Sea-Level Rise Along the Coast of Bangladesh

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Chapter 10
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Abstract Sea-level rise along the Bangladesh coast was estimated using tide gauge data. It showed considerable variation in sea-level change in different parts of the coastal zone. The tide gauge station at Hiron Point in the Sundarbans showed a SLR of 3.38 mm/year. SLR at Reyenda and Amtali was observed as 3.64 and 3.16 mm/year, respectively. Sea-level rise along the central coast was observed as 5.73 mm/year at Char Changa station in Hatiya. The station in Companiganj, representing the Noakhali Feni coastal zone, showed a SLR of 2.5 mm/year. Sea-level change along the eastern part of the coast showed very low rise or fall. Sadarghat station in the Chittagong coastal zone showed a sea-level fall of 11.75 mm/year. Sea-level rise calculated from the PSMSL dataset was observed as 1.36 mm/year at the Cox's Bazar station. However, similar calculations from BIWTA in Moheshkhali and Teknaf showed a sea-level fall of 5.59 and 8.33 mm/year, respectively. Additionally, Physical vulnerability of the coast towards sea-level change was assessed revealing that the coastal areas along Patuakhali and Bhola Districts and Hatiya Island are very high vulnerable and the coastal areas along the Sundarbans and Barguna coastal zones are high vulnerable. The Noakhali Feni coastal zone is moderately vulnerable in terms of sea-level change. Vulnerability along the eastern part of the coast is very low.

Keywords Bangladesh • Coastal vulnerability • Coastal zone • Sea-level rise • Tide-gauge data

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10.1 Introduction

Global climate have changed at a rate of 0.13 °C per decade over the last 50 years (Meehl et al. 2005). It is predicted that global temperature will rise by 1.1–2.9 °C in the twenty-first century (IPCC 2007). One of the significant impacts of global warming is a rise in sea level. Global sea level has been observed to rise at a rate of 1.8 mm/year over the period 1961–2003 and about 3.1 mm/year over the period 1993–2003 as a response to global temperature rise (IPCC 2007). Sea-level rise (SLR) will have a significant effect on global ecosystems (IPCC 2007; Nicholls et al. 2007). It will affect the coastal zone by causing shoreline erosion, saltwater intrusion and increasing threats of flooding. Compounding the effects of sea-level rise, climate change is likely to cause an increase in the number and frequency of extreme weather events globally, including tropical cyclones, floods and storm surges (Malik 1988; Groisman et al. 2004; Emanuel 2005; Webster et al. 2005; Knutson et al. 2010). Consequently, this will affect the coastal communities and populations globally.

As a low-lying country, Bangladesh is highly vulnerable to SLR (Milliman et al. 1989; Ortiz 1994; Warrick and Ahmad 1996; Choudhury et al. 1997; Ali 2000; Sarwar 2005; Sarwar and Khan 2007; Karim and Mimura 2008; Oliver-Smith 2009). The projected SLR of 1 m in the twenty-first century may affect approximately 1,000 km^2 of the coastal land of Bangladesh and its coastal population (Cruz et al. 2007). In spite of great concern about SLR impacts on Bangladesh, few studies have focussed on assessing the actual rates of SLR for this coast. The wide discussion of sea-level rise impacts on Bangladesh has largely arisen from a general perception about the low-lying elevation (Woodroffe et al. 2006) of the coastal zone of the country. Assessing location-specific sea-level rise along different parts of the coast is the main focus of this study.

10.2 Background

10.2.1 The Coastal Zone of Bangladesh

The coast of Bangladesh (Fig. 10.1) is a home to approximately 46 million people. It covers an area of 47,201 km^2 (WARPO 2006). The floodplain of the Bengal delta comprises 2.85 million hectares of cultivable land (Bala and Hossain 2010) and supports 20 % of the rice acreage of Bangladesh (Begum and Fleming 1997). Additionally, the coastal zone contains the world's largest single chunk of mangrove forests; the Sundarbans. From spatial point of view the coast of Bangladesh can be divided into three zones. The southwest coast is the coastal areas of the Ganges Tidal Plain, the southcentral zone is the Meghna Delta Plain and the southeast zone is the Chittagong Coastal belt. Karim and Mimura (2008) have named these zones as western, central and eastern regions. In addition to generalized division of the coastal zone of Bangladesh, Islam and Peterson (2009) have divided it into five

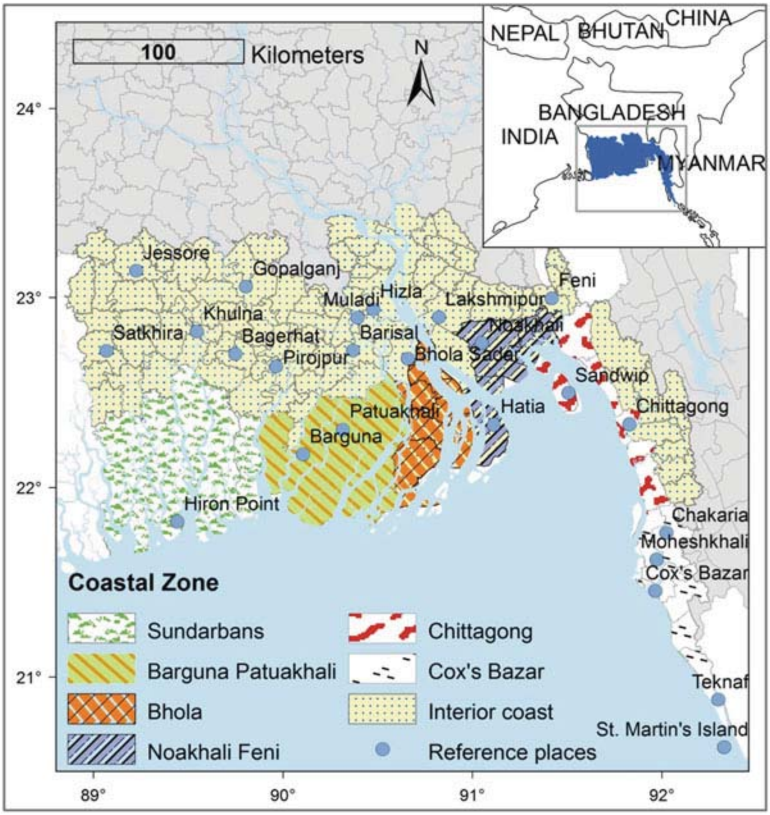

Fig. 10.1 The coast of Bangladesh showing the six coastal zones: The Sundarbans coastal zone, Barguna Patuakhali coastal zone, Bhola coastal zone, Noakhali Feni coastal zone, Chittagong coastal zone and Cox's Bazar coastal zone. Locations referred in the text are also shown

zones on the basis of administrative units. Five coasts are Khulna Coast, Barisal Coast, Noakhali Coast, Chittagong Coast and Cox's Bazar Coast. The present study has divided the coast into six zones: (1) Sundarbans coastal zone, (2) Barguna Patuakhali coastal zone, (3) Bhola coastal zone, (4) Noakhali Feni coastal zone, (5) Chittagong coastal zone and (6) Cox's Bazar coastal zone (Fig. 10.1). Administrative boundary based zonation was done to facilitate mapping and discussion.

10.2.2 Sea-Level Rise Along the Bangladesh Coast

A broad overview of climate change and sea-level rise in Bangladesh was first documented by Warrick and Ahmad (1996). Based on global trends, Choudhury et al. (1997) postulated a sea-level rise of 1.0–1.5 mm/year along the Bangladesh coast. This seems to be an underestimation compared to the range 4–7.8 mm/year in the assessment by Singh (2002). A numerical hydrodynamic model developed by Begum and Fleming (1997) showed that a combined effect of a SLR of 2 m and an increase in river discharge by 15–20 % will lead to worse flooding situation. Even a mean sea-level rise of 20 cm may cause a devastating situation in the central region of the country as sea-level rise impedes the flow of river water to the Bay of Bengal (BOB) causing flooding in the coastal zone (Singh 2002).

There are seasonal variations in water levels. Mean sea level (MSL) along the Bangladesh coast is highest during the period June–August when river discharge is the greatest because of peak rainfall in the country and also in the upstream countries. On the other hand, MSL is the lowest during January–March. The seasonal variation of MSL varies from 0.3 to 0.5 m (Khandker 1997). Furthermore, seasonal variation was observed in the trend of mean tidal level by Khan et al. (2000). They observed the highest trend in November with a rate of 8.5 mm/year but lowest in May at the rate of 2.5 mm/year at the Hiron Point station. They similarly observed a trend of 4.3 mm/year in May and 10.9 mm/year in November along the Cox's Bazar coast.

Spatial variation in sea-level trends along different parts of the Bangladesh coast was undertaken by Singh (2002), for the period 1977–1998. He analysed 22 years tide gauge data collected from Hiron Point, Char Changa and Cox's Bazar stations on the southwest, central and southeast coast of Bangladesh, respectively. Rise in sea level was highest in Cox's Bazar with a rate of 7.8 mm/year and the second and the third highest rates of change were at Char Changa and Hiron Point at rates of 6.0 and 4.0 mm/year, respectively. His assumption was that a high subsidence rate in the eastern part of Bangladesh was responsible for the higher SLR trend. In contrast Khan et al. (2005) observed uplift on the eastern coast of Bangladesh at a rate of 3.6 mm/year in the Maiskhali Anticline from 18,000 years ago until present and 2.86 mm/year in Jaldi anticline on the mainland in Cox's Bazar, from 35,000 years ago until present.

A higher trend of SLR at a rate of 5.22 ± 0.43 mm/year at Diamond Harbour near Kolkata was observed by Unnikrishnan and Shankar (2007) that suggests that a higher SLR rate may be prevailed along the Bangladesh coast. Emery and Aubrey (1989) observed a rise in sea level at Calcutta and Diamond Harbour at a rate of 6.93 and 7.26 mm/year, respectively. The rise seems to be high, but was supported by Unnikrishnan and Shankar (2007) where a rise of 5.74 mm/year was observed in Diamond Harbour by analysing the tide-gauge data of 1948–2004. In contrast, Kidderpore and Sagor Island in the vicinity of Indian Sundarbans experienced a fall in sea level at the rate of 6.06 and 4.2 mm/year respectively (Emery and Aubrey 1989).

10.2.3 Data Used in Global SLR Estimation

In understanding sea-level change, tide gauge data is the most reliable and available data over the past two centuries. Scientists worldwide have been relying on tide-gauge data in researching sea-level rise for long time (Woodworth 1991; Douglas 1997; Haigh et al. 2009; Woodworth et al. 2009). It is expected that tide-gauge data

Table 10.1 Vulnerability of coastal zone on the basis of sea-level rise

Reference	Very low	Low	Moderate	High	Very high
Gornitz (1991)	≤ −1.1	−1.0–0.99	1.0–2.0	2.1–4.0	≥4.1
Gornitz and White (1991)	≤ −1.1	−1.0–0.99	1.0–2.0	2.1–5.0	≥5.1
Gornitz et al. (1994)	< −1.0 (uplift)	−1.0–0.99	1.0–2.0	2.1–4.0 (subsidence)	>4.0 (subsidence)
Dwarakish et al. (2009)	<1.8	1.8–2.5	2.5–3.0	3.0–3.4	>3.4
Abuodha and Woodroffe (2010)	<0.0	0.0–0.9	1.0–2.0	2.1–3.0	>3.1
Ozyurt and Ergin (2010)	<1	1–2	2–5	5–7	7–9 and over
Gornitz and Kanciruk (1989)	≤ −1.0 (land rising)	−1.0–0.99	1.0–2.0	2.1–5.0	≥5.1
Gornitz et al. (1997)	< −1.0 (land rising)	≥ −1 and ≤ +1	>1 and ≤ +2	>2 and ≤4	>4.0 (land sinking)

will remain a strong factor for monitoring sea-level change. The introduction of the Gravity Recovery and Climate Experiment (GRACE) in 1992 has opened another window in researching satellite-based methods of detecting sea-level change (Woodworth et al. 2011). Since 1992, satellite altimetry data has been used for the estimation of SLR (Church and White 2006).

10.2.4 Sea-Level Rise in Coastal Vulnerability Index

Vulnerability is strongly correlated with rate of sea-level rise. Rates of relative sea-level changes are an important input into calculations of a coastal vulnerability index. All studies consider that a lower sea-level rise rate or a fall in the sea level represents the least vulnerable coast (Table 10.1). The studies covering the coastal zone of America place a fall in sea level in the lowest vulnerability class. Negative SLR trends are ignored by Dwarakish et al. (2009), Abuodha and Woodroffe (2010) and Ozyurt and Ergin (2010). Small intervals are used on the coast where the range of sea-level change is small (Dwarakish et al. 2009; Abuodha and Woodroffe 2010) and alternatively, higher intervals are used where there is a high range of sea-level change (Ozyurt and Ergin 2010).

10.3 Seal-Level Change Data

Tide gauge data has been collected from the Bangladesh Water Development Board (BWDB), Bangladesh Inland Water Transport Authority (BIWTA) and the Permanent Service for Mean Sea Level (PSMSL). After receiving data from the provider, an initial screening is done and recorded with PSMSL. This type of data is termed “Metric” data and can be used for different aspects of mean sea-level (MSL) analysis. Metric data is upgraded by verifying monthly and annual MSL against the

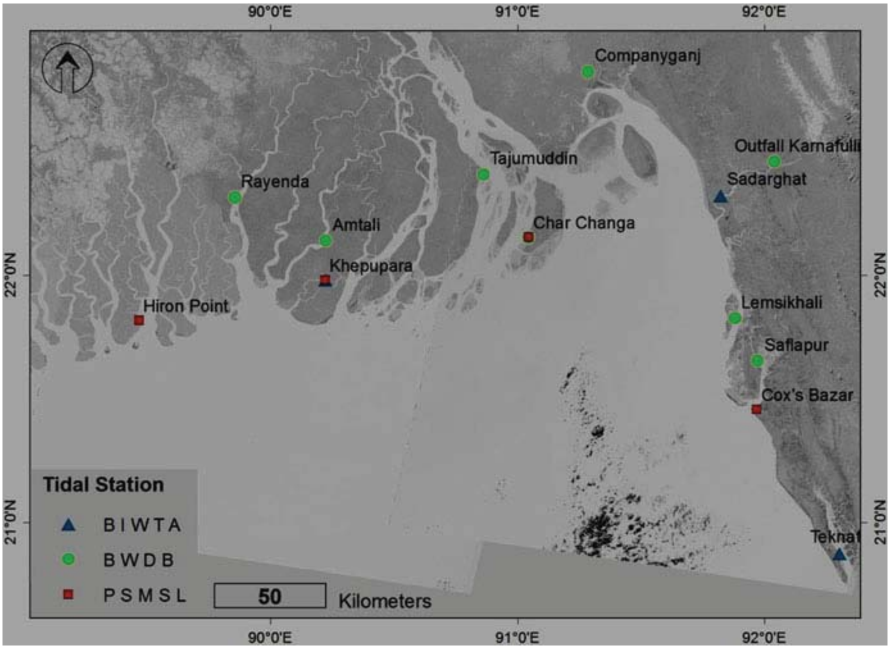

Fig. 10.2 Tide gauge stations along the Bangladesh coast

Tide Gauge Bench Mark (TGBM) of nearby land and is termed the "Revised Local Reference (RLR)" record of the station. Data categorized as RLR are suitable for time-series analysis and can be used for the estimation of long term sea-level change (Woodworth 1991; Woodworth and Player 2003). Tide gauge data from Bangladesh is obtained by PSMSL from BWDB which is then checked for further judgement. Metric data from Bangladesh is available for 11 stations (Fig. 10.2) having a data range from 1 to 33 years, but data for only four stations, Hiron Point, Khepupara, Hatiya Island (Char Changa) and Cox's Bazar, are processed to RLR level (Table 10.2).

Tidal data of Rayenda, Amtali, Tajumuddin, Hatiya, Companiganj, Outfall Karnafully (Chittagong), Lemsikhali and Saflapur stations have been collected from the Bangladesh Water Development Board (BWDB). Data of Khepupara, Sadarghat (Chittagong) and Teknaf stations have been collected from Bangladesh Inland Water Transport Authority (Table 10.2).

Standard PSMSL guidelines have been followed in selecting appropriate data periods. Data for a month is considered if tidal records for a minimum of 15 days of the month are available. Again, data for a year is considered if a minimum of 11 month's data are available. Generally, data from 20 years are analysed for SLR trend estimation (Haigh et al. 2009). However, data for a shorter period are considered in this study for cross-checking a result obtained from one data set, or if longer-term data are unavailable. The time span for the station at Companiganj, Sadarghat and Teknaf are 16, 16 and 15 years, respectively. The data for Khepupara station

Table 10.2 Tidal data for the Bangladesh coast

Station	Data source	Data period	No. of years	Missing data year
Hiron Point	PSMSL	1983–2003	20	0
Khepupara		1979–2000	21	0
Char Changa		1979–2000	21	0
Cox's Bazar		1979–2000	21	0
Rayenda	BWDB	1969–2001	32	1982, 1983
Amtali		1958–2002	44	
Tajumuddin		1969–2002	33	1980–1983
Companyganj		1984–1999	15	1989
Hatiya		1976–2007	31	
Outfall Karnafully		1976–2005	29	
Lemsikhali		1970–2007	37	1972, 1979–1981, 1987–1992
Saflapur		1969–1997	28	0
Khepupara	BIWTA	1986–1999	14	0
Sadarghat (ctg.)		1986–2001	16	0
Teknaf		1986–2000	15	0

obtained from BIWTA is only 14 years. These short-term data were also analysed to check the validity of the high rates of SLR obtained from the PSMSL dataset. Data collected from PSMSL and BIWTA have been provided as mean daily water level. Data collected from BWDB have been provided in the form of mean daily high water level and mean daily low water level. Mean daily water level of BWDB data have been obtained by averaging mean daily high water level and mean daily low water level.

Good quality data is important to have a worthy result. Data quality has been checked before analysis. The errors in tidal data have been corrected manually. In case of an overestimation of tidal level, erroneous data are removed from that dataset. Some impractical values, such as same figure for high and low tides, are removed from the data set before obtaining a sea-level rise trend. A total of 31 data points have been identified as erroneous and have had removed manually.

10.4 Methodology

The PSMSL data are provided in the form of mean sea level (MSL) in millimetres (mm), but the water level data from BWDB and are provided as daily high and daily low water levels in metre (m). From the BWDB data, mean water level is calculated by averaging daily high and daily low water in metres, which is then converted to millimetres. The data obtained from BIWTA are in the form of mean daily water level in metres which has also been converted into millimetres. Mean yearly water level has been calculated and plotted in Excel. Finally, trends of mean sea level (MSL) have been calculated by linear regression.

10.5 Results

10.5.1 Sea-Level Change

Sea-level change obtained by analysing tidal data in 13 stations along the Bangladesh coast indicates significant variation in different parts (Fig. 10.3). The SLR at Hiron Point has been observed as 3.38 mm/year. However, SLR at Khepupara and Amtali have been obtained as 14.84 and 3.16 mm/year, respectively, although the distance between the two stations is only 17.5 km. Rayenda station is only 53 km away from Khepupara station but shows a SLR rate of 3.64 mm/year.

Sea-level rise along the central part of the coast shows an extreme increasing trend. SLR at the Char Changa station is observed as 5.73 mm/year but that at Hatiya Island and Tajumuddin stations is observed as 19.81 and 38.82 mm/year, respectively. SLR at the Char Changa station is calculated using data from PSMSL while data from BIWTA are used to calculate SLR at Hatiya Island and Tajumuddin stations. Companiganj station represents the Noakhali Feni coastal zone and shows a rise in sea level at the rate of 2.5 mm/year.

In contrast, sea-level change along the eastern part of the coast shows very low rise or fall but the Outfall Karnafulli station in the Chittagong coastal zone

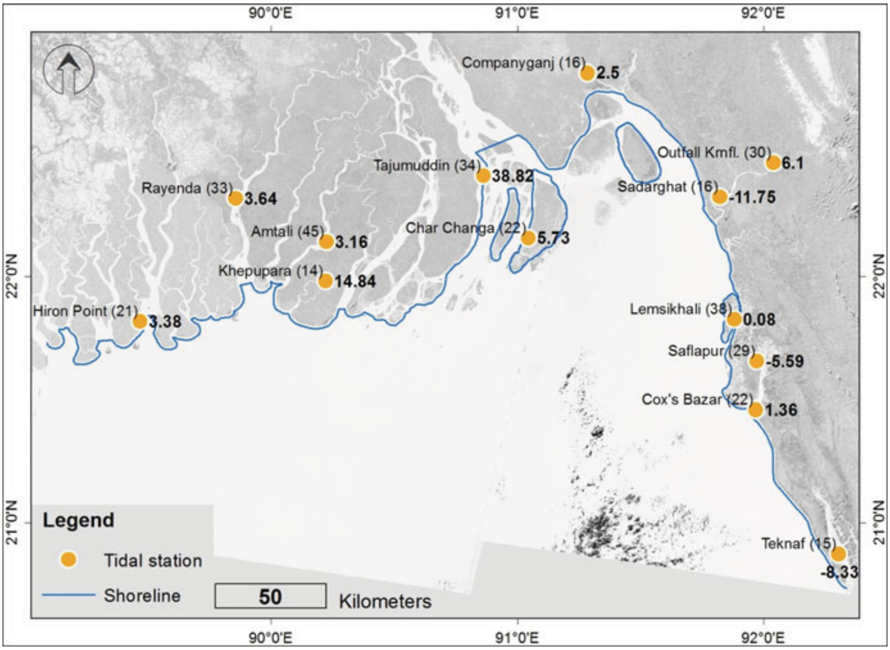

Fig. 10.3 Sea-level change at different tide-gauge stations along the coast of Bangladesh. The numbers in parenthesis are number of years of record used in the SLR calculation (data sources have been shown in Fig. 10.2)

demonstrates a SLR of 6.1 mm/year. However, Sadarghat, another tide-gauge station located in the same zone shows a sea-level fall of 11.75 mm/year. Sadarghat station is located at 15 km inland from the estuary and the Outfall station is located 30 km farther inland from Sadarghat. From the viewpoint of geographic location, the Sadarghat station is closer to the shoreline and represents a more reasonable sea-level change than the Outfall Karnafulli station. On the other hand, the eastern coastal zone of Bangladesh is treated as an active zone where uplifting is observed by Khan et al. (2005). However, a fall in sea level by 11.75 mm/year seems unusual compared to nearby Companiganj station.

Sea-level change along the Cox's Bazar coastal zone calculated from PSMSL data shows a rise of 1.36 mm/year. However, similar calculations from BIWTA data demonstrate a fall of sea level at the rate of 0.08, −5.59 and −8.33 mm/year at the Lemsikhali station on Kutubdia Island, Saflapur station in Moheshkhali Island and Teknaf station, respectively.

10.5.2 Sea-Level Rise Vulnerability of Bangladesh

A huge variation has been observed in calculated sea-level change along the coastal zones of Bangladesh. A wide range of variations between two close stations in the Barguna Patuakhali coastal zone, Bhola coastal zone and in Chittagong coastal zone have been observed. Therefore, logical sense of sea-level vulnerability has been used, instead of using numerical values.

Disregarding a high rate of SLR of 14.84 mm/year at Khepupara station, the southwest coastal zone shows a SLR of 3.16–3.64 mm/year. The Sundarbans coastal zone is believed to be subsiding by 2–4 mm/year (Goodbred and Kuehl 2000; Umitsu 1997). Thus, the relative SLR of the coastal zone becomes 5–8 mm/year because of this high rate of SLR, the southwest coastal zone has been considered as high vulnerable coast (Fig. 10.4).

The central coast demonstrated the highest rate of rise in sea level. The calculation revealed a SLR of 38.82 mm/year at Tajumuddin station in Bhola that seems to be an over estimation of sea-level change. Sea-level at Char Changa station in Hatiya Island has been rising at a rate of 5.73 mm/year. After incorporating local level subsidence, the rise can be more than 8 mm/year. Even if, the SLR estimation in Tajumuddin station demonstrates an overestimation, the coastal zone around Bhola and Hatiya Islands might have experienced the highest rate of SLR. Therefore, this part has been assigned as very high vulnerable coast (Fig. 10.4).

Companiganj station shows a SLR similar to the southwest coast. This station is located offshore with limited connection with the sea and may not represent true sea-level change of the coast. The coastal zone is located near the Meghna River estuary and might show high rates of sedimentation similar to the central coast. However, extreme sedimentation rates in the coastal zone may be compensating the rise of sea-level. Therefore, the extent of sea-level rise in the coastal zone has been treated as moderately vulnerable (Fig. 10.4).

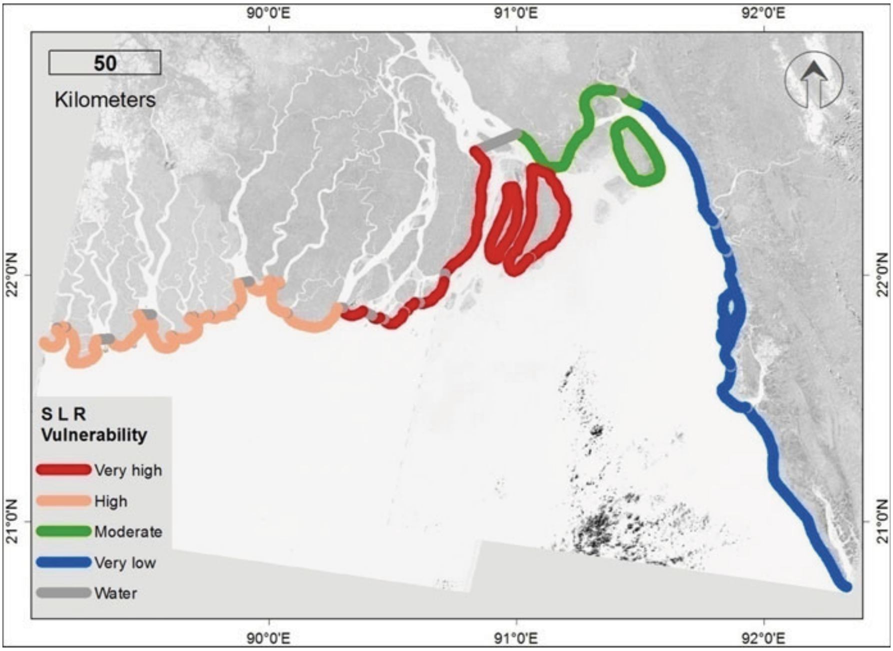

Fig. 10.4 Vulnerability of the Bangladesh coast to sea-level change

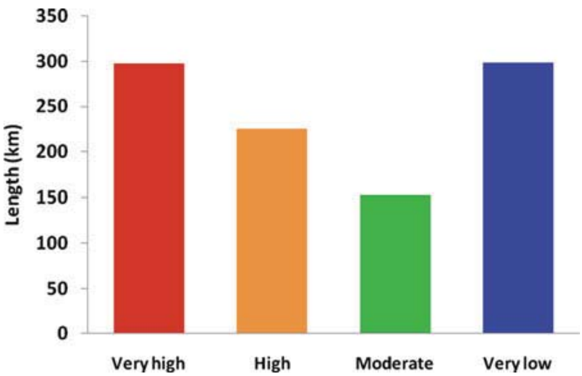

Fig. 10.5 Length of very high, high, moderate and very low vulnerable coast on the basis of sea-level change

Sea-level change along the eastern part of the coast of Bangladesh shows a falling trend, except for the Cox's Bazar station that demonstrates a SLR of 1.63 mm/year. However, this rise is also very low compared to the global SLR rate of 1.8 ± 0.3 mm/year (White et al. 2005). Therefore, the coastal zones of Chittagong and Cox's Bazar have been considered to be a very low vulnerable (Fig. 10.4).

Vulnerability classification has assigned a total of 298 km (Fig. 10.5) shoreline along the Meghna River estuary covering part of coastal zone of Patuakhali district, the whole of Bhola coastal zone and the coasts of Manpura and Hatia Islands as very high vulnerable coast (Fig. 10.4). High vulnerable coast is observed in the Sundarbans coastal zone and part of Barguna Patuakhali coastal zone covering a shoreline length of 226 km. Moderately vulnerable coastal zone has been identified along the shoreline of the mainland in the Noakhali coastal zone, a small section of Chittagong coastal zone and Sandwip Island. The length of moderately vulnerable coastal zone is 253 km and the length of very low vulnerability coast is 297 km which is located in the Chittagong and Cox's Bazar coastal zone. This southeast coastal zone shows a very low rate of sea-level rise.

10.6 Discussion and Conclusion

Bangladesh has got global attention because of potential threat from sea-level rise. Conversely, this study has found it difficult to calculate the rates of sea-level change along the Bangladesh coast. Data availability and data quality are great concerns in estimating sea-level rise. Tide-gauge data for four stations recorded in the RLR list of PSMSL are the most authentic data sources to calculate SLR in the coastal zone, but a rise of 19.14 mm/year in sea level at the Khepupara station seems unrealistic.

The coastal zone of a part of Patuakhali, Bhola, Manpura and Hatiya Islands covering the central coast is very high vulnerable, and the southwest coast is high vulnerable which is consistent with the present coastal setting. Sediment deposition in the central coast is dominated by silt but that in the Sundarbans is mud or mangrove. Therefore, apparent sea-level rise in the Sundarbans should be more than on the central coast because of possible greater compaction. However, the Meghna River estuary area might have experienced a higher SLR because of tectonic activity as well as compaction in the zone.

Tide gauge data from Hiron Point in the Sundarbans and nearby Amtali and Rayenda stations indicate sea-level rise similar to the global average. It has been revealed that the Sundarbans coastal zone was formed in the past few thousand years, and subsidence in the area is suspected by many researchers (Umitsu 1997; Goodbred and Kuehl 2000). Considering the probability of subsidence in the Sundarbans, coastal vulnerability in this zone has been identified as high vulnerable even though SLR in the Sundarbans area has been found to be normal. Because of similar land form in much of the shoreline in the Barguna Patuakhali coastal zone to the Sundarbans coastal area, compared to the mainland and smaller islands covering the rest of BPCZ. Therefore, this part of the shoreline has also been considered as high vulnerable.

Moderate vulnerability has been indicated along the Noakhali Feni Coastal zone. This zone receives the highest volume of sediments along the Bangladesh coast and is located in the vicinity of the Tippera surface which was attributed to uplift by Morgan and McIntire (1959). Geographic location near an uplift zone and receiving a high rate of sediment supply results in a low chance of higher sea-level rise in this zone. Therefore, Noakhali Feni coastal zone has been assigned as moderately vulnerable coast.

Because of low rates of sea-level rise or even the record of sea-level fall Chittagong and Cox's Bazar coastal zones very low vulnerability has been indicated in this eastern part of the Bangladesh coast. Vertical upward movement of land in this zone is causing a fall in sea level. The rate of SLR in the Cox's Bazar coastal zone calculated in this study (1.36 mm/year) is below the global average and indicates the effects of uplift in this area, which is with good agreement with Khan et al. (2005). Despite of a great concern of sea-level rise in southwest and central parts of the coast, eastern coastal zone can be considered as free from such fear.

For Bangladesh, tidal data is the only mode of verification of sea-level change, but quality tidal data are inadequate along the coast. There are frequent tide-gauge stations on the coast but hardly any of them have produced sufficient quality data to allow time-series analysis. Considering potential impacts of SLR on Bangladesh, there is an urgent need to collect and maintain quality data to portray a true picture of SLR along the coast. To collect reliable data, the tide-gauge stations in the country, the data collection methods and data archiving need to be reviewed. Furthermore, there is a great scope for application of sophisticated techniques including altimetry and the conversion of metric data to RLR to augment the meagre tidal records.

There has been much emphasis about the vulnerability of Bangladesh to sea-level rise, and potential sea-level rise impacts on the country are a focus of this study, but variations in the rate of SLR along the coast are still uncertain and incompletely known. Lack of tide-gauge data is one of the main constraints, and may explain why there has been insufficient research on sea-level rise for the Bay of Bengal. Data obtained from three different organizations revealed different sea-level scenarios.

Estimates of sea-level rise along different parts of the coast are inconsistent at the local scale but indicate a general pattern. For the southwest coastal zone a sea-level rise at the global average rate has been indicated, but results obtained by analysing tide-gauge data available for Khepupara station has shown an abnormal rate of about 15 mm/year SLR (Fig. 10.3). The SLR at nearby Hiron Point, Rayenda and Amtali stations have shown rates of 3.16–3.64 mm/year. The SLR obtained at Khepupara has therefore been disregarded. Nonetheless, after considering local subsidence, SLR vulnerability along the southwest coast remains high.

There is a general consideration that the Sundarbans mangrove forest is experiencing sediment deposition and the adjacent coastal zone are experiencing higher rates of SLR because of subsidence and sediment compaction. This has not been detected in the analysis of tide-gauge data. The land area of the Sundarbans zone may have reached sufficient sedimentary maturity over the past 10,000 years (since much of it was deposited), leading to less compaction. On the other hand, sea-level rise along the Meghna River estuary has been found to vary significantly. SLR on Hatiya Island is 5.73 mm/year but at Tajumuddin in Bhola Island is extreme (as high as 38.82 mm/year). In spite of an overestimation of SLR, Bhola Island may be subsiding at a rapid rate possibly in response to big sediment load and local tectonic activities. Sea-level change along the eastern part of the coastal zone has been found to vary but appears very low, or a fall, probably because of uplifting along the coastal zone.

Vulnerability is strongly related to the number of people affected by a hazard and their adaptive capacity. Hence the use of the term "vulnerability" in this study, which mainly assessed physical vulnerability of the coast toward sea-level rise, undermined its true meaning in the disaster literature or development community. The studies by Shaw et al. (1998) and Abuodha and Woodroffe (2010) have designated the term "sensitivity" instead, to explain the susceptibility of a coast. The assessment of vulnerability could be put into practice by integrated sensitivity with affected environment, population and their adaptive response variables.

Sea-level rise imposes the greatest threat to the coast of Bangladesh in its western part of the Meghna River estuary, including the islands of Bhola, Manpura and Hatiya, which is subject to sediment load and compaction induced subsidence. This part of the coastal zone is densely populated and the lands are very fertile. Furthermore, the coastal zone along the Sundarbans has been identified as high vulnerable. Planning to handle the sea-level change impacts in these coastal zones need management attention. These areas must be kept in top priority in dealing with this slow but highly destructive natural threat. In spite of scattered data availability, this study offers a generalized but potential vulnerability assessment of the coast to upcoming sea-level rise. This sea-level rise vulnerability map will assist coastal planners to handle the natural threat in more efficient way.

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