and need reclamation to restore them for satisfactory cultivation. The finding of the present study is quite analogous to the study of Rahman, and Islam Shitangsu and Hassan who found that the EC value was ranged from 12.70 to 20.70 mS/cm and 23.93 to 28.64 mS/cm, respectively in several salt-affected areas of Satkhira district. The present result showed that the soils were extremely saline in nature which caused adversity of soil health and thereby impeded

pH range	***Type***	***Soil Samples***		***Percentage (%)***	
		2018	***1996***	***2018***	***1996***
<4.0	Strongly acidic	-	S10	-	4.55
4.1-5.0	Acidic	S10	S2, S5, S6,S8, S11, S16, S17	4.55	31.82
5.1-6.8	Moderately acidic				
p-value	p-value	S1, S2, S5, S8 S13, S14, S15 S16, S17, S18, S20	S1, S3, S4,S7, S9, S12,S13, S14, S15,S18 S19, S20, S21	50.00	59.09
6.9-7.1	Neutral	S3, S4, S12, S21	-	18.18	-
7.2-7.9	Moderate basic	S6, S7, S9, S11, S19, S22	S22	27.27	4.55
8.0-8.9	Basic	-	-	-	-
> 9.0	Strongly basic	-	-	-	-

Table 3: Classification of soil pH of the samples according to standard of Boyed (1995).

The agricultural activities and crop production. Salinity is being thoughtto be a silent poison for massive loss of crop production in the studied area. Salinity tended to be higher in arable lands that had compacted subsoils, which trapped saline cyclonic sediments and held saline water for longer duration as well as in these poorly drained, low-lying areas. Widespread plus repeated practices of shrimp cultivation in and around the experimental sites may remarkably increase the level of EC in soil and deteriorating soil health by reason of saline water intrusion from coast affecting local cropping pattern, stagnant saline water in the shrimp culture site for a long time and replacement of arable landsinto shrimp ponds. Sooner or later, it imposes an extensive threat to soil productivity, local vegetation, biodiversity of coastal species, and ultimately, local environment with a more variable climate. From the observation, it can be said that this situation might become worsened in the near future.

Soil Organic Carbon Content

Analyzed average value of soil organic carbon was measured as 1.72% in the study sites. The maximal organic carbon was tested in the Barisal soil series at the sample number of S8. Concentrations of organic carbon were between 1.02 and 2.68 percent% (Table 4). Conversely, concentrations of organic carbon were within a range of 0.82% to 3.82% averaged 1.98% in 1996 [10]. As compared to 1996, organic carbon content was gradually decreased but not significantlyat 95% confidence level.

The soil organic carbon content was decreased in the present study in comparison to the study of 1996. Due to disasters like Aila and Mora, soils were greatly affected by salinity. In some study sites, an abrupt increment of organic carbon was notified. It might be due to shrimp culture with gher (shrimp ponds locally mentioned as gher) in these sites. This is likely to be the reason that shrimp culture is responsible to increase organic carbon. Different organic products such as mustard cakes, cow dung, and other phytoplankton are extensively used as shrimp foodstuffs. The applied feed of shrimp is partially dissolved in water and the rest residue accumulates at the bottom of gher. The uneaten feeds and residues are mixed with soil and water and may increase organic carbon.

Soil Organic Matter Content

The highest organic matter was inspected in Barisal soil series in the sample number of S8. The organic matter of soils was varied from 1.75 to 4.62% and the average value of organic matter were noted as 2.96%. Far from it, in 1996, the average value of organic matter was 3.42% with a range of 1.41% to 6.59%. From the observation, it canbe stated that the organic matter content in the present study sites was comprehensively reduced. It might be due to the destructive influences of cyclonic disasters.

The increment of soil organic matter content was caused for maximum retention of field moisture content in the studied sites. The 7.44% of total variation in the field moisture in the studied areas could be elucidated by the organic matter content of that soil . From the observation, apparently, it can be stated that soil organic matter tended to increase as the clay content was augmented in the present study. The 70.4% of total variation in the organic matter content was explained by the clay content. As reported by Rice, soils with higher clay content enhanced the potential for aggregate formation which physically sheltered the organic matter molecules from further mineralization. Consequently, the deposition of organic matter content was prevailed. Here-after, this result is in confirmatory with the investigation analyzed by Rice.

Relationship between EC and other Properties of the Studied Soil

The EC of the soils was regulated by other properties of the studied soil such as the percentage of sand, silt, clay, and organic matter. The intrusion of salty water during the cyclonic disasters might change the aforesaid properties which augmented the salinity level in the studied sites. The 0.73% of the total variation in EC was elucidated by the sand fraction of the experimental soil, whereas the 7.96% of the total variation in EC was explained by the silt fraction and 4.99% of total EC by clay fraction. It is demonstrated from the figure that the EC content of the soil was greatly influenced by the silt fraction followed by the clay and sand fraction. A strong relationship (R2=16.09%) was noted between the EC and organic matter contents of the soil.

Conclusion

It has been deduced from the present study that the salinity level of the studied soils is greatly incremented as compared to 1996 due to the ramifications of the catastrophic cyclonic disasters Aila and Mora. Intimidating cyclonic seawater inundation and resulting sedimentation introduced salinity into coastal areas where it had never before been a problem. The soil health is deteriorated which might threaten the agricultural productivity, cropping pattern, coastal agro-forest ecosystem, and ultimately the coastal environment in those regions on a large scale. The situation might become worsened in the near future if adequate safeguarding and viable measures would not be taken as soon as possible. Furthermore, the adoption of crop residue management, afforestation, incentivizing increases in water-use efficiency, adequate groundwater application, proper drainage system, etc. might alleviate the soil salinity, improve soil health and thereby ensure sufficient crop production in post-Aila and Mora affected soil.

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