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MINISTRY OF WATER RESOURCES

BANGLADESH WATER DEVELOPMENT BOARD

MES II
MEGHNA ESTUARY STUDY

TECHNICAL NOTE MES-031

ANALYSIS OF SHORELINE CHANGES IN THE MEGHNA ESTUARY

June 2001

DHV CONSULTANTS BV

in association with

DEVCONSULTANTS LTD
SURFACE WATER MODELLING CENTRE

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1 INTRODUCTION

The Meghna Estuary is morphologically one of the most dynamic areas in the world. The enormous sediment load brought to the estuary by the Jamuna and Ganges Rivers and very strong flows in the estuary drive the process of a continuous reshaping of the estuary, migration of channels and banks, accretion and erosion.

Morphological development of the Meghna Estuary over the last decades has been analysed by the MES-project. Changes in the position of the shoreline have been determined from aerial photographs from 1957 and from a series of satellite images that covered the period 1973-2000, while migration of channels was derived from bathymetric surveys that were carried out by LRP and MES.

This report discusses the migration of the shoreline. An attempt is made to estimate the long-term development of the shoreline for the coming 30 years. This prediction is based on the trends during last 30-40 years, and enhanced with the knowledge of the area gathered during MES. A prediction based on trends is not very accurate yet it gives an indication of the changes that should be expected in the estuary.

2 APPROACH AND METHODOLOGY

2.1 Approach

The analysis of morphological development in this study is based on the analysis of aerial photographs and satellite images. Good quality topographic maps in 1:50 000 scale based on aerial photographs of the project area, taken in 1956-57 were available to the project. From these photographs positions of shoreline were derived. Since 1973, when earth-observing satellites became operational, accurate images of the study area became available. The satellite image data of the Meghna Estuary study area consist of 8 sets of four Landsat frames taken in the period between 1973/74 and 2000. The ground resolution of the image sets varies from approximately 80 m * 80 m grid for the image sets of 1973/74, 1979 and 1984 to a ground resolution of about 30 m * 30 m grid for 1990, 1993, 1999 and 2000.

Each of the satellite images was georeferenced by using well-distributed ground control points. Standard 50 ground control points were selected for georeferencing each of the images in the time series. After georeferencing, a single satellite mosaic was made for each period from the four frames using the Bangladesh Transverse Mercator (BTM) map projection. BTM is based on the 90 degree central meridian and the Everest ellipsoid. The X-Y coordinates of BTM metric grid are established by designating a false easting of 500 000 meters and a false northing of –2 000 000 meters from its origin at 0 degree North (equator) and 90 degrees East.

The Landsat mosaic covers the entire Meghna Estuary system from the northern border at Chandpur to the seaward border at Chittagong, an area of 16,050 km^2.

From each satellite image, the shoreline was digitised and converted to AutoCad. This way the position of the river banks and coastlines over the years was stored as digital contour lines for further processing, and changes in the position of the river banks were visualised (Figure 1). An overall analysis of changes over the years has been carried out. This included analysis of changes to the position of banks, areas of accretion, new land appearing in the area, and areas of erosion.

Several regions of special interest have been selected for further analysis. The following areas have been considered in detail:

- Chandpur and North Bhola
- Bhola - Manpura - Hatia
- Sandwip - Chittagong mainland
- Noahkali - Char Balua

The geomorphological features in the estuary have generally a north-south orientation that coincides with the direction of the Lower Meghna. The largest islands: Bhola, Hatia, Sandwip have an elongated shape with the longest shoreline in the north-south direction. The main morphological changes in these areas (erosion / accretion) occur perpendicular to the shoreline i.e. in the east-west direction. This is the case for Bhola, East/West Hatia and Sandwip, and approximately for the mainland south of Chandpur. The direction in which Noakhali mainland accretes is more southward. For the global analysis of the shoreline movement, it has been assumed that the analysis of the changes in the *north-south direction* along the Noakhali coast and North Hatia, and in the *east-west direction* in the other areas will give a sufficient insight into the morphological development.

The analysis of shoreline changes has been carried out by deriving the positions of west and east banks (north bank in the case of Hatia and Noakhali mainland) along about 200 transects spaced at 1000 m to 2000 m intervals. The bank positions of all transects have been obtained from the

intersection of the transects with the banklines and stored in a spreadsheet. The eastings of the banklines (northings in the case of Noakhali-Char Balua and Hatia North) have been plotted as a function of time, and trends were identified. Regression analysis has been carried out to obtain an approximation for the migration rate of the shoreline. The time series of 1956-1996 has then been used to forecast the shoreline position of 2000. Next, the results have been compared with the position of the actual shoreline of 2000 digitised from satellite image. This gave an indication of accuracy of the method. Comparison showed also locations where the trend changed during the last decades due to rapid morphological changes, mostly after major floods (as floods carry a lot of sediments and higher velocities during floods cause erosion). The length of the time series has then been modified to compensate for this change. Finally, the computed regression lines have been extrapolated to find an approximation of the future position of the banklines.

2.2 Methodology

2.2.1 Trend Analysis

The eastings (northings in the case of Noakhali mainland and North Hatia) of the banklines plotted as a function of time in the period 1957-2000 for the west bank of the Lower Meghna River from Chandpur to the d/s of Char Gazaria are shown in Appendix A just as an specimen. An approximately linear trend in the bankline movement can be observed in the major part of the Meghna Estuary.

Trend analysis of the bankline movements has been carried out. Positions of the bankline in each transect over the period 1957-2000 are used to calculate the trend. The slope of the trend line gives an average migration rate of the bankline in a transect.

2.2.2 Estimation of Accuracy

The computation of trend in the shoreline movement is prone to errors. The main sources of errors are: (i) inaccuracy in determination of bankline position, and (ii) changes in trend / non-linearity of trend.

The inaccuracy in exact positioning of the bankline from digitised satellite images is caused by:

- limited resolution of satellite image (80m * 80m for the series 1973 to 1984, and 30m * 30m for later images);
- different position of land-water boundary because of variation of water level; in a tidal environment, the position of land-water can be clearly defined only in areas of excessive erosion (e.g. north-west Hatia, north-east Bhola). Eroding river bank is often nearly vertical and the position of land-water boundary does not change much with variation in water level. In other areas, the position of land-water boundary will change with the changing water level. This will introduce an error in the trend analysis, as the satellite images were taken at different moments in tidal cycle. Especially in the areas with gently sloping banks and large tidal amplitude (e.g. Chittagong and Noakhali mainland), position of land-water boundary can vary to more than 100 m during one tidal cycle.

Trends in shoreline migration may change over the years, and erosion may change to accretion, or the rate of migration may slow down due to changed hydraulic conditions. E.g., an area on west bank of Lower Meghna near Gosairhat (opposite Haimchar on the east bank) accreted steadily until end of 80's and is now eroding.

The accuracy of the regression is estimated by means of the statistical methods. For each point, the correlation coefficient (R^2) has been calculated. To obtain more insight in the accuracy of computed migration rates, a statistical method has been applied to calculate a 95%-confidence interval.

The standard error of the regression can be computed as follows (Bethea et al., 1988):

$$\sigma_{x|y} = \sqrt{\{ [\sum (Y-\bar{Y})^2 - b^2 \sum (X-\bar{X})^2]/(N-2)\}} \qquad (1)$$

where:

$\sigma_{x\|y}$	standard error
Y	dependent variable (in our case: easting)
$\bar{Y}$	mean value of Y
X	independent variable (in our case: time)
$\bar{X}$	mean value of X
b	slope of the regression line Y=a+bX

The standard error σ_b in the determination of the slope coefficient *b* (migration rate) can be determined as follows (Blalock, 1983):

$$\sigma_b = \sigma_{x|y} / \sqrt{\sum (X-\bar{X})^2} \qquad (2)$$

The 95% confidence interval for *b* can be computed from the t-distribution with N-2 degrees of freedom (N= number of data points):

$$b \pm \sigma_b * t_{95\%}. \qquad (3)$$

The confidence interval for Y_i (estimate of bankline position in year Xi) can be calculated as follows (Bethea et al., 1988):

$$s_y^2 = [1 + 1/N + (X_i-\bar{X})^2 / \sum (X-\bar{X})^2] * \sigma^2_{x|y} \qquad (4)$$

and:

$$Y_{i,95\%} = Yi \pm s_y * t_{95\%}. \qquad (5)$$

where:

s_y^2	variance of Y
$Y_{i,95\%}$	95% confidence interval for Y_i

2.2.3 Extrapolation of trend

Trends in bankline movement have been used to obtain a prediction of future bankline position at intermediate and long term (15 and 30 years). The method used was based on linear extrapolation of the existing trend. The outcome have been compared with the morphological development expected based on other information, and if necessary, adapted. Also other extrapolation methods (square, exponential, logarithmic) were tested. No significant difference between the methods was found.

In Figure 2, an example of extrapolation of trend including 95% confidence interval is presented.

3 RESULTS

3.1 General

The average rate of migration for each transect is estimated by linear regression of the bankline position over the period 1957-2000. The slope of the trend line gives an average rate of shoreline migration in a transect in the considered period of time. Results of the analysis are presented in Appendix B.

At the east-side of the Lower Meghna Estuary, retreat is indicated by a positive sign and accretion by a negative sign. At the west-side, the positive sign indicates accretion and the negative sign erosion. In the following chapters, the observed changes of the shoreline will be discussed. First, an overall analysis will be presented, followed by an area-wise discussion of observed development.

3.2 Areas Dominated by Accretion and Erosion

A series of six satellite images of the Meghna Estuary covering the period 1973 to 1999 is presented in Figure 3 to illustrate the dynamics of this area. Growth of vast area of new land off the Noahkali coast and Char Bouye can be observed which is associated with an even larger area of mud flat which appears to be emerging land. Between 1996 and 2000 new large chars appeared in this shallow area.

There are new char areas and new areas of mud flats north-west of the Sandwip Island, which continue to grow at a high rate. Other large areas of accretion include the very large char in the Lower Meghna Channel which appears to be a consolidation and extension of Char Gazaria. New chars formed at the north of Manpura. There is a significant accretion at the north-east of Nijhum Dwip, extending this island towards Hatia. A char right at the east of the channel between Hatia and Nijhum Dwip continues to emerge from the large mud flat.

Filling and enlargement of chars in the extreme south-west of the study area, including Char Rangabali, Char Montaz and Char Kukri Mukri is observed.

Most areas of erosion are associated with widening and migration of the main channel of the Lower Meghna River and the Shahbazpur and Hatia Channels. The northern end of Hatia retreated by about 5 to 9 km in the period 1973-2000. In the period 1990-2000 the bankline retreated by about 2.5 to 3.5 km. Also the east bank of Bhola suffers from severe erosion, the most erosion-prone area is found at the west of Char Gazaria. It is believed that these areas are sensitive to changes in river and sediment discharges and migration of thalweg.

Trends in shoreline migration agree in general with the recent bathymetric changes found using data from surveys in 1997 and 2000 (MES, 2001). Generally, significant bank erosion is associated with the widening of the river system and migration of deep conveyance channels towards river banks.

3.3 Shoreline Migration in the Area between Chandpur and Daulatkhan (Northeast Bhola)

The shoreline migration in the Chandpur - North Bhola (Figure 4) area is strongly related to the lateral migration of the tidal-river system. The northern part of the Lower Meghna River system has a wide, shallow, braided distributary system. Channels bifurcate, are separated by shallow shoals and islands and are choked by silty sediments.

The west bank of the Lower Meghna River starting from the downstream of Chandpur towards south up to the northing of about 530 000 N (north of Mehendiganj) shows net accretion (average accretion

is about 4 km) and the same bank starting from the north of Mehendiganj towards south up to about 500 000 N (Daulatkhan) experienced net erosion (average erosion is about 2.4 km) between the period 1974-2000. The rate and time trends differ in detail due to local influences such as changes in the growth or erosion of primary island-chars.

Movement of the west bank was more unsteady during the 70's and 80's. Particularly in the areas between Chandpur and North Bhola (533,000 N – 560,000 N) the shoreline moved eastward due to rapid siltation. These peaks of rapid accretion corresponded to the shift of the main channel in an eastward direction that created new island-chars at the west bank. Late in the 80's the chars consolidated and formed new bankline. This area is now subject to severe erosion. The average erosion rate of the west bank in the area between (533,000 N- 560,000 N) over the period 1990-2000 varies from 50 m/yr to more than 300 m/yr. A large char (Char Bhairabi) developed in the main channel during the 90's. It is accreting towards the west deflecting the flow towards the west bank and causing severe erosion.

Between 1974 and 2000 the east shoreline moved steadily eastward along most of its length. Only the area between (508,000 N – 516,000 N) remained relatively stable over the last decades. The maximum retreat is found downstream of Chandpur (550,000 N – 565,000 N) and near Char Alexander (495,000 N – 505,000 N). The average retreat of the shoreline is about 90 to 300 m/yr. The areas correspond to embayments cut by flow deflected around growing bars and new island-chars near the east bank anabranch of the Lower Meghna River. The bank movement at the level of Char Gazaria is related to the migration of the East Shahbazpur Channel to the east.

The impact of high monsoon floods during 1987-1989 and in 1998 in generating accelerated shoreline retreat can be identified in nearly all transects. It can be concluded that the position of the shoreline is very mobile and sensitive to changes in hydraulic conditions. Chars in the Lower Meghna migrate in the downstream direction.

3.3.1 Shoreline Migration in the Area Bhola - Manpura - Hatia

The west bank of Hatia shows a net retreat of the shoreline to the east (Figure 5). The rate of erosion varies between 5 to 50 m/yr.

The east bank of Hatia from 468 000 N to about 482 000 N experienced net erosion and the same between 442 000 N and 467 000 N experienced net accretion between 1974 and 2000. The maximum bank erosion takes place at the northern head of the island. The rate of erosion is very close to 300 m/yr. This is related to the migration of the Hatia Channel to the south. Data from all the transects indicate that the island is migrating in south-east direction.

The long term shoreline migration of Manpura shows erosion at the west bank and both erosion and accretion at the east bank. The migration rate of the shoreline varies 1 to 25 m/yr at the west bank and from 2 to 20 m/yr of erosion and 2 to 35 m/yr of accretion at the east bank. Infilling of channels occurred between the islands in Manpura which joined together to shape the island. There is a tendency of lengthening in the southern direction.
The small islands between Manpura and Hatia, and between Hatia and Bhola are relatively young islands which started to emerge during the 1970's and 1980's. These islands silted up vary rapidly and extend in southern direction. The shoreline of these islands during the last decades shows a natural tendency to shift in a southward direction. Between 1993 and 2000, large chars emerged right north and northeast of Manpura.

Nijhum Dwip is a relatively young island that started to emerge in the 1950's. During the 1970's and 1980's the higher parts of Nijhum Dwip silted up rapidly to about mean higher high water level. The

coastline migration during the last decades shows a natural tendency to extend in an eastward direction.

Analysis of the shoreline development of Damar Char over the last decades indicates that the island started to emerge in the 1980's. The uncovered accreted intertidal areas around Damar Char show a tendency to silt up rapidly.
The shoreline migration of Bhola shows a long-term trend of erosion. The bank erosion rate decreases slightly in southward direction. The long-term bank erosion rate varies from 10 to 150 m/yr. The southern part of Bhola shows a tendency of accretion. The accretion rate in the southern part is about 10 to 60 m/yr.

3.3.2 Shoreline Migration in the Area Sandwip - Chittagong Mainland

The shoreline migration of the Chittagong mainland shows an overall tendency to shift in westward direction (i.e. accretion, see Figure 6). The migration rate increases in northward direction. The rate varies from 5 to over 150 m/yr. The maximum migration rate is found around the inlet of the Feni River. During the 1980's and 1990's erosion of the coastline is found near the entrance of the Karnafuli River. The erosion process has now stopped due to coastal erosion protection measures.

The east and west banks of Sandwip show a tendency to erode. The migration rate is about 10 to 100 m/yr. The shoreline development at the northern head of Sandwip over the last decades shows a trend of severe erosion during the 1970's, 1980's and the first half of 1990's. This trend reversed during 1996-2000. the movement of the shoreline indicates emergence of a large mudflat at the northern head of the Sandwip Island. Urir Char is a very dynamic island that tends to move in north-east direction. The south-western part of Urir Char shows a long-term trend of erosion.

3.3.3 Shoreline Migration in the Area Noahkali - Char Balua

The shoreline development in the southern part of Noahkali mainland over the last decades indicates a long-term trend of accretion (Figure 7). The accretion rate varies from 50 to about 400 m/yr. Erosion of the shoreline can be recognised near Char Balua due to migration of the tidal channel in northward direction. The erosion rate varies from 80 to 200 m/yr.

3.4 Prediction of bankline movement

The positions of banklines in each considered transect have been calculated by means of linear extrapolation of eastings (northings in the case of Noakhali) in time. Two time horizons have been considered: 2015 and 2030. The above described statistical method has been applied to find the accuracy of the predicted bankline positions. Points with low relative accuracy of migration rate have been disregarded. The calculated new positions of bankline points are used in this analysis only as an indication of the future position of the shoreline. Observed trends are compared with information from bathymetric surveys (MES, 2001), and expert knowledge of the morphological processes is used to confirm the trends and to find an indicative position of the shoreline in the considered areas in 2015 and 2030.

The predicted bankline positions are presented in Figure 8 and Figure 9. Also the points used for prediction and the points giving 95%-confidence interval are plotted in the same figures.

In the prediction it is assumed that the erosion trend of north and east banks of Sandwip will not continue as mud flats along these banks emerged over the last years and according to visual observations in 2000 they became land. Also, it is assumed that the erosion trend of the northern head of Hatia will continue, but will be much more pronounced at the eastern side due to flow constriction in the North Hatia Channel caused by the growth of Noakhali mainland, while the erosive forces of flow on the western side of island's head will decrease. Extrapolation of trends indicates that extreme

erosion will occur at the west bank of Lower Meghna at the level of Char Bhairabi. However, analysis of cross-sections in this area (MES, 2001) shows that the main conveyance channel migrates towards the east bank, therefore the rate of erosion is expected to be less than according to the trend.

According to the above-mentioned analysis, large shoreline movements are expected in the following areas:

- west bank of Lower Meghna near Gosairhat (opposite Haimchar on the east bank, in the northern part of the project area), which will continue to erode severely. This is related to the migration of channel to the west and the development of a large char in the middle of the river;
- east bank of Lower Meghna near Haimchar, which will continue to erode. This movement is related to the migration of the main conveyance channel towards the east bank;
- west bank downstream of Khorki to North Bhola and east bank downstream of Haimchar which will continue to erode due to migration of channels towards west and east respectively, resulting in widening of the river;
- area Char Bouye – Noahkali mainland: the massive accretion in this area will continue, causing southward migration of the Hatia Channel;
- the northern head of Hatia which will continue to erode excessively due to above mentioned movement of the Hatia Channel to the south;
- mouth of Feni which will continue to accrete;
- east, west and south banks of Sandwip where some erosion is expected.

3.5 Accuracy of prediction

The accuracy of the trend analysis has been assessed by making a forecast based on the bankline positions of 1973-1996 and by comparing the predicted bankline position with the actual digitised bankline of 2000 (i.e., extrapolation over a period of 4 years). In the locations where large disagreement with the present bankline position is found, the time series has been shortened to compensate for the changing trend. The results of comparison are presented in Figure 10 and in the numerical form in Appendix C. Generally, a good agreement with the actual position of the bankline is found. The erosion of the east bank near Ramgati is underestimated. The accretion of Noakhali mainland is overestimated. East bank of Sandwip extends more to the east than according to prediction. This could be attributed to the above mentioned inaccuracy in determination of bankline position in this area with large variations in water level (the result is quite consistent with the shoreline development during the years).

Besides the calculated migration rate, also results of the statistical analysis are presented in Appendix B. Relative inaccuracy, expressed as ratio of half-width of 95% confidence interval ($\sigma_b * t_{95\%}$) and migration rate, gives an indication of expected margin of error. For most of the points this value is less than 40-50%. Higher values relate either to very inconsistent bank movements, or low migration rate, which makes the calculation of standard error very inaccurate. Also points, which are located on a bank not perpendicular to the direction of analysis give in general large error. This is in particular the case for points on the southern or northern edge of islands. Erosion causes a change in the direction of the shoreline, which may even become parallel to the transect. Very high values (more than ca. 500%) of relative inaccuracy, which can be seen in the tables in Appendix B, are caused by missing values in the dataset, which confuses computation of standard error.

4 CONCLUSIONS AND RECOMMENDATIONS

The goal of the present study is to provide a rough indication of the long-term morphological development of the Meghna Estuary. An empirical method for predicting of the development of the coastline has been developed. Analysis of trends in the bankline migration shows that this development can reasonably be described by linear regression combined with expert knowledge of the morphological processes in the study area.

The prediction method is based on some crude assumptions (e.g. only south-north, east-west movement is considered). Furthermore, a data series of at maximum 44 years (27 years in most of the cases) is used for extrapolation 30 years ahead. This causes a significant uncertainty. An attempt is made to quantify this uncertainty. It is assumed that areas which were eroding during last decades would continue to erode in the future, and that the areas with a high rate of change would not slow down rapidly. However, *the outcome of this study should serve purely as an indication of the possible development of the coastline.*

In the future, it is recommended to take into account the actual orientation of the shoreline. Although the banks of many islands are oriented North-South, there are parts which are oriented South-West or South-East. Transects should be drawn perpendicular to the bankline. This should enhance the accuracy of prediction. The database of shoreline positions should be frequently updated, and the predictions corrected for changing trends. Changes to the banklines of the Tetulia River should also be included in the analysis.

FIGURES

Figure 1: CHANGES OF THE SHORELINE IN THE PERIOD 1973-2000

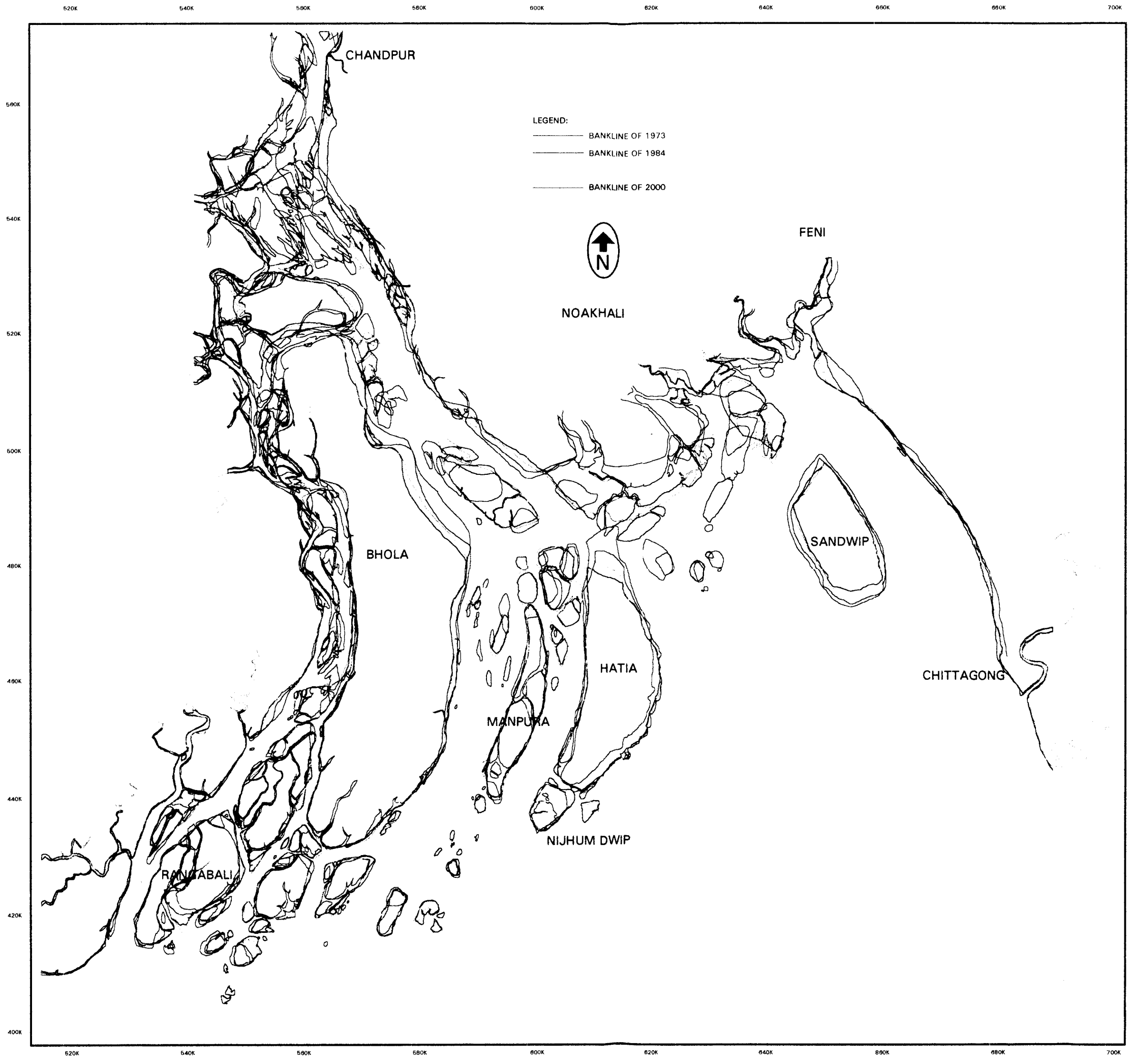


Figure 2: Example of extrapolation of the shoreline migration trend in a transect on East Bank of Bhola

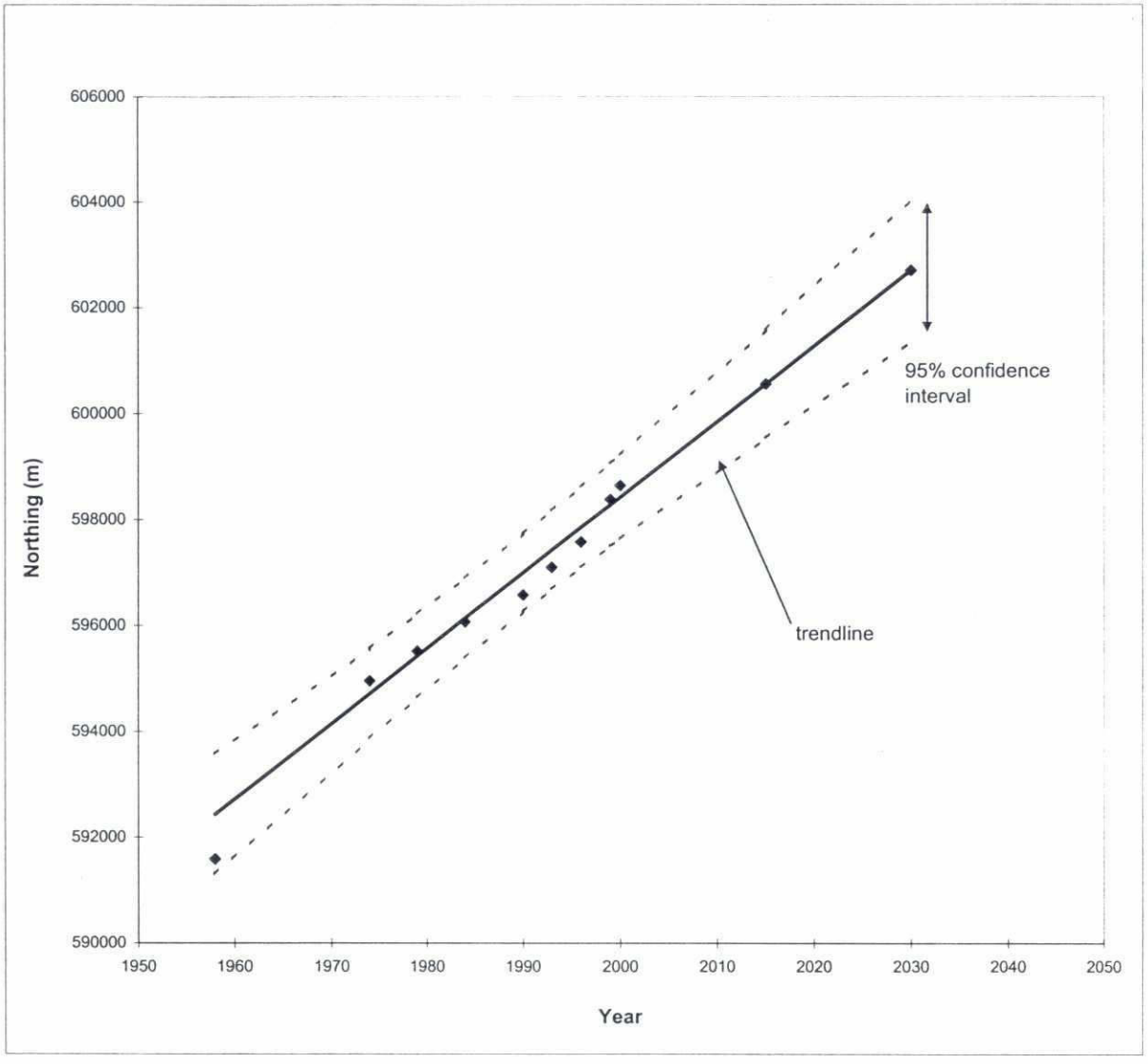


Figure 3. Satellite images of the Meghna Estuary in the period 1973 – 1999

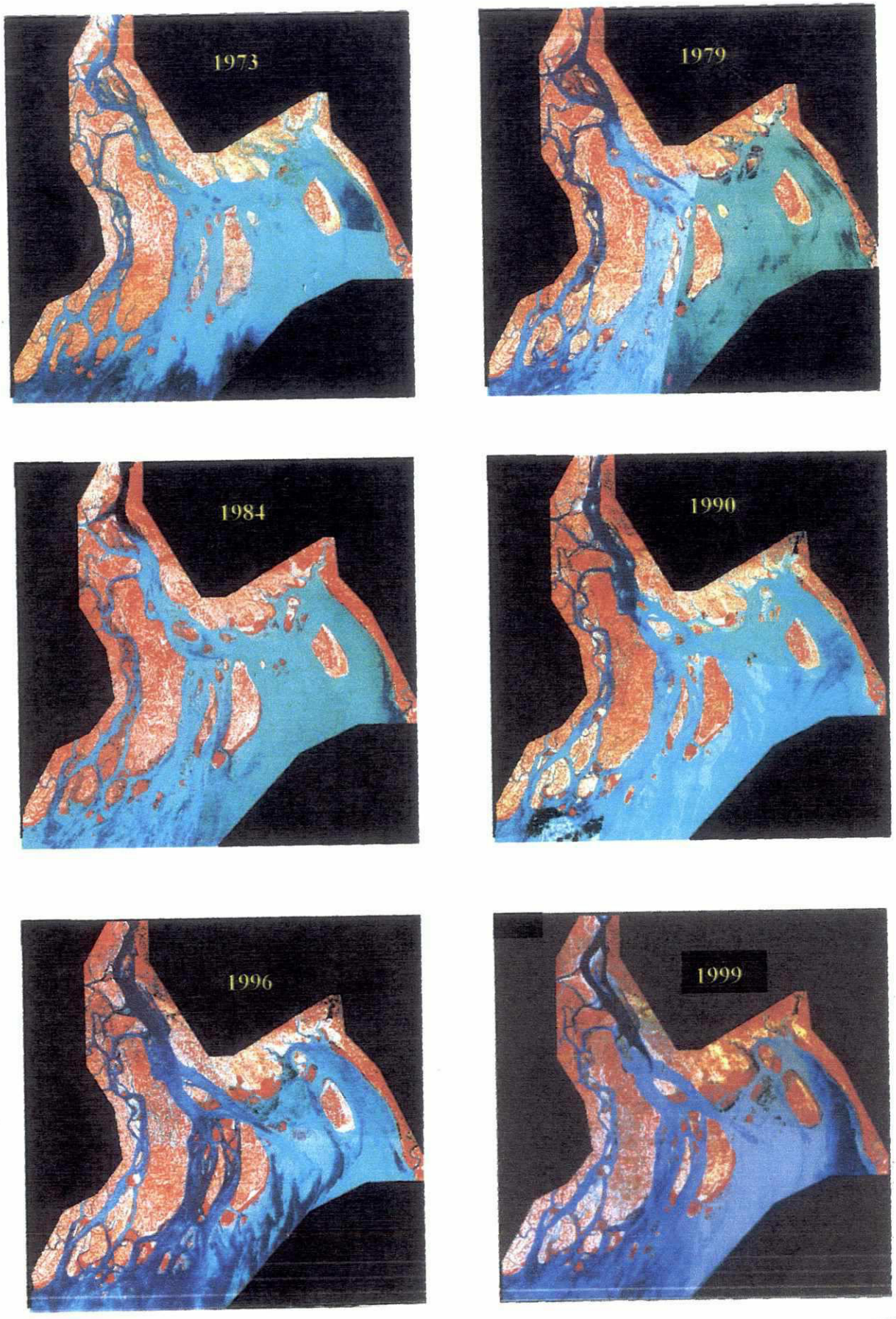


Figure 4: Shoreline migration in the area Chandpur-Daulatkhan during 1973-2000

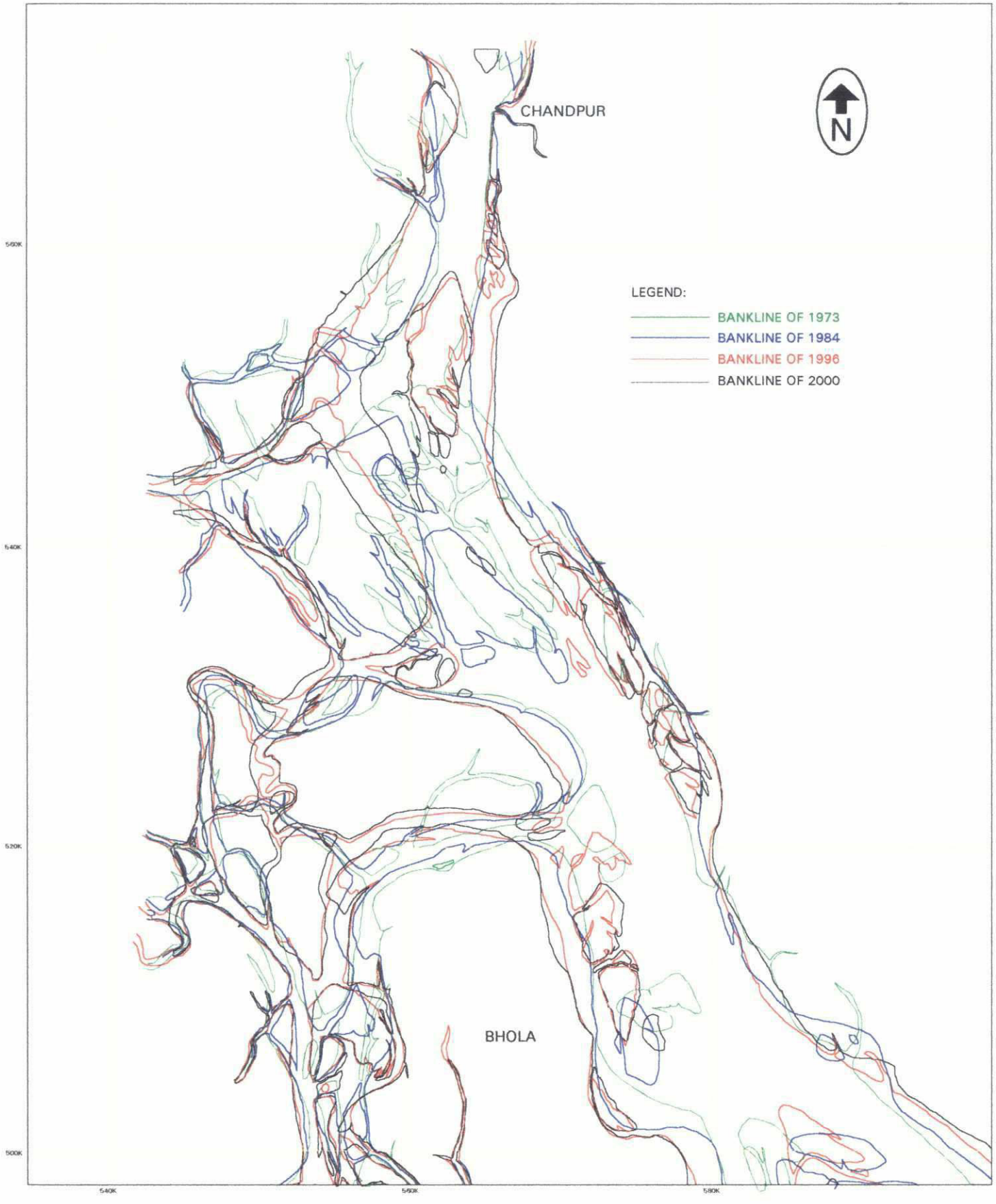


Figure 5: Shoreline migration in the area Bhola-Manpura-Hatia during 1973-2000

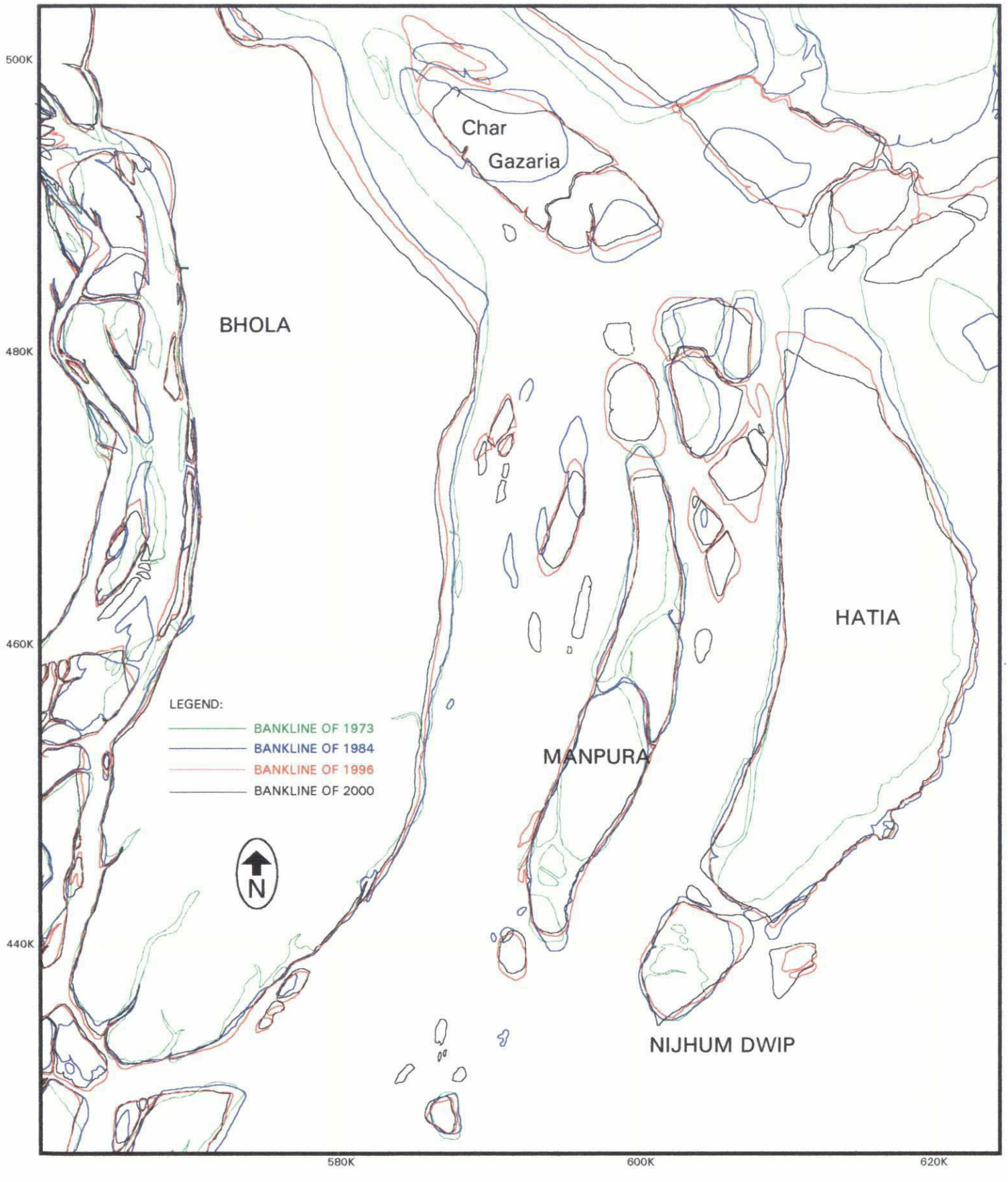


Figure 6: Shoreline migration in the area Sandwip-Chittagong during 1973-2000

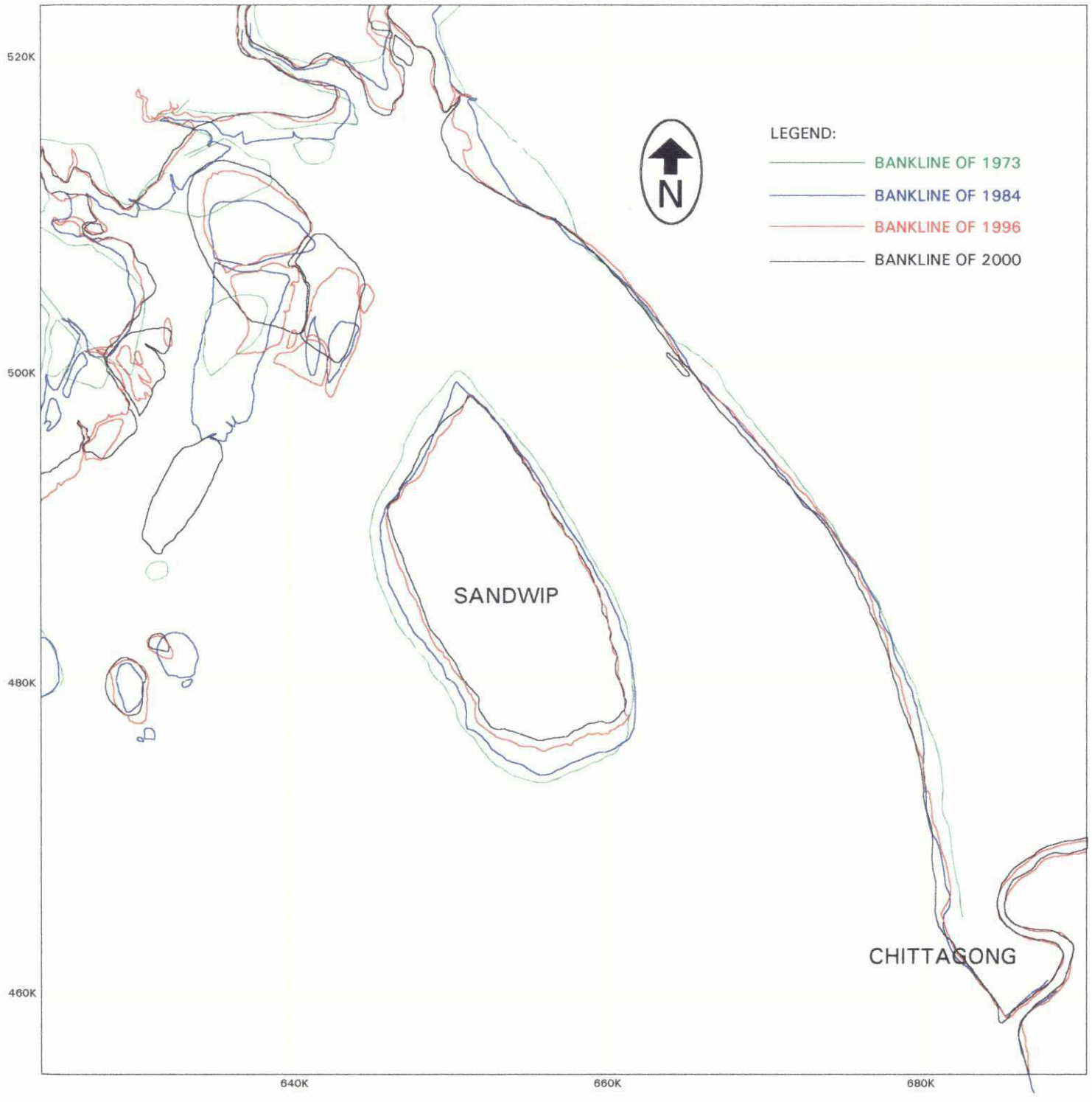


Figure 7: Shoreline migration in the area Noakhali-Char Balua during 1973-2000

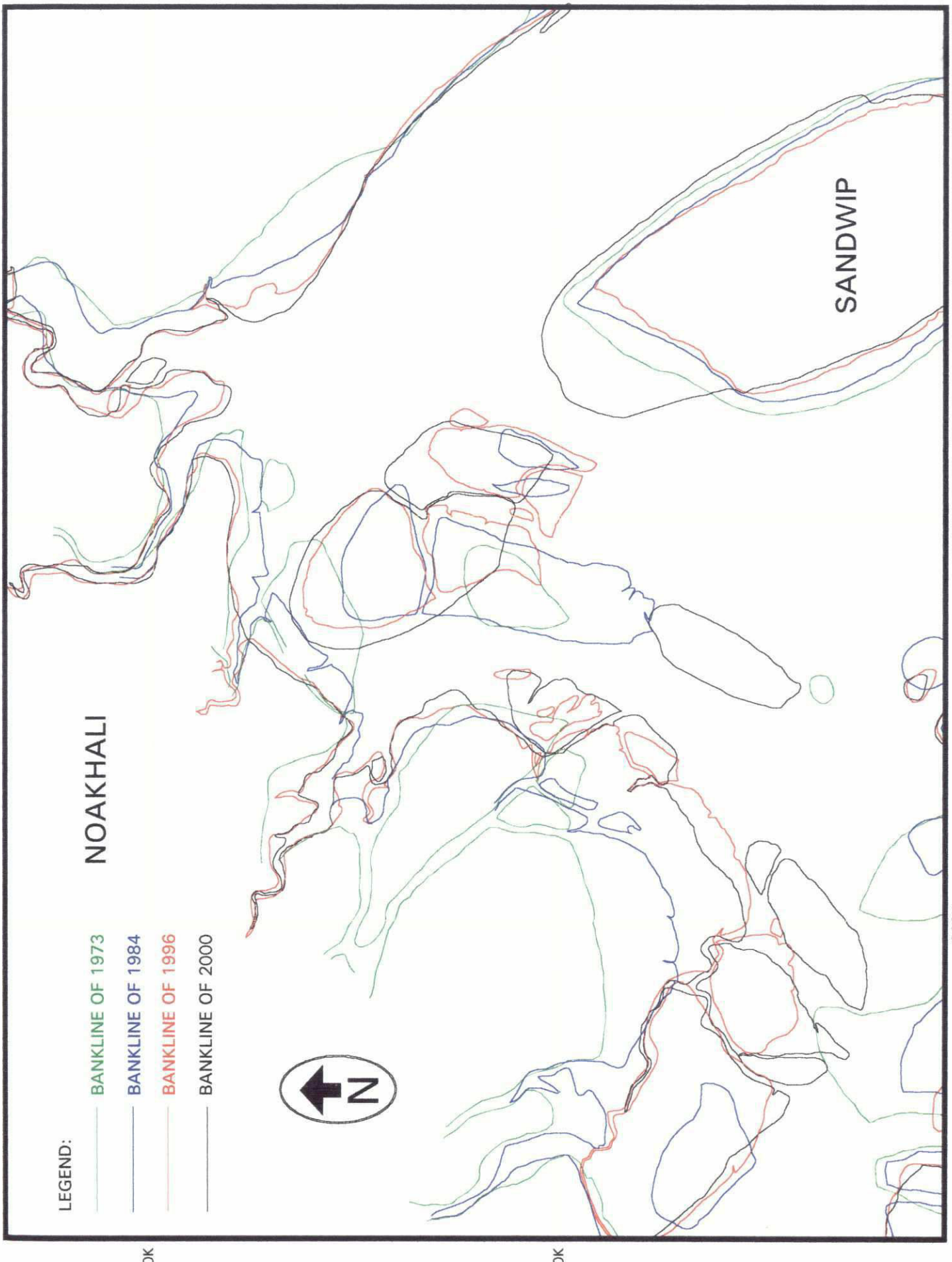


Fig. 8: Predicted shoreline position in 2015

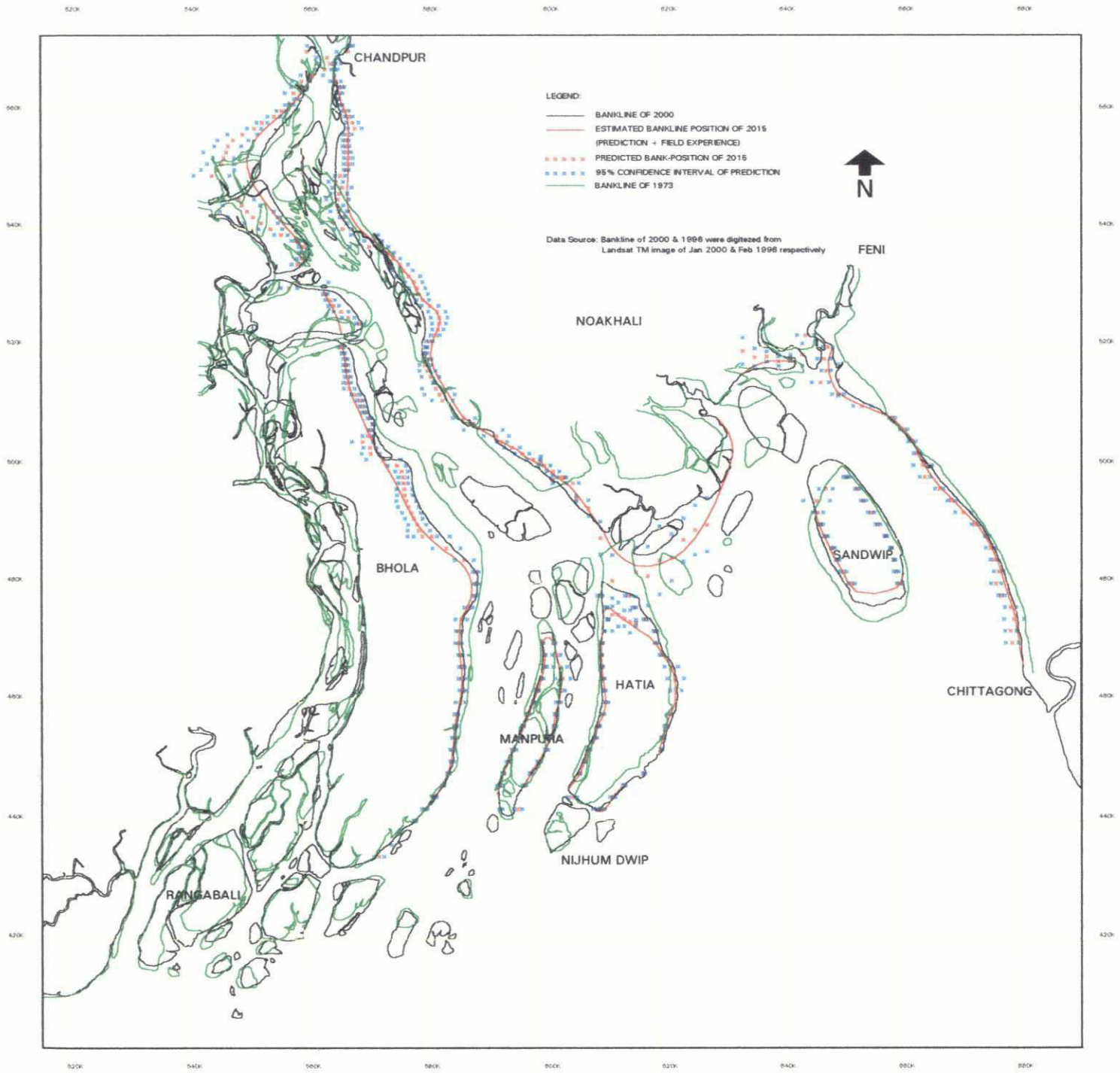


Fig. 9: Predicted shoreline position in 2030

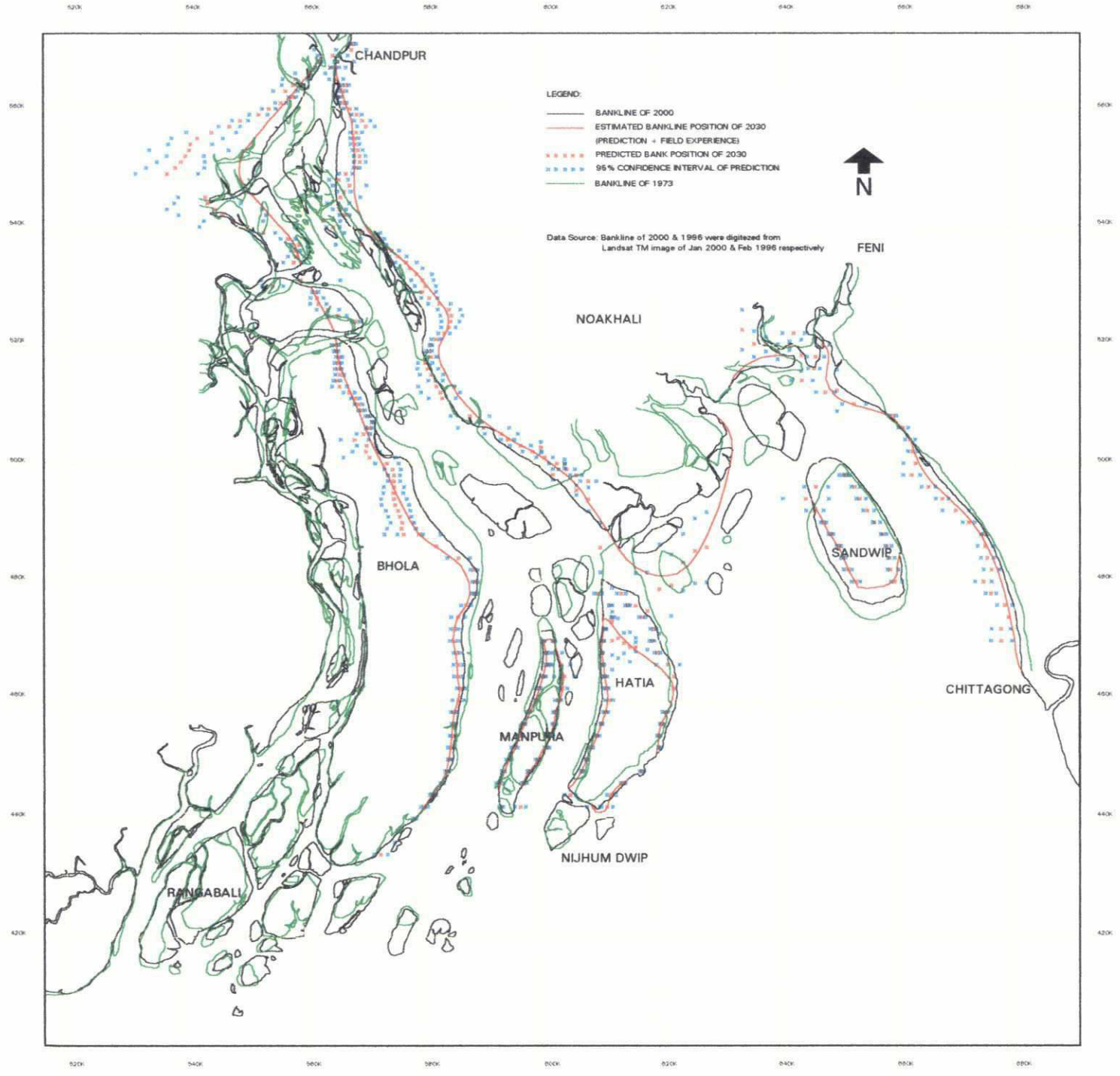
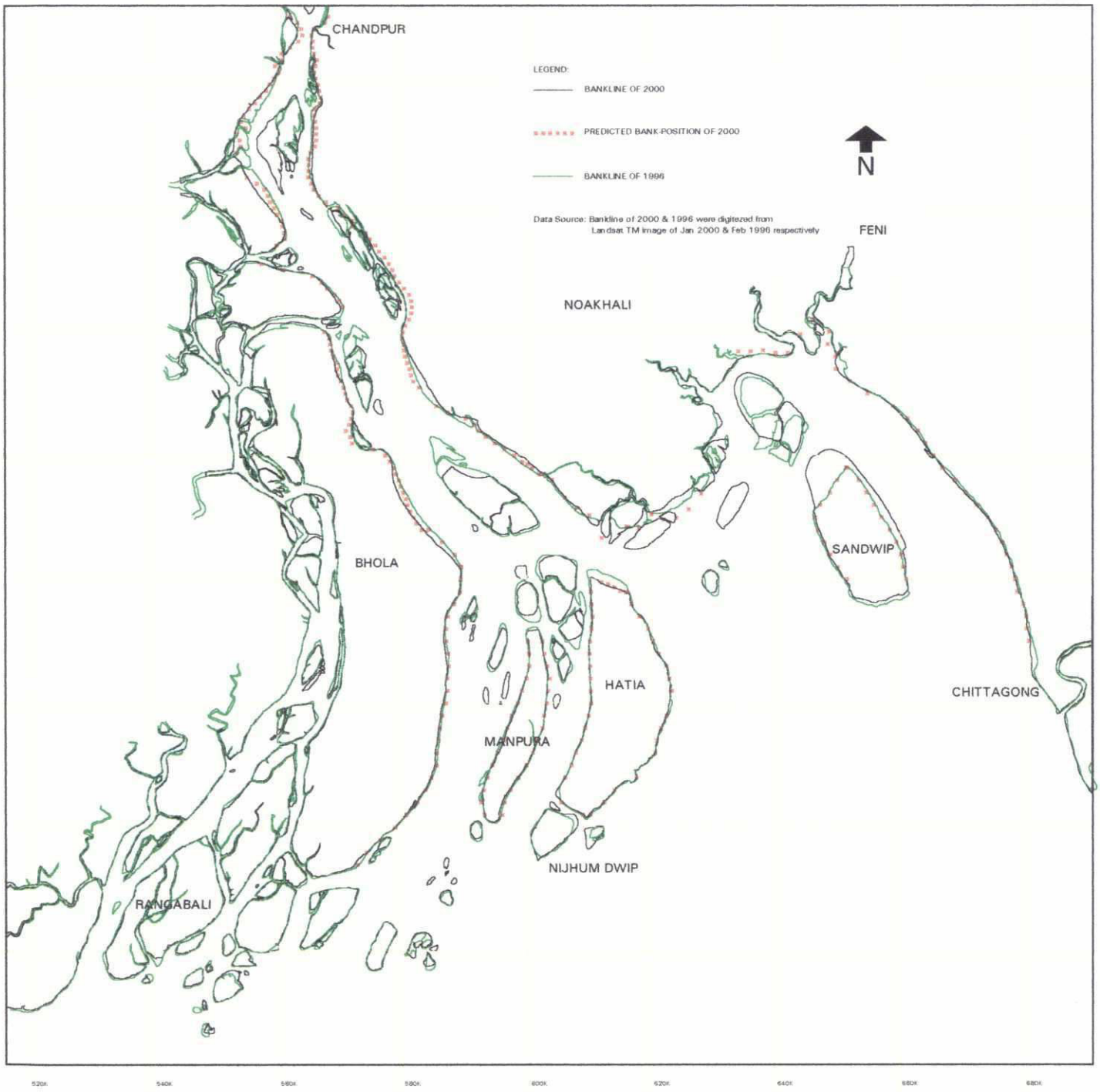
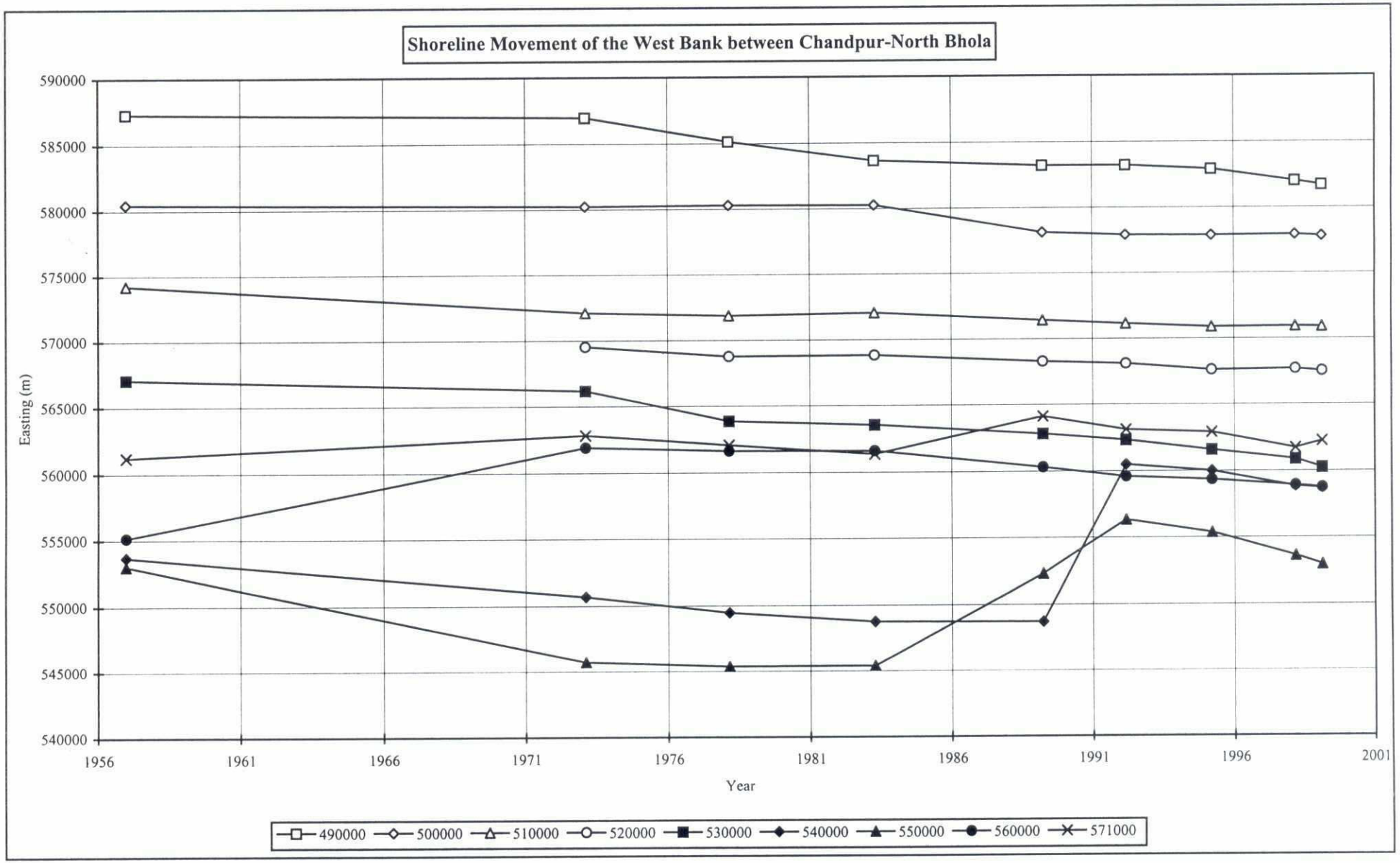


Figure 10: Comparison between predicted and actual shorelines of 2000



APPENDIX A


Shoreline Movement of the West Bank between Chandpur-North Bhola
590000
585000
580000
575000
570000
565000
560000
555000
550000
545000
540000
Easting (m)
1956
1961
1966
1971
1976
1981
1986
1991
1996
2001
Year
490000
500000
510000
520000
530000
540000
550000
560000
571000

APPENDIX B

Longterm Shoreline Migration Rate (from 1957 to 2000)
of West and East Banks between Chandpur and North Bhola

Northing	West Bank				East Bank			
	Migration Rate (m/yr)	R^2	half-width 95% confidence interval (m/s)	half-width 95% confidence interval (%)	Migration Rate (m/yr)	R^2	half-width 95% confidence interval (m/s)	half-width 95% confidence interval (%)
488000	-214.0	0.86	67.3	31%				
489000	-198.0	0.91	50.4	25%				
490000	-172.2	0.92	40.8	24%				
491000	-162.4	0.91	40.4	25%				
492000	-154.4	0.89	42.2	27%	109.3	0.87	85.3	78%
493000	-151.8	0.86	47.9	32%	92.6	0.85	81.3	88%
494000	-145.0	0.87	44.6	31%	84.2	0.97	n/a	n/a
495000	-134.6	0.90	35.0	26%	88.5	0.99	n/a	n/a
496000	-122.0	0.88	35.6	29%	167.1	0.65	n/a	n/a
497000	-112.8	0.95	21.5	19%	174.0	0.96	27.7	16%
498000	-106.0	0.94	21.0	20%	161.3	0.98	20.2	13%
499000	-105.5	0.90	28.6	27%	151.5	0.95	28.6	19%
500000	-118.0	0.84	40.9	35%	142.7	0.94	27.6	19%
501000	-163.4	0.71	111.6	68%	124.8	0.92	28.8	23%
502000	-61.2	0.55	58.7	96%	109.7	0.88	32.8	30%
503000	-45.6	0.57	41.9	92%	93.9	0.81	35.9	38%
504000	-97.0	0.72	48.5	50%	62.5	0.82	23.0	37%
505000	-55.5	0.78	23.3	42%	52.8	0.35	56.7	107%
506000	-28.8	0.81	11.1	39%	n/a	0.00	n/a	n/a
507000	-13.0	0.85	4.4	34%	86.5	1.00	7.9	9%
508000	-29.9	0.89	8.2	27%	67.4	0.67	98.3	146%
509000	-44.4	0.91	11.2	25%	138.6	0.68	196.5	142%
510000	-52.9	0.91	13.5	26%	222.1	0.83	209.5	94%
511000	-62.8	0.92	14.9	24%	-4.8	0.01	n/a	n/a
512000	-83.3	0.92	19.8	24%	n/a	0.00	n/a	n/a
513000	-118.7	0.93	28.9	24%	n/a	0.00	n/a	n/a
514000	-122.7	0.96	21.2	17%	11.6	0.04	46.7	403%
515000	-101.4	0.97	17.0	17%	n/a	0.01	n/a	n/a
516000	-98.6	0.98	11.7	12%	n/a	0.00	n/a	n/a
517000	-92.8	0.97	11.8	13%	n/a	0.00	n/a	n/a
518000	-80.9	0.97	12.1	15%	38.1	0.74	18.1	48%
519000	-90.1	0.99	7.5	8%	37.3	0.90	10.1	27%
520000	-72.4	0.95	12.8	18%	47.2	0.98	5.2	11%
521000	220.2	0.38	n/a	n/a	66.7	0.93	14.9	22%
522000	-226.7	0.43	206.9	91%	98.0	0.94	20.1	20%
523000	157.7	0.57	101.3	64%	114.9	0.93	25.2	22%
524000	-45.1	0.86	14.5	32%	125.5	0.91	31.6	25%
525000	-124.9	0.92	39.7	32%	134.5	0.89	38.1	28%
526000	-156.8	0.92	48.6	31%	132.8	0.88	39.1	29%
527000	-179.6	0.97	35.1	20%	101.9	0.81	38.8	38%
528000	-156.3	0.97	25.2	16%	68.9	0.79	28.0	41%
529000	-123.8	0.99	10.6	9%	50.1	0.41	48.1	96%
530000	-192.4	0.95	36.6	19%	85.3	0.77	36.5	43%
531000	n/a	0.01	n/a	n/a	90.5	0.77	39.1	43%
532000	n/a	0.11	n/a	n/a	86.2	0.62	53.6	62%
533000	n/a	0.17	n/a	n/a	70.3	0.60	45.1	64%
534000	-51.0	0.81	51.4	101%	65.3	0.66	37.4	57%
535000	-67.2	0.92	40.7	61%	44.2	0.57	30.2	68%
536000	-79.0	0.98	22.5	28%	29.8	0.44	26.5	89%
537000	-55.4	0.89	41.2	74%	-95.8	0.43	87.6	91%
538000	-97.8	0.97	36.6	37%	-15.6	0.09	40.6	260%
539000	-206.2	0.98	59.5	29%	-34.8	0.16	62.2	179%
540000	-270.7	0.97	103.9	38%	-115.8	0.62	71.6	62%
541000	-319.4	0.95	147.4	46%	-131.3	0.77	57.5	44%
542000	-354.3	0.92	219.1	62%	13.9	0.56	25.3	182%
543000	-375.2	0.91	238.0	63%	n/a	0.00	45.8	n/a
544000	-390.9	0.96	166.4	43%	6.1	0.05	56.0	n/a
545000	-383.5	0.97	135.8	35%	23.6	0.19	100.8	428%
546000	-379.4	1.00	41.8	11%	47.4	0.64	74.3	157%
547000	-213.2	0.81	214.8	101%	77.0	0.78	84.7	110%
548000	-453.8	0.99	93.5	21%	23.4	0.24	32.9	140%
549000	-512.8	0.98	156.8	31%	57.3	0.79	23.2	41%
550000	-486.9	0.98	145.7	30%	106.9	0.98	10.6	10%
551000	-456.8	0.98	119.8	26%	122.2	0.96	20.4	17%

Northing	West Bank				East Bank			
	Migration Rate (m/yr)	R^2	half-width 95% confidence interval (m/s)	half-width 95% confidence interval (%)	Migration Rate (m/yr)	R^2	half-width 95% confidence interval (m/s)	half-width 95% confidence interval (%)
552000	-434.9	0.99	92.8	21%	119.9	0.96	19.6	16%
553000	-426.6	0.95	198.5	47%	108.5	0.96	17.7	16%
554000	-432.7	0.97	103.7	24%	95.5	0.96	15.3	16%
555000	-412.2	0.96	120.9	29%	89.8	0.96	13.8	15%
556000	-357.5	0.94	117.4	33%	90.9	0.93	19.6	22%
557000	-286.5	0.98	46.0	16%	118.5	0.90	30.8	26%
558000	-253.7	0.98	34.3	14%	101.4	0.90	27.4	27%
559000	-182.0	0.96	35.0	19%	80.0	0.93	17.3	22%
560000	-150.0	0.96	26.4	18%	49.2	0.83	30.0	61%
561000	-105.2	0.95	19.6	19%	21.8	0.72	18.3	84%
562000	-60.9	0.94	12.7	21%	2.1	0.06	11.5	557%
563000	-100.3	0.79	47.1	47%	24.7	0.68	13.4	55%
564000	-81.5	0.75	42.3	52%	32.0	0.80	12.5	39%
565000	-76.0	0.67	47.7	63%	n/a	0.00	n/a	n/a
566000	-27.2	0.14	60.5	222%	n/a	0.03	n/a	n/a
567000	54.9	0.45	64.8	118%	-4.5	0.06	14.0	310%
568000	80.6	0.60	70.2	87%	n/a	0.01	n/a	n/a
569000	53.6	0.41	58.1	109%	9.7	0.89	2.7	28%
570000	-118.2	0.80	81.3	69%	27.1	0.14	52.9	195%
571000	-206.7	0.89	99.4	48%	15.9	0.62	9.9	62%
	positive = erosion negative = sedimentation				positive = erosion negative = sedimentation			

Longterm Shoreline Migration Rate (from 1957 to 2000)
of West and East Banks of Manpura

Northing	West Bank				East Bank			
	Migration Rate (m/yr)	R^2	half-width 95% confidence interval (m/s)	half-width 95% confidence interval (%)	Migration Rate (m/yr)	R^2	half-width 95% confidence interval (m/s)	half-width 95% confidence interval (%)
472000	21.5	0.61	n/a	n/a	-12.6	0.66	n/a	n/a
470000	9.3	0.76	4.1	44%	-7.3	0.61	4.6	63%
468000	17.3	0.92	4.0	23%	n/a	0.00	n/a	n/a
466000	26.5	0.90	7.1	27%	n/a	0.05	n/a	n/a
464000	23.3	0.91	5.9	25%	17.5	0.13	35.4	203%
462000	18.3	0.87	5.5	30%	10.4	0.20	16.5	159%
460000	25.9	0.94	5.4	21%	-5.4	0.14	10.4	193%
458000	7.1	0.45	6.3	89%	-13.2	0.78	5.5	42%
456000	11.7	0.83	4.2	36%	-7.0	0.42	6.6	94%
454000	n/a	0.09	n/a	n/a	n/a	0.08	n/a	n/a
452000	5.1	0.12	10.7	210%	4.7	0.16	8.6	182%
450000	4.4	0.12	9.4	214%	-10.8	0.51	8.5	78%
448000	2.3	0.11	5.3	228%	-18.4	0.84	6.4	35%
446000	n/a	0.06	n/a	n/a	n/a	0.04	n/a	n/a
444000	-35.3	0.58	23.7	67%	38.2	0.63	23.4	61%
442000	3.6	0.15	6.8	189%	26.7	0.56	18.8	70%
	positive = erosion negative = sedimentation				positive = erosion negative = sedimentation			

Longterm Shoreline Migration Rate (from 1957 to 2000)
of East and West Banks of Hatia

Northing	West Bank				East Bank			
	Migration Rate (m/yr)	R^2	half-width 95% confidence interval (m/s)	half-width 95% confidence interval (%)	Migration Rate (m/yr)	R^2	half-width 95% confidence interval (m/s)	half-width 95% confidence interval (%)
482000								
480000	-80.0	0.57	73.6	92%				
478000	-21.2	0.64	16.9	80%	-76.8	0.94	15.8	21%
476000	44.7	0.98	7.4	17%	-70.6	0.98	8.5	12%
474000	49.8	0.99	6.8	14%	-38.0	0.87	11.6	31%
472000	18.3	0.98	2.9	16%	-18.1	0.69	12.8	71%
470000	14.7	0.91	3.6	24%	-46.1	0.95	8.3	18%
468000	9.2	0.82	3.9	42%	-43.8	0.93	13.1	30%
	10.5	0.76	4.6	44%	-32.4	0.56	59.6	184%
464000	19.7	0.82	9.8	49%	n/a	0.44	n/a	n/a
462000	25.4	0.89	9.7	38%	-18.8	0.36	51.3	273%
460000	40.4	0.87	16.6	41%	-32.9	0.24	120.8	368%
458000	33.6	0.91	11.1	33%	-45.2	0.93	12.8	28%
456000	29.4	0.98	4.6	16%	-37.0	0.94	10.1	27%
454000	23.8	0.86	8.8	37%	-33.6	0.96	7.0	21%
452000	23.0	0.92	5.9	26%	-19.46	0.92	5.9	30%
450000	21.3	0.94	4.9	23%	-46.52	0.76	27.9	60%
448000	25.6	0.97	5.2	20%	-16.70	0.82	10.8	64%
446000	-56.1	0.89	16.3	29%	-9.42	0.47	10.6	112%
444000	-23.2	0.55	15.8	68%	-13.85	0.45	20.6	149%
442000	68.1	0.92	26.5	39%	-36.67	0.72	30.9	84%
	positive = erosion negative = sedimentation				positive = erosion negative = sedimentation			

Longterm Shoreline Migration Rate (from 1957 to 2000)
of North Bank of Hatia

Easting	North Bank			
	Migration Rate (m/yr)	R^2	half-width 95% confidence interval (m/s)	half-width 95% confidence interval (%)
612000	-317.6	0.95	145.3	46%
613000	-292.2	0.95	94.6	32%
614000	-302.3	0.98	36.0	12%
615000	-310.2	0.96	51.1	16%
616000	-294.8	1.00	22.9	8%
	positive = erosion negative = sedimentation			

Longterm Shoreline Migration Rate (from 1957 to 2000) of Hatia North

Easting	North Bank			
	Migration Rate (m/yr)	R^2	half-width 95% confidence interval (m/s)	half-width 95% confidence interval (%)
612000	-317.6	0.95	145.3	46%
613000	-292.2	0.95	94.6	32%
614000	-302.3	0.98	36.0	12%
615000	-310.2	0.96	51.1	16%
616000	-294.8	1.00	22.9	8%
	positive = erosion negative = sedimentation			

Longterm Shoreline Migration Rate (from 1957 to 2000) of East Bank of Bhola

Northing	East Bank			
	Migration Rate (m/yr)	R^2	half-width 95% confidence interval (m/s)	half-width 95% confidence interval (%)
488000	-146.1	0.78	60.3	41%
486000	-117.0	0.79	46.6	40%
484000	-64.1	0.70	31.8	50%
482000	-19.5	0.66	10.5	54%
480000	-13.2	0.61	7.9	60%
478000	-11.1	0.61	6.7	60%
476000	-26.8	0.69	13.6	51%
474000	-37.7	0.69	19.3	51%
472000	-48.7	0.89	13.3	27%
470000	-48.9	0.88	14.6	30%
468000	-44.4	0.91	11.0	25%
466000	-39.5	0.85	22.7	57%
464000	-34.4	0.76	15.1	44%
462000	-19.8	0.60	12.0	61%
460000	-22.1	0.49	16.7	76%
458000	-32.9	0.89	9.3	28%
456000	-20.7	0.82	7.8	38%
454000	-16.8	0.61	10.7	64%
452000	-18.3	0.59	12.1	66%
450000	-24.4	0.87	7.4	30%
448000	-15.9	0.80	7.3	46%
446000	-12.7	0.71	7.4	58%
444000	-18.2	0.69	13.0	71%
442000	-8.2	0.21	12.5	152%
440000	-5.0	0.36	5.3	107%
438000	-7.9	0.65	5.3	66%
436000	33.6	0.50	26.8	80%
434000	12.8	0.16	23.5	183%
432000	n/a	0.01	n/a	n/a
	positive = erosion negative = sedimentation			

Longterm Shoreline Migration Rate (from 1957 to 2000) of Chittagong Mainland

Northing	East Bank			
	Migration Rate (m/yr)	R^2	half-width 95% confidence interval (m/s)	half-width 95% confidence interval (%)
526000	-304.9	0.80	136.2	45%
524000	-225.9	0.73	107.9	48%
522000	-124.0	0.86	39.0	31%
520000	-39.2	0.67	22.0	56%
518000	-79.7	0.81	30.3	38%
516000	-121.2	0.96	20.5	17%
514000	-193.3	0.94	37.6	19%
512000	-126.3	0.92	39.4	31%
510000	-79.2	0.70	41.5	52%
508000	17.2	0.51	13.4	78%
506000	6.2	0.08	17.0	276%
504000	-9.1	0.15	19.4	213%
502000	-38.1	0.78	18.3	48%
500000	-66.5	0.61	42.4	64%
498000	-136.6	0.96	39.6	29%
496000	-106.6	0.95	33.1	31%
494000	-89.9	0.94	30.4	34%
492000	-71.7	0.70	63.6	89%
490000	-56.4	0.88	28.6	51%
488000	-15.5	0.57	10.7	69%
486000	-42.8	0.73	35.8	84%
484000	-60.0	0.88	29.6	49%
482000	-62.3	0.84	37.4	60%
480000	-125.9	0.95	39.3	31%
478000	-102.1	0.97	25.0	25%
476000	-51.5	0.71	26.2	51%
474000	-43.8	0.64	25.9	59%
472000	-92.7	0.89	44.7	48%
470000	-104.9	0.89	49.3	47%
	positive = erosion negative = sedimentation			

Longterm Shoreline Migration Rate (from 1957 to 2000)
of Sandwip

Northing	West Bank				East Bank			
	Migration Rate (m/yr)	R^2	half-width 95% confidence interval (m/s)	half-width 95% confidence interval (%)	Migration Rate (m/yr)	R^2	half-width 95% confidence interval (m/s)	half-width 95% confidence interval (%)
498000	12.4	0.69	11.3	91%	-19.1	0.51	14.7	77%
496000	-93.5	0.91	60.0	64%	-16.2	0.52	12.3	76%
494000	-106.9	0.78	115.9	108%	-30.0	0.80	11.7	39%
492000	-20.1	0.48	43.6	217%	-28.1	0.70	14.5	52%
490000	48.1	0.94	9.7	20%	-29.9	0.82	11.0	37%
488000	68.5	0.98	7.9	11%	-25.1	0.92	6.1	24%
486000	83.5	0.98	8.3	10%	-35.4	0.96	5.4	15%
484000	78.3	0.99	7.7	10%	-44.9	0.98	4.6	10%
482000	65.2	0.93	14.5	22%	-51.3	0.93	11.0	21%
480000	63.8	0.92	14.8	23%	-41.1	0.86	13.0	32%
478000	55.8	0.94	11.4	20%	-25.0	0.65	14.7	59%
476000								
474000								
	positive = erosion negative = sedimentation				positive = sedimentation negative = erosion			

9a

Longterm Shoreline Migration Rate (from 1957 to 2000) of Noakhali Mainland

Easting	South Bank			
	Migration Rate (m/yr)	R^2	half-width 95% confidence interval (m/s)	half-width 95% confidence interval (%)
600000	125.6	0.97	18.2	14%
602000	31.8	0.66	18.2	57%
604000	133.4	0.99	21.1	16%
606000	71.9	0.93	20.7	29%
608000	75.0	0.71	51.5	69%
610000	-130.8	0.63	106.8	82%
612000	-482.9	0.92	116.4	24%
614000	-633.4	0.96	146.5	23%
616000	-402.8	0.89	112.0	28%
618000	-416.8	0.86	134.0	32%
620000	-347.4	0.76	154.9	45%
622000	-336.3	0.86	106.8	32%
624000	-278.7	0.83	98.6	35%
626000	-259.8	0.77	112.9	43%
628000	-273.6	0.76	121.6	44%
630000	-319.6	0.44	323.7	101%
632000	-226.7	0.16	463.2	204%
634000	216.8	0.88	86.3	40%
636000	127.1	0.85	55.8	44%
638000	115.2	0.93	27.7	24%
640000	83.3	0.88	32.5	39%
642000	114.3	0.97	16.6	15%
644000	-30.4	0.17	60.8	200%
646000	-171.6	0.22	291.2	170%
648000	-284.9	0.70	167.5	59%
650000	-140.7	0.71	72.0	51%
	positive = erosion negative = sedimentation			

Longterm Shoreline Migration Rate (from 1957 to 2000)
of East and West Banks of Hatia

Northing	West Bank				East Bank			
	Migration Rate (m/yr)	R^2	half-width 95% confidence interval (m/s)	half-width 95% confidence interval (%)	Migration Rate (m/yr)	R^2	half-width 95% confidence interval (m/s)	half-width 95% confidence interval (%)
482000								
480000	-80.0	0.57	73.6	92%				
478000	-21.2	0.64	16.9	80%	-76.8	0.94	15.8	21%
476000	44.7	0.98	7.4	17%	-70.6	0.98	8.5	12%
474000	49.8	0.99	6.8	14%	-38.0	0.87	11.6	31%
472000	18.3	0.98	2.9	16%	-18.1	0.69	12.8	71%
470000	14.7	0.91	3.6	24%	-46.1	0.95	8.3	18%
468000	9.2	0.82	3.9	42%	-43.8	0.93	13.1	30%
466000	10.5	0.76	4.6	44%	-32.4	0.56	59.6	184%
464000	19.7	0.82	9.8	49%	n/a	0.44	n/a	n/a
462000	25.4	0.89	9.7	38%	-18.8	0.36	51.3	273%
460000	40.4	0.87	16.6	41%	-32.9	0.24	120.8	368%
458000	33.6	0.91	11.1	33%	-45.2	0.93	12.8	28%
456000	29.4	0.98	4.6	16%	-37.0	0.94	10.1	27%
454000	23.8	0.86	8.8	37%	-33.6	0.96	7.0	21%
452000	23.0	0.92	5.9	26%	-19.46	0.92	5.9	30%
450000	21.3	0.94	4.9	23%	-46.52	0.76	27.9	60%
448000	25.6	0.97	5.2	20%	-16.70	0.82	10.8	64%
446000	-56.1	0.89	16.3	29%	-9.42	0.47	10.6	112%
444000	-23.2	0.55	15.8	68%	-13.85	0.45	20.6	149%
442000	68.1	0.92	26.5	39%	-36.67	0.72	30.9	84%
	positive = erosion negative = sedimentation				positive = erosion negative = sedimentation			

Longterm Shoreline Migration Rate (from 1957 to 2000)
of North Bank of Hatia

Easting	North Bank			
	Migration Rate (m/yr)	R^2	half-width 95% confidence interval (m/s)	half-width 95% confidence interval (%)
612000	-317.6	0.95	145.3	46%
613000	-292.2	0.95	94.6	32%
614000	-302.3	0.98	36.0	12%
615000	-310.2	0.96	51.1	16%
616000	-294.8	1.00	22.9	8%
	positive = erosion negative = sedimentation			

Longterm Shoreline Migration Rate (from 1957 to 2000)
of West and East Banks Upper Tetulia River

Northing	West Bank				East Bank			
	Migration Rate (m/yr)	R^2	half-width 95% confidence interval (m/s)	half-width 95% confidence interval (%)	Migration Rate (m/yr)	R^2	half-width 95% confidence interval (m/s)	half-width 95% confidence interval (%)
498000	160.5	0.73	69.3	43%	31.6	0.48	25.8	81%
499000	106.5	0.76	42.8	40%	6.3	0.18	9.7	153%
500000	-9.7	0.33	10.0	103%	-11.7	0.81	3.9	33%
501000	-33.7	0.65	17.6	52%	-26.3	0.85	8.7	33%
502000	-68.6	0.88	18.5	27%	-28.2	0.94	10.1	36%
503000	-41.8	0.88	11.2	27%	-27.6	0.89	8.2	30%
504000	33.0	0.92	7.0	21%	-17.8	0.87	5.9	33%
505000	99.3	0.93	19.2	19%	-3.8	0.38	3.3	86%
506000	109.0	0.92	22.6	21%	21.5	0.53	12.2	57%
507000	89.5	0.88	23.7	26%	55.4	0.64	28.1	51%
508000	69.5	0.86	19.9	29%	53.3	0.11	105.7	198%
509000	45.8	0.87	13.0	28%	-113.1	0.42	95.2	84%
510000	18.5	0.82	6.3	34%	-189.5	0.82	67.4	36%
511000	-72.1	0.53	48.5	67%	-192.2	0.82	63.2	33%
512000	-101.0	0.73	43.7	43%	-99.1	0.88	25.9	26%
513000	-89.1	0.79	32.5	36%	-94.4	0.91	19.6	21%
514000	-87.4	0.73	38.0	44%	-87.9	0.86	20.8	24%
515000	-53.8	0.66	27.8	52%	-84.9	0.84	25.9	31%
516000	-63.3	0.81	21.9	35%	-84.5	0.88	23.9	28%
517000	-119.4	0.84	37.0	31%	-104.3	0.97	26.1	25%
518000	-174.1	0.95	27.4	16%	-110.1	0.98	21.3	19%
519000					-149.0	0.96	79.1	53%
	positive = erosion negative = sedimentation				positive = erosion negative = sedimentation			

APPENDIX C

Predicted Eastings of West and East Bank of Chandpur in 2000 versus actual situation

Northing	West Bank			East Bank		
	predicted	actual	difference	predicted	actual	difference
488000	583074	583412	338			
489000	582189	582569	379			
490000	581775	581708	-67			
491000	581217	580963	-254			
492000	580821	580299	-522	607099	607474	375
493000	580494	579631	-863	606039	606308	269
494000	580105	579245	-861	n/a	605450	n/a
495000	579681	578815	-866	n/a	604643	n/a
496000	579434	578549	-886	n/a	603925	n/a
497000	578923	578387	-536	602275	602936	662
498000	578511	578358	-153	600777	601353	576
499000	577962	578278	316	599220	600198	977
500000	577205	577796	590	597905	598646	741
501000	575220	576337	1117	596370	597196	826
502000	571852	572570	719	594775	595527	752
503000	571571	572155	584	593298	594067	769
504000	570915	571984	1069	592342	592651	309
505000	571422	571985	563	591511	592107	596
506000	571738	572055	316	n/a	591136	n/a
507000	571981	572081	99	587249	587192	-58
508000	571726	571706	-19	585434	586173	739
509000	571102	571112	10	584023	585472	1449
510000	570821	570907	86	583400	584924	1524
511000	570501	570672	171	n/a	584189	n/a
512000	570059	570186	127	n/a	583776	n/a
513000	569591	569520	-71	n/a	583161	n/a
514000	569463	569183	-280	581161	582454	1292
515000	569311	569062	-249	n/a	581920	n/a
516000	568876	568753	-123	n/a	581366	n/a
517000	568510	568647	137	n/a	580849	n/a
518000	568349	568561	212	580256	580469	213
519000	568248	568186	-63	579965	580108	143
520000	567460	567528	67	580080	580037	-43
521000	n/a	565971	n/a	580480	580152	-328
522000	566120	558457	-7663	581087	580530	-557
523000	572550	569657	-2893	581426	580634	-792
524000	570453	570004	-450	581545	580569	-976
525000	569863	569342	-521	581444	580425	-1020
526000	569071	568691	-380	581080	580124	-956
527000	567891	567913	21	580264	579489	-775
528000	566931	567039	108	579470	578843	-627
529000	565512	565832	321	578709	578362	-348
530000	560845	560243	-601	578394	577637	-757
531000	n/a	557805	n/a	577837	576891	-946
532000	n/a	554404	n/a	577150	575930	-1220
533000	n/a	558619	n/a	576225	575439	-786
534000	559768	559824	55	575672	575065	-607
535000	561080	560807	-273	574752	574484	-268
536000	560980	561101	122	574127	573579	-549
537000	560701	561014	313	572154	572433	279

Northing	West Bank			East Bank		
	predicted	actual	difference	predicted	actual	difference
538000	560573	560310	-264	571890	571636	-254
539000	559860	559498	-361	570631	570155	-475
540000	559349	558717	-633	569650	568170	-1480
541000	558783	557895	-888	567713	567268	-446
542000	558380	557074	-1306	566551	566594	43
543000	557827	556368	-1458	n/a	566125	n/a
544000	556606	555712	-894	n/a	565784	n/a
545000	555067	555114	47	564864	565626	762
546000	554780	554529	-252	564932	565485	553
547000	555818	554227	-1591	564908	565548	640
548000	554185	553487	-698	564876	565565	688
549000	553253	552622	-632	565250	565637	388
550000	554067	552960	-1107	565935	565604	-330
551000	553893	553017	-876	566153	565612	-541
552000	553385	553109	-277	566189	565692	-497
553000	554875	553384	-1491	566163	565721	-443
554000	554086	553925	-160	566054	565802	-253
555000	554512	554436	-76	565824	565996	172
556000	555420	555264	-156	565912	566393	482
557000	556395	556152	-242	566739	567169	430
558000	557155	557047	-108	566895	566833	-62
559000	558125	557963	-162	566683	566516	-168
560000	558745	558750	5	566470	566327	-143
561000	559439	559439	0	566093	565962	-131
562000	560169	559943	-225	565852	565809	-43
563000	559553	560351	798	566079	565768	-311
564000	560726	560980	254	566338	566008	-330
565000	560567	561438	870	n/a	565317	n/a
566000	562014	562017	3	n/a	565328	n/a
567000	563342	562666	-676	565622	565392	-230
568000	563953	563135	-818	n/a	565534	n/a
569000	563776	563060	-716	565909	565989	80
570000	563189	562446	-743	567601	567447	-154
571000	561927	562213	286	568132	567917	-215

Predicted Eastings of West and East Bank of Manpura in 2000 versus actual situation

Northing	West Bank			East Bank		
	predicted	actual	difference	predicted	actual	difference
472000						
470000	600025	600138	114	602402	602312	-90
468000	600274	600366	92	602699	602574	-125
466000	600305	600219	-86	603140	603061	-79
464000	599842	599764	-78	603557	603283	-274
462000	599110	599068	-42	603344	603221	-123
460000	598486	598482	-4	603072	602993	-79
458000	597471	597684	212	602638	602718	80
456000	596754	596820	66	602414	602476	62
454000	596180	596204	24	601486	601591	105
452000	595231	595383	152	600869	600807	-61
450000	594349	594418	69	599825	599677	-147
448000	593566	593482	-84	598522	598457	-64
446000	592945	592852	-93	597285	597110	-175
444000	592507	592863	357	596357	595903	-455
442000	593078	593147	69	595962	595405	-557

Predicted Northings of Noakhali in 2000 versus actual situation

Easting	South Bank		
	predicted	actual	difference
600000	498626	499185	559
602000	496970	497388	417
604000	496088	495919	-169
606000	493237	493375	138
608000	491546	491733	186
610000	490367	489464	-903
612000	486710	487571	861
614000	487652	486331	-1321
616000	488532	488100	-432
618000	488292	489460	1168
620000	490499	490863	364
622000	489673	491514	1840
624000	489957	493230	3273
626000	491334	494433	3099
628000	493860	494203	343
630000	503854	495819	-8035
632000	512670	500985	-11686
634000	516810	515473	-1337
636000	516849	516126	-723
638000	517021	516401	-620
640000	516592	516149	-443
642000	516598	516288	-310
644000	519618	518828	-791
646000	517514	516198	-1315
648000	520023	520637	614
650000	516564	516453	-110

Predicted Eastings of West and East Banks of Sandwip in 2000 versus actual situation

Northing	West Bank			East Bank		
	predicted	actual	difference	predicted	actual	difference
502000						
500000						
498000	651283	651196	-87	651488	651707	219
496000	649899	649263	-636	653329	653519	190
494000	648734	647958	-776	654577	654773	196
492000	647165	646907	-259	655764	655987	223
490000	646345	646324	-21	656989	657269	280
488000	646823	647079	256	658343	658482	139
486000	647812	647844	32	659393	659517	124
484000	648777	648626	-151	660095	660164	69
482000	649967	649832	-136	660458	660635	177
480000	651466	651074	-392	660999	660975	-24
478000	652179	652088	-91	661467	661139	-329
476000	654475		n/a	657931		n/a
474000	658672		n/a	654400		n/a

Predicted Eastings of East Bank of Chittagong in 2000 versus actual situation

Northing	East Bank		
	predicted	actual	difference
526000	647595	647093	-502
524000	646547	646720	174
522000	646096	646734	638
520000	648598	649043	445
518000	648389	649197	809
516000	649620	649906	287
514000	649673	649992	318
512000	651956	651845	-111
510000	654773	655646	872
508000	658832	658708	-125
506000	661185	660587	-598
504000	662885	662350	-535
502000	664071	663806	-265
500000	665403	665412	9
498000	666761	666789	28
496000	668929	668535	-394
494000	670556	670311	-246
492000	672394	672218	-176
490000	674125	673996	-129
488000	675446	675210	-236
486000	676423	676187	-235
484000	677132	677149	17
482000	677939	677983	44
480000	678478	678517	39
478000	678834	679093	259
476000	679829	679840	11
474000	680269	680265	-4
472000	680339	680483	145
470000	680721	680945	224

Predicted Eastings of East Bank of Bhola in 2000 versus actual situation

Northing	East Bank		
	predicted	actual	difference
488000	584152	583412	-739
486000	586306	585194	-1112
484000	588399	587401	-998
482000	589430	589081	-349
480000	589347	589254	-93
478000	589194	589103	-90
476000	588268	588007	-261
474000	587289	586936	-353
472000	586993	586744	-249
470000	587023	586621	-402
468000	587303	586899	-404
466000	587376	587184	-192
464000	587152	587006	-146
462000	587219	586911	-308
460000	586948	586493	-455
458000	586355	586067	-288
456000	585935	585796	-139
454000	585724	585554	-170
452000	585464	585242	-223
450000	585398	585145	-253
448000	584586	584521	-65
446000	583654	583554	-100
444000	582357	582241	-117
442000	580515	580469	-46
440000	578768	578714	-54
438000	576296	576247	-48
436000	574129	574319	190
434000	572644	572180	-464
432000	n/a	566319	n/a

Predicted Eastings of West and East Bank of Hatia in 2000 versus actual situation

Northing	West Bank			East Bank		
	predicted	actual	difference	predicted	actual	difference
480000	610179	610238	59			
478000	610215	610261	47	615931	615577	-354
476000	610303	610399	96	616756	616733	-23
474000	610522	610511	-11	618038	618446	409
472000	610329	610339	10	619460	619551	92
470000	610099	609981	-118	620259	620022	-237
468000	610008	609988	-20	621103	620885	-219
466000	610085	610038	-46	622385	622315	-70
464000	610162	610162	0	622869	622805	-64
462000	610192	610242	49	623308	622923	-385
460000	610271	610276	5	623722	622860	-862
458000	609859	609864	5	622435	622273	-162
456000	609287	609302	15	621500	621601	101
454000	608715	608686	-29	620843	620938	94
452000	607790	607707	-83	620587	620582	-5
450000	607070	606949	-121	618514	618668	154
448000	606054	606078	24	617576	617556	-20
446000	604693	604741	48	614018	614129	111
444000	605404	605725	321	612443	612227	-215
442000	608918	609104	186	610184	609894	-289

Predicted Northings of North Bank of Hatia in 2000 versus actual situation

Easting	North Bank		
	predicted	actual	difference
611000	480141.75	479994.6	-147.1
612000	479562.08	479310.2	-251.9
613000	479202.4428	478824.5	-377.9
614000	478717.6739	478558.8	-158.9
615000	478128.643	478318.5	189.9
616000	477865.9667	477729.8	-136.2