# SUSPENDED PARTICULATE MATTER DYNAMICS IN THE NORTHERN DVINA DELTA, THE WHITE SEA, DURING THE FLOOD

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## Introduction

Study of biogeochemical processes in estuaries and deltas is of particular significance in understanding their role in global cycles of carbon and many other chemical elements. Most of the suspended matter is trapped in the estuaries where freshwater and salt water are mixed (salinity of about 2–15 psu), and rapid accumulation (precipitation) of fine-grained suspension occurs due to coagulation processes. According to A.P. Lisitsyn (1995), more than 90% of the suspended matter (including particulate organic carbon) and about 30% of the dissolved matter probably accumulate within this so-called “marginal filter”.

The Northern Dvina river is the main source of riverine suspended matter supply of the White Sea (Gordeev et al., 1996). The most part of this suspended particulate matter (SPM) is delivered to the White Sea during the floods, but the particulate matter dynamics in estuaries and deltas of rivers, flowing into the White Sea, practically is not studied (Lisitzin et al., 2003). The aim of the expedition to the Northern Dvina delta in May 2004 was to study SPM during the floods.

## Materials and methods

The distribution of SPM and hydrological characteristics of Northern Dvina river and its tributaries and branches (Fig.1) were studied during the flood period from 13 till 30 May, 2004. The studies were carried out onboard the RV “Iceberg-2”. Water samples were obtained from the water column by Niskin bottles and from the surface by plastic bucket. The filtration of water samples was carried out through pre-weighted Nuclepore filters 47 mm in diameter (pore size 0.45 μm). After filtration filters were washed with distilled water and dried at 50–55°C, packed in plastic Petry dishes and then sealed in plastic envelopes for later analyses in the land laboratory. In more detail working procedures are described elsewhere (Lisitzin et al., 2003). 141 samples of SPM have been collected. At each station temperature, salinity and turbidity were measured by CTD90 and 3”Micro CTD probes.

## Results and discussion

Continuous measurements of water level and discharge at the Ust’-Pinega cross-section (position of section is shown at Fig. 1) by specialists of gauging station of SEVHYDROMET show that in March and the first week of April both water level and discharge were very low (about 210 cm above the sea level and 880 $m^3/s$, correspondingly). They sharply increase in the period from April 20 to May 19 (up to 750 cm and 16400 $m^3/s$, correspondingly). Our field studies were carried out during the peak of flood. Both water level and discharge sharply decreased from June 2 to June 17.

Concentration of SPM at the Ust’-Pinega cross-section varied from 4 to 14.7 mg/l (8.9 mg/l on average, n = 16 samples). Near the same values were registered upstream this cross-section in the Pinega River (6.7–11.3 mg/l) and in Northern Dvina 10–50 km upstream the Ust’Pinega (7.3 mg/l). In the Maimaksa Branch from the Solombala Island to Lapominka concentration of SPM in the surface layer varied from 5.8 to 13.9 mg/l (10.2 mg/l on average, n = 11). It is at the same level as it was previously reported (Shevchenko et al., 2004) for this branch for the end of flood at 11.06.2003 (13.2 mg/l); at middle of April 2003 it was 2.48 mg/l and 20.08.2003 – 6.14 mg/l (Fig. 2). All these values were much lower than concentrations in marginal filters of the large Siberian rivers (Gordeev et al., 1996; Lisitzin et al., 2003).

In the mixing zone the concentrations of SPM sharply decrease with the increase of salinity. Near the Mud'yug Island they were 1.9 mg/l. In the marginal filter of N. Dvina the same as in Siberia (Lisitzin et al., 2003), the following processes sequentially change each other at the way from the river to the sea: gravitational sedimentation, physico-chemical processes in colloid system (coagulation and flocculation, formation of sorbents), and, finally, biological processes (growth of phytoplankton with conversion of dissolved elements to biogenic suspended matter and the process of biofiltration).

Even in the outer part of the delta riverine water dominated. The distribution of temperature, salinity and turbidity (SPM) were influenced by tidal movements. In the mouth of Murmansky Branch near Kumbysh Island the concentrations of SPM at the Station 36 were 3.4–4.6 mg/l during the tide and 13–14 mg/l during the ebb (Fig. 3). During the maximal tide the depth increased to 11 m and termo- and haloclynes were pronounced. Turbidity decreased under the picnoclyne. During the ebb all water column (water depth was 10 m) was gomogeneously mixed, values of temperature, salinity and turbidity were constant with the increasing the depth.

Near the southern part of the Mud'ug Island at the Station 89 during the maximal tide the saline wedge was registered in 3-m layer over the bottom. Turbidity in this layer decreased. During the ebb at this station salinity was constant and very low (0.05 psu), temperature slowly decreased with the increase of depth, turbidity and SPM concentration increased in this direction.

## Conclusions

During the flood period the concentration of SPM in the lower stream and delta of the Northern Dvina were comparatively low.

Near the mouths of Northern Dvina the distribution of SPM concentrations, temperature and salinity are influenced by tides.

At the outer part of the delta the SPM concentration is decreased with increasing of salinity.

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### References

Gordeev, V.V., Martin, J.M., Sidorov, I.S., Sidorova, M.V., 1996. A reassessment of the Eurasian river input of water, sediment, major elements, and nutrients to the Arctic Ocean. American J. Sci., 296, 664–691.

Lisitsyn, A.P., 1995. The marginal filter of the ocean. Oceanology (English Translation), 34, 671–682.

Lisitzin, A.P., Shevchenko, V.P., Burenkov, V.I. et al., 2003. Suspended matter and hydrooptics of the White Sea – new regularities of quantitative distribution and granulometry. In: Actual Problems of Oceanology. N.P. Laverov, M.E. Vinogradov, A.P. Lisitzin et al. (Eds.). Moscow: Nauka. P. 554–605 (in Russian).

Shevchenko, V.P., Lisitzin, A.P., Belyaev, N.A. et al., 2004. Seasonality of suspended particulate matter distribution in the White Sea. Arctic Coastal Dynamics. Report on the 4th International Workshop. VNIIOkeangeologia, St. Petersburg (Russia), 10–13 November 2004. V. Rachold, G. Cherkashov (Eds.). Reports on Polar and Marine Research, 482, 142–149.

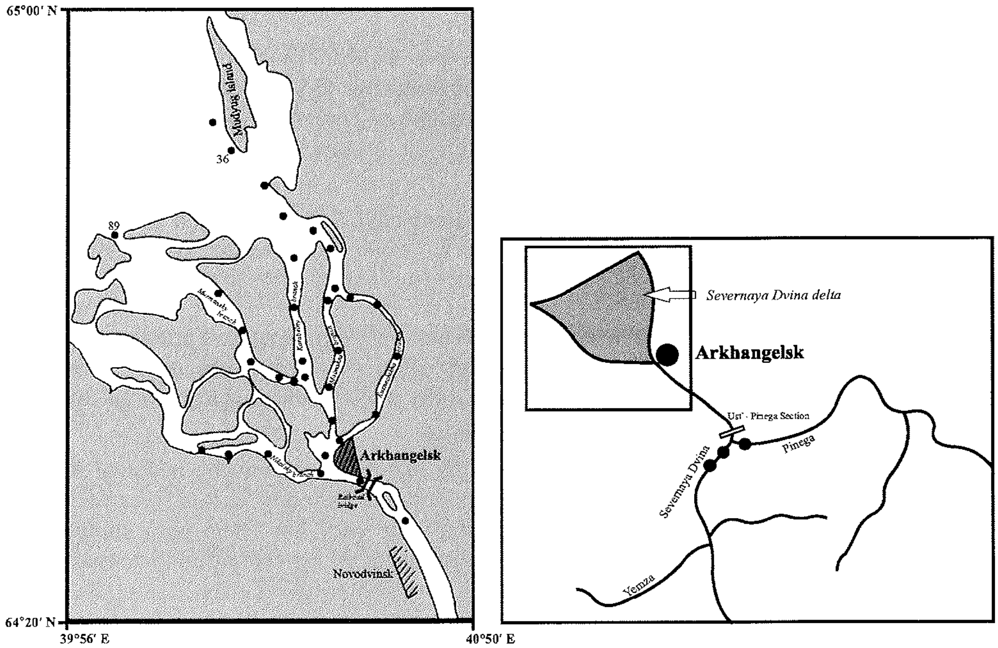


**Figure 1. SPM sampling sites in the Severnaya Dvina river and its tributaries and branches, May 2004.**

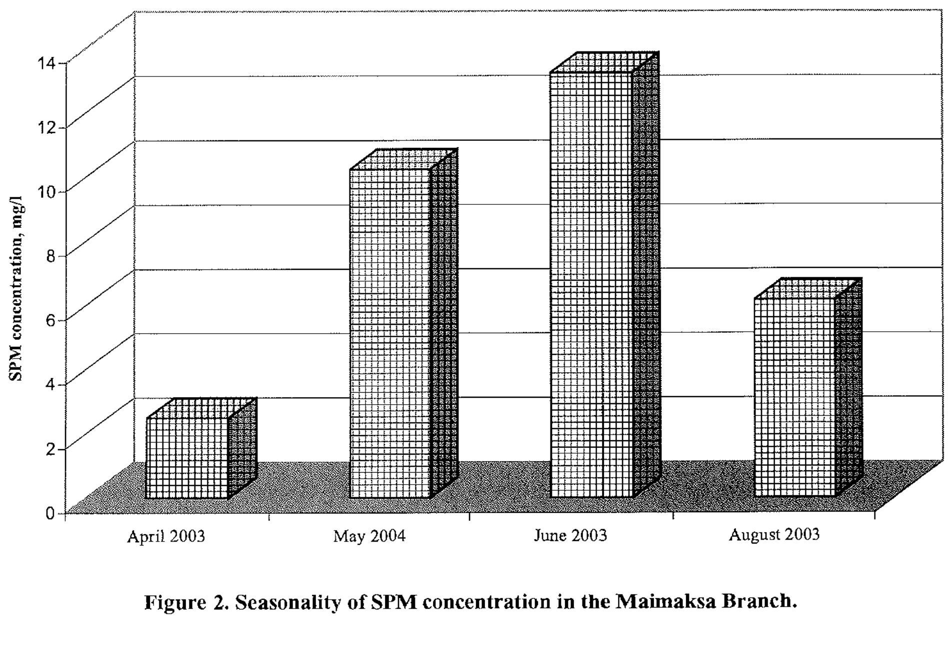


**Figure 2. Seasonality of SPM concentration in the Maimaksa Branch.**

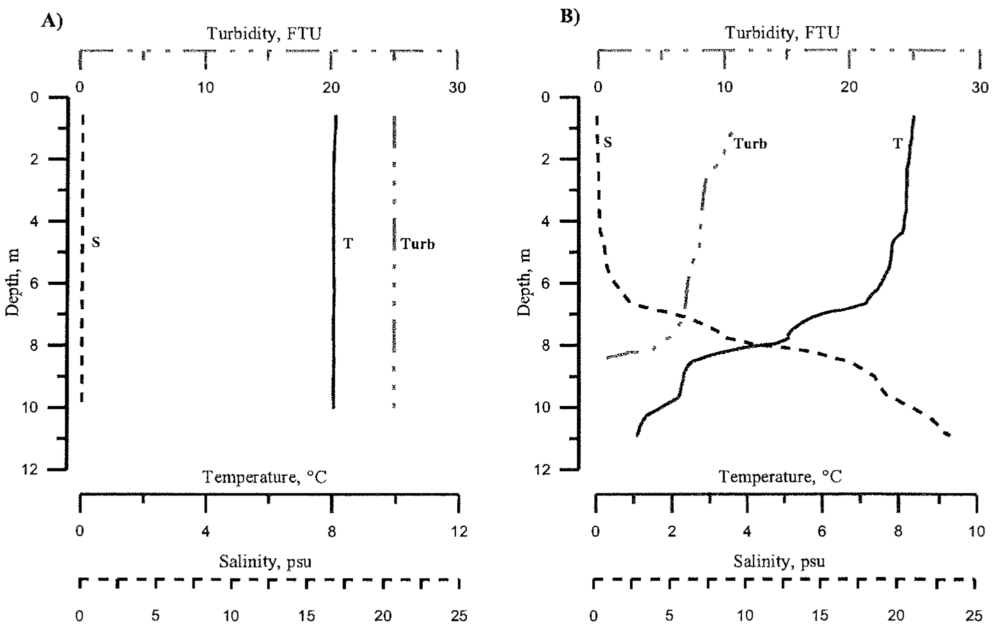


**Figure 3. Distribution of salinity, temperature and turbidity at station 36 on May 21, 2004 a) during the ebb; 14:00 (GMT+3:00) b) during the tide; 21:00 (GMT+3:00).**