3.12 Shore erosion in the apex of the Lena Delta

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3.12.1 Introduction

Accumulation and erosion in the coastal zone and deltas are of major importance for the sediment budget of the Laptev Sea. The sediment balance within the Lena Delta is still an open question. The portion of sediment that is deposited in the Lena Delta and the sediment flux from eroded delta islands is not known. However, the modern sediment output from the Lena Delta exceeds the amount of deposits accumulating in that area.

One of the goals of the coastal team was to conduct reconnoitering studies of shore dynamics in the apex of the Lena Delta. The first part of the studies carried out in July 2002 was to evaluate the dynamics of erosive island shores and to study the resulting sediment flux. In total 34 key sites, which are characterized by active shore erosion, were investigated in order to estimate the range of shore retreat rates and the amount of sediment entering the branches of the Lena Delta due to shore erosion (see Fig. 3-56). Most studied sites belong to the islands composing the first terrace above the floodplain, which is the dominating geomorphological level in the studied area.

3.12.2 Methods

The methods to estimate shore dynamics are simple in principle. Measurements of the distance between the shoreline and some natural land forms (marks), which can be identified on an aerial photograph or a small scale map, have been carried out by a special tape measure. As natural marks mostly small lakes with stable shores were used. Most often we simply measured the distance to the cliff edge ignoring the width of the beach. The comparison of the modern field data with remote sensing information taken in the past decades allows to calculate the average annual retreat rates of selected shores. Aerial photographs (scale 1:40 000-1:70 000, taken 1951, 1962, 1972), topographic maps (scale 1:25 000-1:100 000) and satellite images were used. For the quantification of the sediment flux resulting from shore erosion, average ice content and specific density of the deposits composing the shores in the apex of the Lena Delta were taken into account. In total ca. 60 km of shore cliffs were studied in respect of erosion rate.

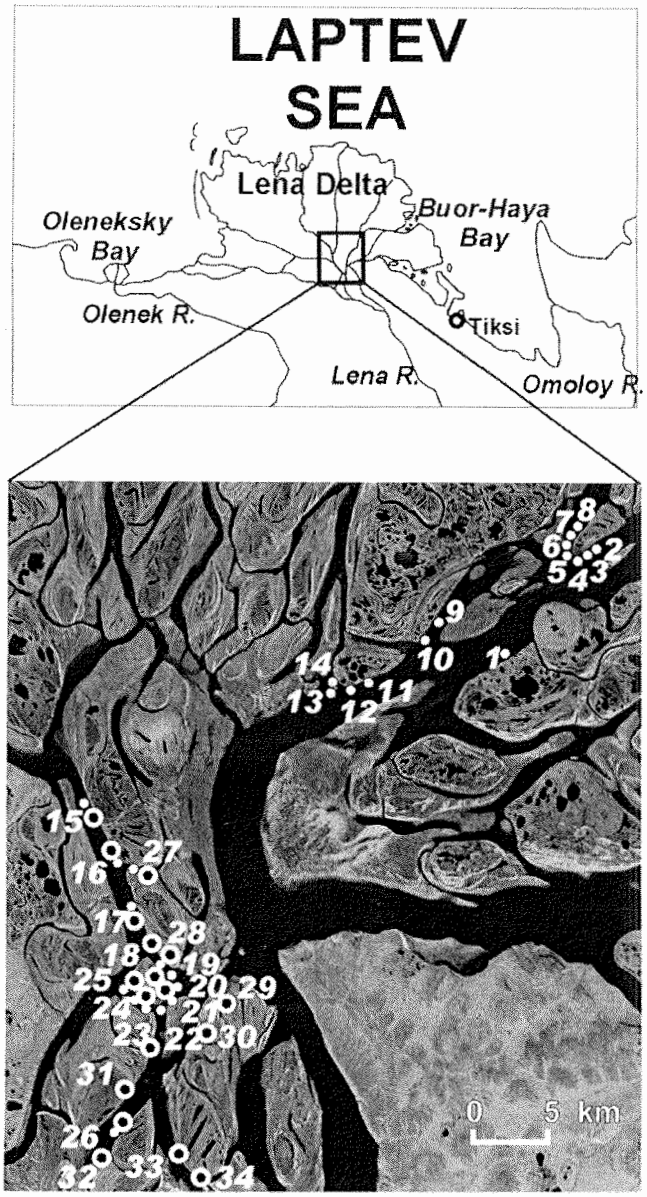

Figure 3-56. Key sites for measurement of shore retreat rates in the Lena Delta Apex (2001-2002). White circles – key sites 2001, Black-and-white circles –key sites 2002.

3.12.3 Results

The main results are shown in Table 3-26. All stations were located along the shores of the first terrace and the floodplain in the delta apex. The average cliff height is about 6 m (3-11 m) and the average retreat rate of actively eroded coast is about 3.9 m/yr. The shores exposed to the current of the main channels

are destroyed much faster - for example stations 4-6 (Gogolevsky Island) and station 20-21 (Samoylovsky Island). The maximum retreat rates were observed at Gogolevsky Island (station 5, south-western cape) which divides the two largest delta channels: Trofimovsky and Sardakhsky (Fig. 3-56).

The comparison of the shoreline position on an aerial photograph of Samoylovsky Island taken in September 1980 with the shoreline taken from a satellite image (Landsat, July 2000) shows that there has been a considerable modification of the margins of the island during the last 20 years. It has to noted that changes of the western and northern shorelines positions are difficult to evaluate because the contours of these low and flooded shores strongly depend on the river-water-level, which is highly variable.

In 2001 the average retreat rate of all studied actively eroded coasts was 4.7 m/yr. In 2002 new data on additional eroded sites were obtained, which indicate lower retreat rates. The average retreat rate of all (2001 and 2002) studied coasts is 3.9 m/yr and the sediment flux calculations were revised accordingly.

At the moment it is not possible to accurately quantify the volume of sediments resulting from eroded shores for the whole delta. But the preliminary results indicates that this sediment flux cannot be ignored. Based on average retreat rates of 3.9 m/yr (R), average cliff height of 6 m (H), average ice content of 20% (Ice coefficient = 0.8) and an average specific density of 1.6 g/cm^3 (SD), the sediment flux from the studied 60 km shores (L) in the Lena Delta can be quantified in the following way:

3.9 (R) • 60000 (L) • 6 (H) • 0.8 (Ice coefficient) • 1,6 (SD) = 1797120 t/yr

3.12.4 Discussion and conclusion

There are a number of unsolved questions concerning the sediment balance of the Lena Delta: (1) it is not known how much sediment is deposited within the delta, e.g. on the surface of floodplains, along the delta margins and within near-delta shallows; (2) it is very difficult to estimate the sediment input from eroded sand banks; (3) there is no information on the volume of the bed-load discharge; (4) almost nothing is know about the sediment dynamics during the spring-flood. Nevertheless, the fact that only local sections (60 km length) of the eroded island shores within the delta can supply about 1.8 m million tons of sediments per year, shows the great importance to erosion processes in the sediment balance of the delta.

We have only studied actively eroded cliffs in the area where the delta channels are characterized by fastest currents and highest water levels. Evidently, it is impossible to transfer the obtained sediment flux parameters to the entire Lena Delta. However, in any case the preliminary results of this study suggest that the sediment flux from eroded shores of the Lena Delta plays an important role in the sediment budget of the Laptev Sea. In 2001-2002 our measurements concentrated on erosive shores only and the next step will be to include accumulative shore sections as well.

Table 3-26. Average retreat rates of actively eroded shores at the key sites in the apex of the Lena Delta (2001-2002).

Key sites	Average retreat rate, m/yr	
	July -August 2001	July 2002
1. Sardakh-Aryta Island	4.8	-
2. Gogolevsky Island	2.1	-
3. Gogolevsky Island	1.9	-
4. Gogolevsky Island	12.2	-
5. Gogolevsky Island	14.2	-
6. Gogolevsky Island	13.4	-
7. Gogolevsky Island	4.5	-
8. Gogolevsky Island	2.3	-
9. Trofimovsky Island	8.4	-
10. Trofimovsky Island	6.7	-
11. Baron Island	9.2	-
12. Baron Island	3.6	-
13. Small Baron Island	5.4	-
14. Small Baron Island	3.7	-
15. Matvey-Aryta Island	4.7	4.5
16. Matvey-Aryta Island	6.1	6.0
17. Yrbylakh-Aryta Island	2.7	2.4
18. Samoylovsky Island	1.4	1.4
19. Samoylovsky Island	1.6	1.5
20. Samoylovsky Island	2.9	3.0
21. Samoylovsky Island	3.4	3.3
22. Samoylovsky Island	1.9	2.0
23. Samoylovsky Island	1.9	1.8
24. Samoylovsky Island	1.5	1.4
25. Samoylovsky Island	2.1	2.0
26. Sordokh-Aryta Island	1.6	1.7
27. Matvey-Aryta Usland	3.3	3.4
28. Yrbylakh-Aryta Ialand	-	1.8
29. Debenek-Aryta Island	-	1.2
30. Sistekh-Aryta Island	-	3.0
31. Sasyl-Ary Island	-	2.4
32. Sordokh-Ary Island	-	2.7
33. Sistekh-Aryta Island	-	4.2
34. Sistekh-Aryta Island	-	5.1
Average retreat rates of actively eroded shores	**3.9**	