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Russian-German Cooperation SYSTEM LAPTEV SEA:
The Expedition LENA 2006

edited by
Julia Boike, Dmitry Yu. Bolshiyanov, Mikhail N. Grigoriev

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2. Hydrobiological investigations in the Lena Delta

Ekaterina Abramova, Irina Vishnyakova, Torsten Sachs

Objectives

Former zooplankton monitoring in different types of lakes on the Samoylov Island was continued during the "Lena-Delta-2006" expedition. The main purpose of these investigations was to provide an outline of the seasonal cycle and interannual variability in zooplankton communities based on multiannual observations. Analyses of the long-term data series allow indicating some trends or oscillations in the species composition and dynamics of the pelagic system.

Materials and methods

The hydrobiological investigations had been carried out on Samoylov Island from the beginning of June to the end of August in summer 2006. 308 zooplankton samples were collected during this period from 6 polygons (3 deep and 3 shallow ones).

Like in previous years, sampling from the shore of polygons was performed by filtering 50-100 liters of water through an 80-µm mesh size net with a periodicity of 5-6 days and a fixation with 70% alcohol or 4% borax-buffered formalin. A rubber boat was used for sampling from the centre of the polygons. There, a 100-µm mesh size small hand net was extended from the bottom to the surface (Figure 2-1). For statistic calculations, 3 samples from each polygon were collected concurrently. At the same time, the water temperature was measured at the bottom and in surface layers. Also, data on the pH of water, depth and size of each polygon were obtained.

Zooplankton samples were analyzed in a Bogorov chamber under the binocular microscope MBS-10. Detailed taxonomic analyses and measurements of plankton organisms (with an accuracy of one hundredth of micron) were carried out using Olympus SZX9 and Olympus BX60 microscopes with the adjusted camera and computer program “Analysis” in the Otto Schmidt Laboratory in St.-Petersburg. To identify individual weights of organisms, we used the formula: $W = ql^b$ (W = body weight, l = body length in mm, q = weight at 1 mm body length, b = index).

Figure 2-1: Zooplankton sampling from the deep polygon.

Preliminary results

The copepods were the most important group in the zooplankton community of the polygonal lakes in terms of abundance and biomass in summer 2006. Among them, only some species constituted the bulk of zooplankton stock. The juvenile stages of few Cyclopoida species were abundant in the deep and shallow polygons in June. The different stages of Calanoida, first of all *Heterocope borealis* and species of the Diaptomidae family, prevailed in July and August.

In the deep polygon the maxima of biomass were observed in the beginning of June (with water temperature less than four) and in the end of August (when water temperature was about ten) - (Figure 2-2 A). The highest abundance of zooplankton in this polygon was noted in the end of July due to intensive reproduction of *Conochilus unicornis* (Roratoria). The last species is not typical for the polygonal lakes and was probably washed in with river water during spring tide.

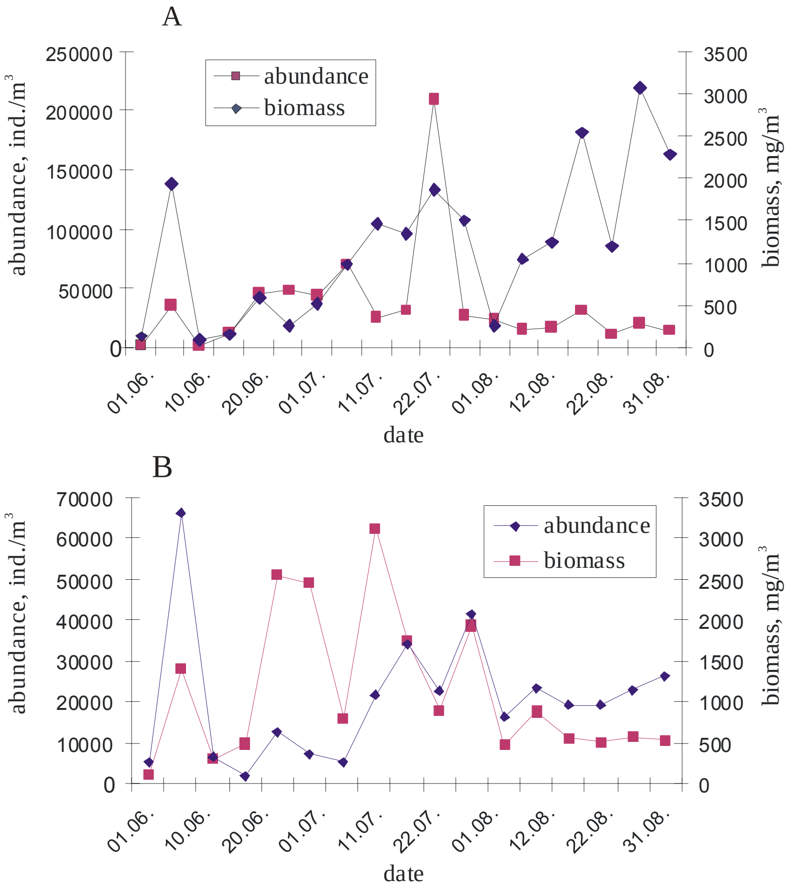

Figure 2-2: Seasonal dynamic of zooplankton abundance and biomass in the deep (A) and shallow (B) polygons in summer 2006.

Another type of seasonal dynamics was observed in the zooplankton community of the shallow polygon, where water temperature fluctuations were pronounced much stronger in comparison with the deep polygon. The biomass of pelagic organisms was very high in July, when the water temperature reached 18^{o} C, and was comparatively low in August (Figure 2-2 B). In July the intensive reproduction period of several large Calanoida species took place in this lake. Like in the deep polygon, the maximum of zooplankton abundance connected with Cyclopoida species reproduction was recorded in the beginning of the period of our observations in June (Figure 2-2 B).

The life cycle of the common copepod species was analyzed in relation to the water temperature variations. According to the results, there was no evident correlation between temperature conditions and life strategies of copepods in the different types of polygons. However, the notable variations of water temperature considerably influenced the abundance of some Calanoida species.

3. Shore erosion studies on the Ice Complex Islands in the South-East Lena Delta

Mikhail N. Grigoriev

Introduction

Shore erosion research within the framework of the Expedition "Lena 2006" was carried out from 4th to 20th August 2006. These studies were conducted with the transport ship "Neptune" (on the large Lena Delta channels) and by motorboat (on the small and shallow Lena Delta channels). In total 10 key sites, which are characterized by active shore erosion, were investigated in order to estimate a range of shore retreating and an amount of sediment income into the water due to shore erosion. Most studied sites belong to the islands composing the third terrace and consisting mainly of an Ice Complex (Figure 3-1).

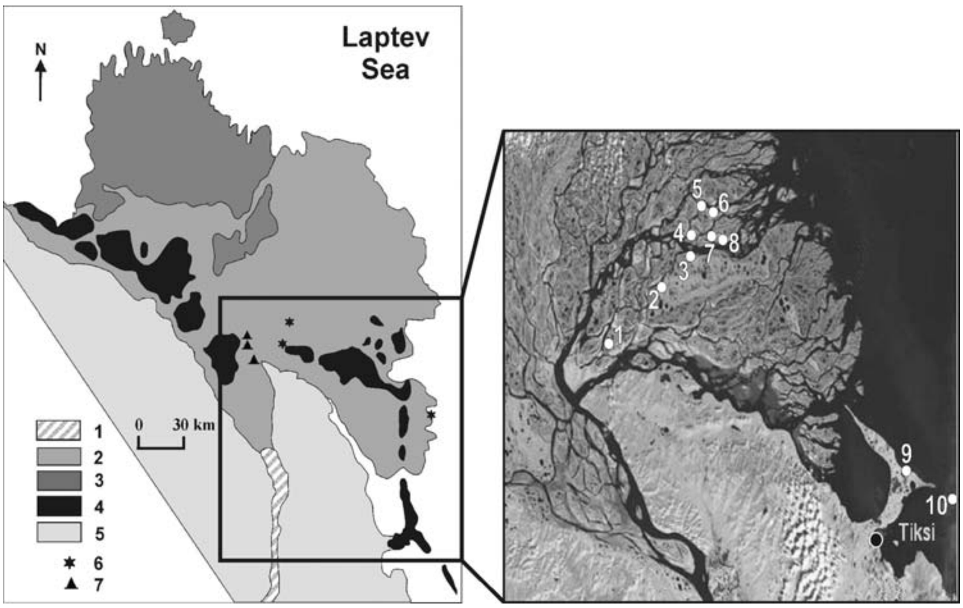

Figure 3-1: General geomorphological scheme of the Lena Delta (left) and the key sites for shore erosion studies (right) in the South-West Lena Delta, including two sites within the Buor-Khaya Bay.

Scheme legend: 1 - Lena River valley; 2 - first terrace and flood-land levels (Q_4); 3 - second sandy terrace (Q_{3-4}); 4 - third terrace (Ice Complex, Q_3); 5 - low-mountain and foothills relief (Mz); 6 - pebble conglomerates (Q_1-N_3); 7 - rock hills (Pz).

Key sites (white circles): 1 – Botulu-Sise Island (Botulu-Uesya Channel); 2 – Sobo-Sise Island (Uyalakh-Uesya Channel); 3 - Sobo-Sise Island (Sardakh Channel); 4 – Khonturdakh-Aryta Island (Dulga-Uesya Channel); 5 – Boskuo-Aryta Island (Satar-Uesya Channel); 6 – Besel-Jangy-Aryta Island (Toyonnakh-Uesya Channel); 7 – Dulga-Aryta Island (Toyonnakh-Uesya Channel); 8 – Kyllakh-Khaya-Aryta Island (Sardakh Channel); 9 – Mamontovy-Khayata site (Bykovsky Peninsula, Buor-Khaya Bay); 10 – Muostakh Island, Northern Cape (Buor-Khaya Bay).

Processes of erosion and accumulation within the Lena Delta and along its margins are of major importance for the sediment budget of the Laptev Sea. Sediment balance within the Lena Delta is an open question, still. The portion of sediment that is deposited in the Lena Delta and sediment flux from eroded delta islands is not known, neither. One of the goals of the coastal expeditionary team was to conduct reconnoitering studies of shore retreat dynamics in the south-east part of the Lena Delta as well as at the key sites of Bykovsky Peninsula (Mamontovy Khayata site) and Muostakh Island (Northern Cape) in the Buor-Khaya Bay. An evaluation of shore dynamics was made only on eroded shore sections. In 2001-2002 the first preliminary investigations of shore erosion processes and sediment flux from eroded islands within the Lena Delta apex were carried out.

Methods

The methods to estimate shore dynamics were based on coastal cliff measurements in comparisons with remote sensing materials. Measurements of the distance between the shoreline and some natural land forms (mark) on the land, which could be identified on aerial photographs or on small scale maps, have been measured by tape. As natural marks, mostly small lakes with stable shores were used. Most times we simply measured the distance to the cliff edge ignoring the width of the beach. Analysis of remote sensing materials from past decades in comparison with own up-to-date measurements, allowed us to calculate average annual retreat rates of selected shores. Aerial photographs (scale 1:30000 - 1:70000; 1951, 1971), topographic maps (scale 1:25 000 - 1:100 000, 1971) and satellite images were used during field works and office studies. Totally about 13.5 km of shore cliffs were studied in respect to the rate of erosion processes (thermal erosion).

An estimation of sediment flux coming from studied eroded shores in the Lena Delta was based on the following parameters: average retreat rates (R, m/yr); length of shoreline (L, m); average cliff height (H, m); average ice content (IC, %); average specific density of deposits (SD, g/cm^3 or t/m^3). A quantity of sediment output (SO) from eroded shores was accounted by formula: R • L • H • 100-IC • SD = SO (t/yr).

Results

The main results of shore retreat rate studies are shown in Table 3-1. All stations/sites were located along the shores of the third terrace in the south-east part of the Lena Delta including two sites within the Buor-Khaya Bay. The average cliff height is about 20 m (10-30 m) and the average retreat rate of actively eroded coast is about 3.4 m/yr.

Table 3-1: Average retreat rates of actively eroded shores at the key sites and erosion sediment flux in the south-east part of the Lena Delta (third terrace, Ice Complex).

Key sites	Average shore retreat rate (R), m/yr	Section length (L), m	Average cliff height (H), m	Average ice content (IC), %	Average specific density of sediment (CD), g/cm^3 (t/m^3)	Sediment output (SO), t/yr
Within the south-east part of the Lena Delta, 1971-2006 (35 years)						
1. Botulu-Sise Island (Botulu-Uesya Channel)	0.3	700	19	50	1.27	2534
2. Sobo-Sise Island (Uyalakh-Uesya Channel)	1.5	3500	24	50	1.27	80010
3. Sobo-Sise Island (Sardakh Channel)	3.5	2600	12	70	1.27	41605
4. Khonturdakh-Aryta Island (Dulga-Uesya Channel)	1.5	400	12	50	1.27	4572
5. Boskuo-Aryta Island (Satar-Uesya Channel)	4.5	2200	25	60	1.27	125730
6. Besel-Jangy-Aryta Island (Toyonnakh-Uesya Channel)	2.2	800	17	50	1.27	18999
7. Dulga-Aryta Island (Toyon-nakh-Uesya Channel)	1.5	700	17	50	1.27	11335
8. Kyllakh-Khaya-Aryta Island (Sardakh Channel)	3.1	1700	20	50	1.27	66929
Within the Buor-Khaya Bay, 1951-2006 (55 years)						
9. Mamontovy-Khayata site (Bykovsky Peninsula,)	2.7	400	30	60	1.27	16459
10. Muostakh Island, Northern Cape	13.1	300	20	70	1.27	29947
Average retreat rate of actively eroded shores at the studied key sites in the south-east part of the Lena Delta (m/yr)	**2.3**					
Average retreat rate of actively eroded shores at two key sites in the Buor-Khaya Bay (m/yr)	**7.9**					
Average retreat rate of actively eroded shores at all 10 key sites (m/yr)	**3.4**					
Sediment output from key sites in the south-east part of the Lena Delta (t/yr)	**352000**					
Sediment output from two key sites in the Buor-Khaya Bay (t/yr)	**46000**					
Total sediment output from all studied key sites (t/yr)	**398000**					

The average retreat rate of studied sites (2.3 m/yr) relating to the third terrace in the south-east Lena Delta are essentially smaller than the average retreat rate of first terrace shores (3.9 m/yr) established in the Lena Delta apex in 2001-2002 (Grigoriev, Schneider, 2002; Grigoriev, 2003). This difference can be explained by more rapid river current, higher spring river levels within the Lena Delta apex and by relatively low shore cliffs of the first terrace islands. The shores located in front of the channel current are destroyed much faster.

The largest ice content was observed at two sites: Sobo-Sise Island (site 2), strongly washed by biggest Sardakh Channel (Figure 3-2) and Muostakh Island in the Buor-Khaya Bay, site 10 (Figure 3-3), washed by open sea waves.

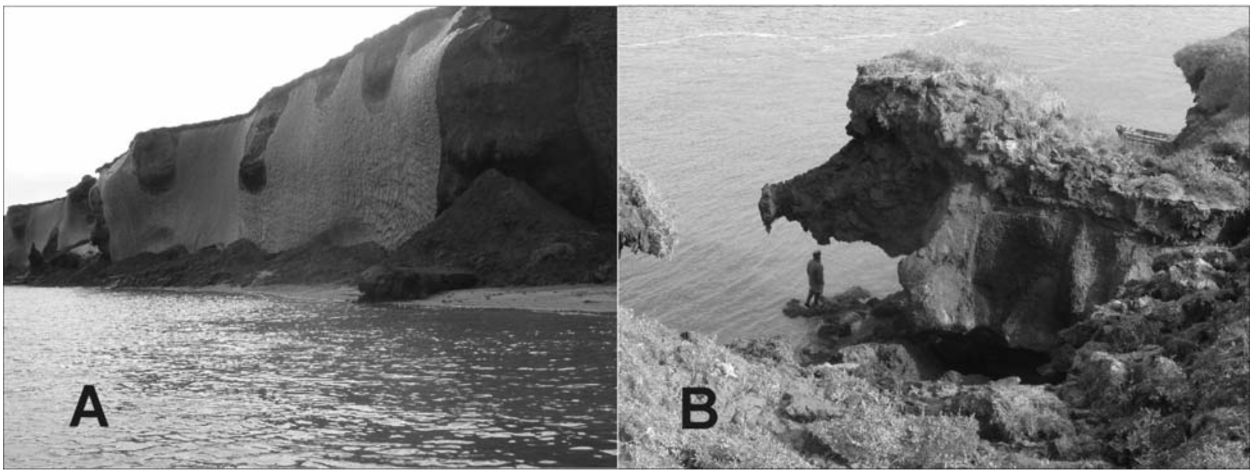

Figure 3-2: Ice-rich cliff (A) and thermal erosion capes (B) with evident high shore erosion rate along the Sobo-Sise Island, Sardakh Channel (site 3).

Figure 3-3: Icy Northern Cape of Muostakh Island, Buor-Khaya Bay (site 10). Coastal erosion rate at this site has reached 20 m/yr.

There are a few small islands composed of an ice complex in the south-east part of the Lena Delta (Figure 3-4), which are destroyed very fast. Sometimes these islands are not indicated even on large-scale maps.

Figure 3-4: An ice complex at the small Island (Khonturdakh-Aryta Island, Dulga-Uesya Channel, site 4).

Shore erosion rate in delta strongly depends on hydrological river regime and lateral movement of the delta channels. For example, the actively retreated icy cliff at the Sobo-Sise Island, Sardakh Channel (Figure 3-2) was formed just several years ago due to meandering processes. And vice versa, when the riverbed moves from the island, the coastal erosion rates along this island were decreasing very quickly, even if the island is composed of an ice complex (Figure 3-5).

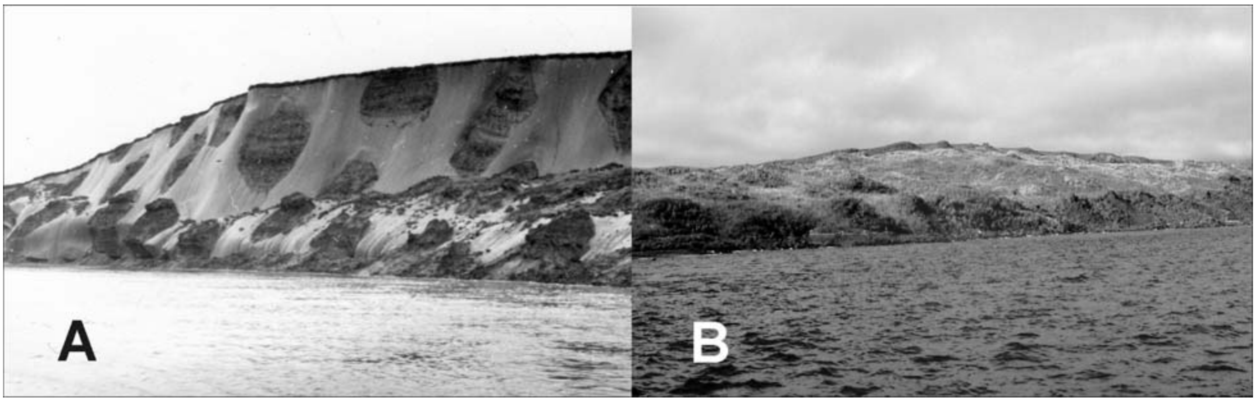

Figure 3-5: During last decades the south shore of Boskuo-Aryta Island (Satar-Uesya Channel, site 5) is characterized by shore erosion damping. Photographs were taken in 1984 (A) and 2006 (B).

Sometimes within the sea eroded coastal sections, there are considerable changes of coastal erosion rates due to natural and technological reasons. For example, during last decades the Mamontovy-Khayata key site at the Bykovsky Peninsula (site 9) was characterized by evident reduction of coastal retreat rate because of a sand bank accretion near the shore (Figure 3-6).

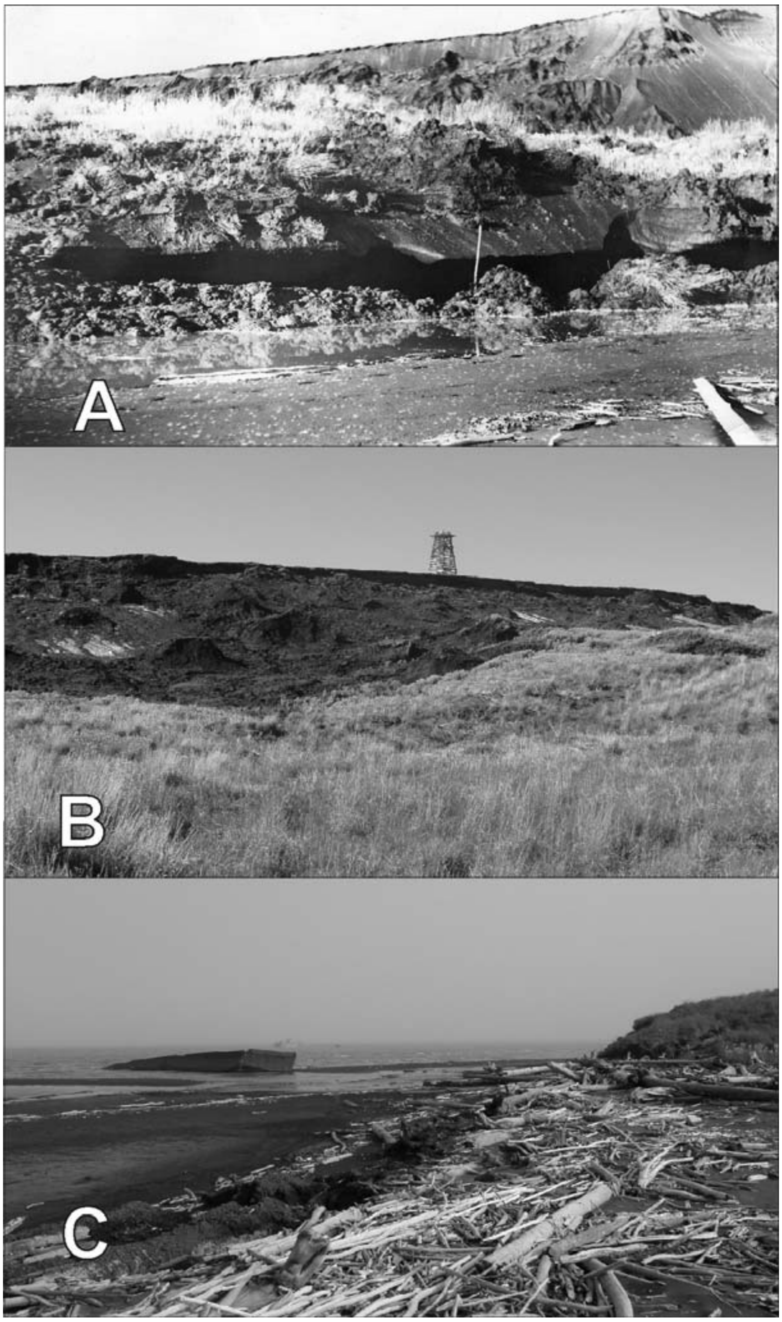

Figure 3-6: Mamontovy-Khayata site, Bykovsky Peninsula, (site 9): actively destroying thermal abrasion and thermal denudation icy cliffs in 1984 (A); relatively slow development of the coastal cryogenic processes within this slope in 2006 (B); old barge (left), submerged more than 25 years ago, blocks the alongshore sediment current. In this connection in the north-east edge of Mamontovy-Khayata outcrop a lengthy sandy bank was formed. Due to this bank a rate of coastal erosion is essentially reduced (C). Photographs were taken in 2006.

On the whole, the average retreat rate of the studied actively eroded coast at all 10 sites is 3.4 m/yr (Table 3-1). The average erosion rate at the 8 sites within the South-East Lena Delta during last 35 years is about 2.3 m/yr. The average sediment flux from studies at the delta sites (expedition "Lena 2006") is about 350000 t/yr. We cannot yet evaluate volume of sediments from eroded shores for the whole delta, but such a sediment flux could be quite large and plays an important role in the sediment budget of the Laptev Sea.

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4. Sensitivity of the permafrost system's water and energy balance under changing climate: A multi-scale perspective

Julia Boike, Konstanze Piel, Simone Bircher, Günther Stoof

Objectives

The main objective is to elucidate the two major cycles (water and heat) in the complex Arctic landscape system at scales from metres to kilometres (meso-scale). This will allow us to close the gap between our small-scale process understanding and the large scale that is accessible to satellite remote sensing. The research group focuses on: (i) establishing spatial and temporal linkages between water and energy fluxes at the plot and landscape scales of different permafrost affected ecosystems; (ii) developing a process-oriented model for the typical Arctic permafrost system to predict subsurface processes (soil water and heat).

Methods

Field work (August 15 to September 1, 2006)

- Already established instrumentation on soil thermal and hydrologic dynamic and micrometeorology was checked and data were retrieved.
- End of August a new micrometeorological site was established inside a polygonal lake. Two poles were set up in the lake each with PT100 temperature sensors in the sediment, water column and air as well as net radiation. A supplementary pole has sensors for water level and snow depth. In addition surface moisture and temperature sensors were installed in surface moss and grasses around the lake shoreline. All parameters were measured every 10 minutes and recorded as an hourly average on a data logger.
- Aerial imaging methods were tested using balloons and kites. Ground control points (white fabric, 1x1 m) were laid out for later calibration purposes.
- A 27 m deep borehole was instrumented with 24 PT100 sensors. Temperatures were recorded every hour and stored on a data logger.
- Spectral measurements were carried out at various sites using an ASD spectrometer on August 17, 18, 19 and 26.
- A dye tracer experiment using Brilliant Blue was started on August 21 and profiles were excavated on August 30 and September 1.

5. Satellite images and ground measured reflectance spectra, thaw depth, soil moisture and vegetation type for characterizing permafrost regions

Merten Minke, Stefanie Kirschke

Objective

Vegetation, microrelief, thaw depth and hydrological conditions determine methane fluxes from permafrost soils (Wagner 2003, Kutzbach et al. 2004). According to Dostovalov & Kudryavtsev (1967), Washburn (1979) and Perfil'eva et al. (1991), the above mentioned parameters are related to each other. From reflectance spectra (ground measurements or remote sensing data) one can derive information on vegetation, microrelief and hydrology. Therefore it is possible to extrapolate these parameters over large tundra areas.

The following hypotheses will be studied:

a) Vegetation, microrelief, thaw depth, water table position and soil moisture are related to each other.

b) Correlations between reflectance spectra and (some of) these parameters exist.

c) Vegetation structure can be interpreted from satellite images.

In a modeling approach, a process-based model (Walter 1998) is used to calculate methane emissions for the Lena River Delta region. Remote sensing data will be used to derive input data for the model. Integrating optical remote sensing data with ground measurements across multiple scales is essential for understanding patterns of surface-atmosphere fluxes of carbon, energy and water (Gamon et al. 2006) and hence for modeling these fluxes.

Field spectrometry enables research of interrelations between spectral properties of the observed objects and both their biophysical properties and the physical properties of the respective environment. The key step in using remotely sensed data is correlating ground ecological properties of interest to spectral reflectance data (Riedel et al. 2005). In this context, the above mentioned hypotheses will be tested. The main objective of the field work was to obtain reflectance spectra of sites with different vegetation (e.g., polygon centre/rim, first terrace/floodplain) and land surface cover (e.g., bare soil, water bodies, fully vegetated sites).

Methods

Vegetation, microrelief, thaw depth, water table position and soil moisture were investigated on the micro- and mesoscale.

On the microscale, along a transect of 126 m covering eight low-centre polygons (Figure 5-1), ground surface, permafrost table and water table to a horizontal reference, volumetric water content [%] and vegetation cover in relevés of 1 m^2 [%] were measured in August 2006. The volumetric water content was measured using a HH2 Moisture Meter (Delta-T Devices). Identification of vascular plants was verified by Dr. V.I. Sakharova and A.P.Efimova (IBPC SD RAS), following the nomenclature by Cherepanov (1995).

The same parameters were also analyzed on the mesoscale. The satellite based land cover classification used in this study (Schneider 2005) defines 10 vegetation types for Samoylov. For each type, a representative number of plots (10-20) was chosen and located using GPS. Plots comprised areas of 25 to 100 m^2 and were chosen to cover one homogeneous vegetation type. Investigations were carried out in June 2006. Vegetation cover was assessed using Braun-Blanquet (1964). Thaw depth and soil moisture were recorded at five points for each plot.

The vegetation will be classified using the K-means partitioning program 'K-means2' by Legendre (2001). To find differences among the vegetation types regarding microrelief, thaw depth, soil moisture and water level, multivariate statistical analysis and significance tests will be carried out.

Spectral measurements were taken in July 2006 on 58 sites. 20 of these sites belong to the test set of vegetation plots described above. The first terrace of the Lena River Delta is represented by 26 sites, the floodplain by 32 sites. At 16 sites ground temperature gradients were recorded using a Temperaturmessgeraet DTTF (Umwelt- und Ingenieurtechnik GmbH). An ASD FieldSpec®FR spectroradiometer (Analytical Spectral Devices) was used to measure reflectance spectra. The portable instrument allows for sampling reflectance spectra of all kinds of surfaces, providing measurements covering the full spectral range (350-2500nm) at a high spectral resolution of 1 nm. At each site, 3-5 single spectra were taken to allow for correction and statistical analysis.

The spectra will be processed using the ENVI®software. In this study, the spectral data will be used to

- Explore spatial and temporal variability in vegetation/surface (bio-) physical properties
- Validate satellite remote sensing data (MERIS, Medium Resolution Imaging Spectrometer)
- Generate and validate input data for modeling methane emissions from permafrost soils in the Lena River Delta region (e.g., active layer depth ALT).

To study the information content of satellite images for ground surface properties, a vegetation map of Samoylov will be generated using the meso-scale vegetation classification and air photographs taken by Boike (2006). These data will subsequently be compared with the satellite based vegetation classification by Schneider (2005).

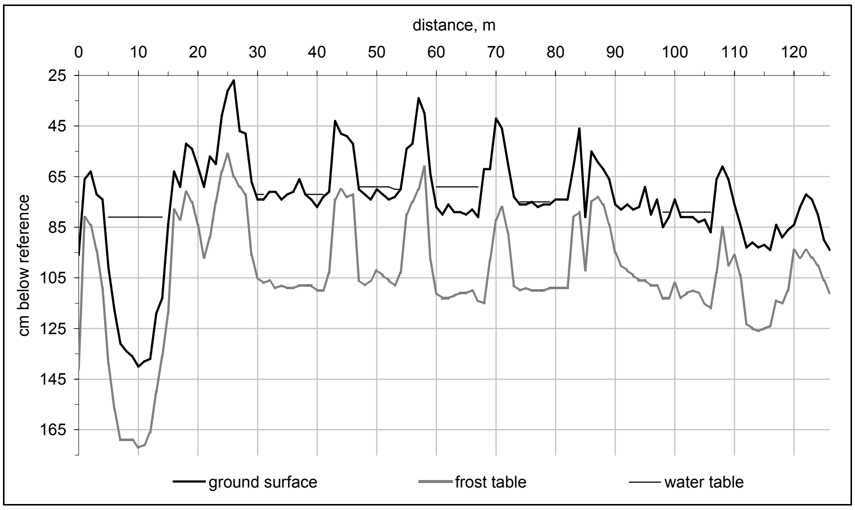

Figure 5-1: Transect of microscale studies (measurements August 30th).

Preliminary results

A vegetation classification has not been carried out yet. As an example, the results for one site, J68 (72°22'15''N, 126°31'3''E) are presented. The site is located in a floodplain and characterized by mesic tundra vegetation, dominated by herbs (*Hedysarum arcticum, Festuca rubra*, *Deschampsia borealis*) and shrubs *(Salix reptans* &/or *Salix glauca*). Further important species are *Astragalus alpinus*, *Equisetum arvense* and *Tanacetum bipinnatum*. Mosses and lichens are absent. The mineral soil has no organic layer. The mean volumetric water content (N=5, mineral) is 41.06% (1.53s.d.), the mean thaw depth (N=5) is 66cm (2.92s.d.).

Figure 5-2: Site J68, floodplain (A) and Site J68, floodplain-close-up (B).

Figure 5-2 A and B show the vegetation cover of site J68 (photos taken in July 2006), which is dominated by herbs and shrubs with high chlorophyll contents. Vegetation is on its maximum of growth. The respective spectra (Figure 5-3 shows the uncorrected spectra taken from site J68) are characterized by a steep rise in the curves that marks the transition from VIS to NIR. This is used as an indicator for vegetation vitality: the steeper the rise, the greener and more vital the vegetation.

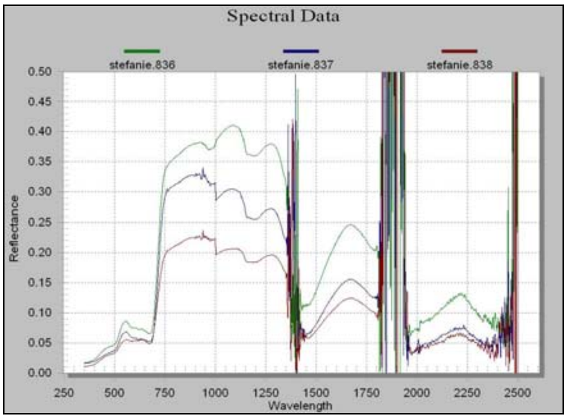

Figure 5-3: Uncorrected spectra taken from site J68.

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6. Ecosystem scale and plot scale measurements of carbon dioxide and methane exchange between Arctic tundra and the atmosphere

Torsten Sachs, Michael Giebels

The micrometeorological measurements of the years 2002 – 2005 were continued during the 2006 campaign. Turbulent fluxes of energy, water vapor, carbon dioxide and methane from the ground into the atmosphere were measured using the eddy covariance technique. For the first time, the entire growing season was covered with measurements from June 5 – September 19. The investigation site and the technical set-up of the eddy covariance system (ECS) and supporting measurements were identical to 2005. For a detailed description see Kutzbach et al. (2004).

Mean daily air temperatures during the study period ranged from -1.5°C at the end of May to +19.4°C in July and fell down to -5°C at the beginning of September. Temperatures exceeding 10°C were reached in the second week of June, causing early and rapid snow melt. Towards the end of the campaign mean daily air temperatures were slightly above freezing due to southerly winds. Several strong rainfall events occurred during the study period with the strongest one on August 4 yielding almost 23 mm of rain within 24 hours. Overall liquid precipitation during the study period was 158 mm.

Turbulent fluxes of sensible and latent heat and of carbon dioxide showed clear diurnal and seasonal trends as expected. Methane flux measurements were also conducted successfully and showed no diurnal or seasonal trends.

Strong peaks with maximum methane fluxes of more than 83 mg m^{-2} d^{-1} and 58 mg m^{-2} d^{-1} were measured on June 27 and August 4, respectively. These peaks correspond to peaks in windspeed, precipitation, and strong and sudden decreases in air pressure. On average, methane fluxes were below 19 mg m^{-2} d^{-1}. The cumulative methane emission as measured by eddy covariance was 1.9 g m^{-2} during the 2006 growing season.

Closed chamber flux measurements of carbon dioxide and methane were conducted in close proximity to the eddy covariance tower. Altogether, 18 chambers were set up in four polygons and one polygon rim site during the 2005 campaign. The four polygons are in different stages of development and feature different vegetation, with one polygon being a high-center polygon.

The purpose of these additional chamber measurements within the eddy covariance footprint is:

- to determine the small scale variability of carbon dioxide and methane fluxes and its influence on the quality of eddy covariance data
- to improve process understanding of the underlying single processes that make up parameters measured by eddy covariance

- to help develop robust models and scaling algorithms for up-scaling flux data from plot to landscape scale and beyond

The chambers consist of a 50x50 cm PVC base inserted about 10 cm into the active layer. A water-filled channel on top of the base provides a gastight seal between the base and the actual chamber. Four ports on top of the PVC chambers are used to draw sample air as well as to circulate the air inside the chamber with an external pump. Chamber volume is 12.5 liters and 37.5 liters where higher vegetation does not allow for the use of small chambers. Dark PVC chambers are used for measurements of respiration and transparent chambers are used for measurements of net carbon dioxide flux and methane flux.

Measurements were conducted daily from July 12 – September 19, 2006 using an Innova AirTech Instruments Multi-gas Monitor Type 1412. Samples were drawn from the chamber headspace every 45 seconds for 8-10 minutes and analyzed by photo-acoustic infrared spectroscopy. Flux rates will be calculated from the change of concentration during closure time using a newly developed routine which uses statistical decision criteria to determine whether linear or non-linear regression models will be used.

Preliminary viewing of the data indicates some variability of fluxes within the micro-sites and clear variability between the different polygons. The high-center polygon shows fluxes more similar to those of the polygon rim than to those of other polygons. Methane data show the most significant difference between polygon centers and the polygon rim with concentrations at the polygon rim micro-site reaching the instrument's detection limit and very high concentrations at polygon center micro-sites.

Additional chamber flux measurements were conducted on water-filled troughs and cracks using floating chambers in order to determine the flux contribution of thermokarst-features. On at least two occasions, ebullition of methane was observed.

7. Long-term Studies on trace gas fluxes (methane)

Jürgen Joseph, Anastasia Germogenova

More than 14% of the global terrestrial carbon is accumulated in soils and sediments of Arctic permafrost (Post et al., 1982). Over microbial access to this carbon pool trace gases like carbon dioxide (CO_2) and methane (CH_4) are released to the atmosphere.

Global climatic changes have a more dramatic effect in the Arctic than in any other region of the world. An increase in temperature twice the global average would make these areas a sensitive marker for changes in the lower latitudes. It might also enhance a global warming tendency through positive feedback effects in the production of climate relevant trace gases.

Estimated 17 to 42 Tg CH_4 y^{-1} efflux from tundra soils (Cao et al., 1996; Christensen et al., 1996), about 25 % of the methane release from natural sources (Fung et al., 1991) are set free in northern wetland environments.

A small group of strictly anaerobic Archea produce methane as terminal step in degrading organic matter, while methanotrophic bacteria oxidise CH_4 to CO_2.

Between 10 and 57 % of CH_4 produced by microbiological reaches the atmosphere (Le Mer, 2001; Roslev & King, 1996).

In order to make an assertion about the enhancing effect of trace gases produced by microorganisms to the global warming, long-term gas flux measuring campaigns are necessary. Of special interest for predictions of the future methane budget will be the relation between increasing annual temperature and the netto efflux of the highly potent trace gas methane (CH_4). Considering this, the 2006 measuring campaign is part of the long-term studies carried out since 1998 (Wagner et al., 2003; Wagner et al., 2005; Liebner and Wagner, 2007).

Low-centred ice-wedge polygons are characteristic elements for the northern tundra areas. Due to their microrelief (elevated rim, compressed center) different environmental conditions for methanogenic and methane-oxidising microbial communities can be found, which influence also the effective CH_4 efflux.

Additional to the measurement site on Samoylov Island a further long-term methane flux study site was established on a high plateau at Kurungakh Island and several measuring excursions were executed successfully (Figure 7-1).

Methane emission and the ecological parameters thaw depth, water level, air pressure and soil temperature were measured daily on low-centre polygons from the middle of June until the end of September.

For the methane emission measurement 5 chambers were placed on the rim and center of the polygon, respectively. A chamber consists of a 0.5 x 0.5 m steel frame with an u-profile on top, permanently installed in the active layer and a PVC-chamber with four ports connected to 2 perforated PVC-pipes (see Figure 7-2 and 3).

When measuring, the u-profile was filled with water to tighten the chamber and headspace air was pumped circular through it and a gas collecting tube for 30 minutes.

Figure 7-1: Frame of the new established measurement field for long term closed chamber flux studies (Kurungnakh Island) (A). Shoreline of Kurungnakh Island (B).

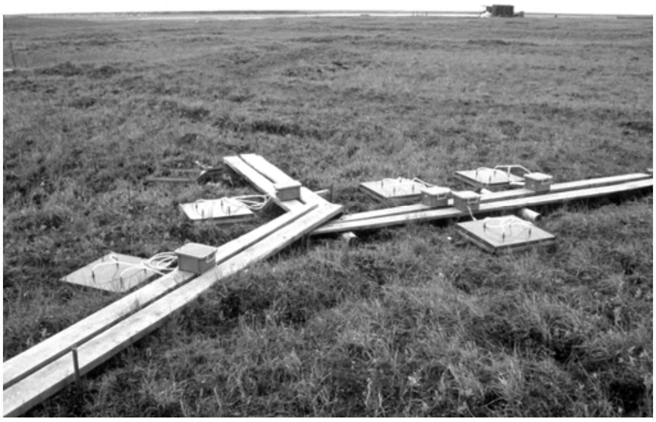

Figure 7-2: Measurement field for long term closed chamber flux studies (Samoylov).

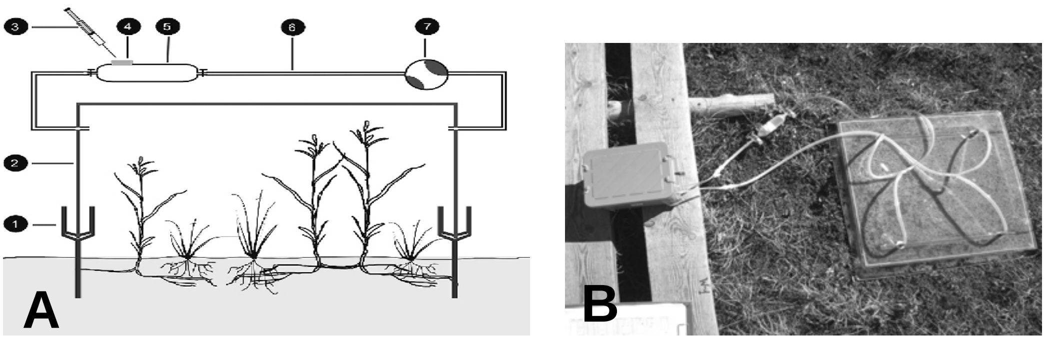

Figure 7-3: Scheme of the methane flux measurement set with the closed chamber method (A) and a connected sampling set (B).

CH_4 concentrations were conducted, using a gas chromatograph (Chrompack GC 9003) in the field laboratory (Hubberten et al., 2006).

The gas chromatograph was equipped with an Agilent Technologies Inc. HP-Plot/Q 15 m x 0.53 mm column and a flame ionisation detector.

As carrier gas (20 ml min^{-1}) Helium was used. The injector/detector temperatures were set to 160°C and the column oven temperature to 80°C. The calibration of the device was done by standard gases (Linde).

The analysis of the obtained raw data will follow in a summarising study.

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8. Hydrological and geomorphological investigations

Dmitry Bolshiyanov, Alexander S. Makarov

Hydrometrical measurements in the Lena Delta channels are providing new data of water discharge, sediment load and redistribution of flow between the main branches of the delta (Figure 8-1, Table 8-1).

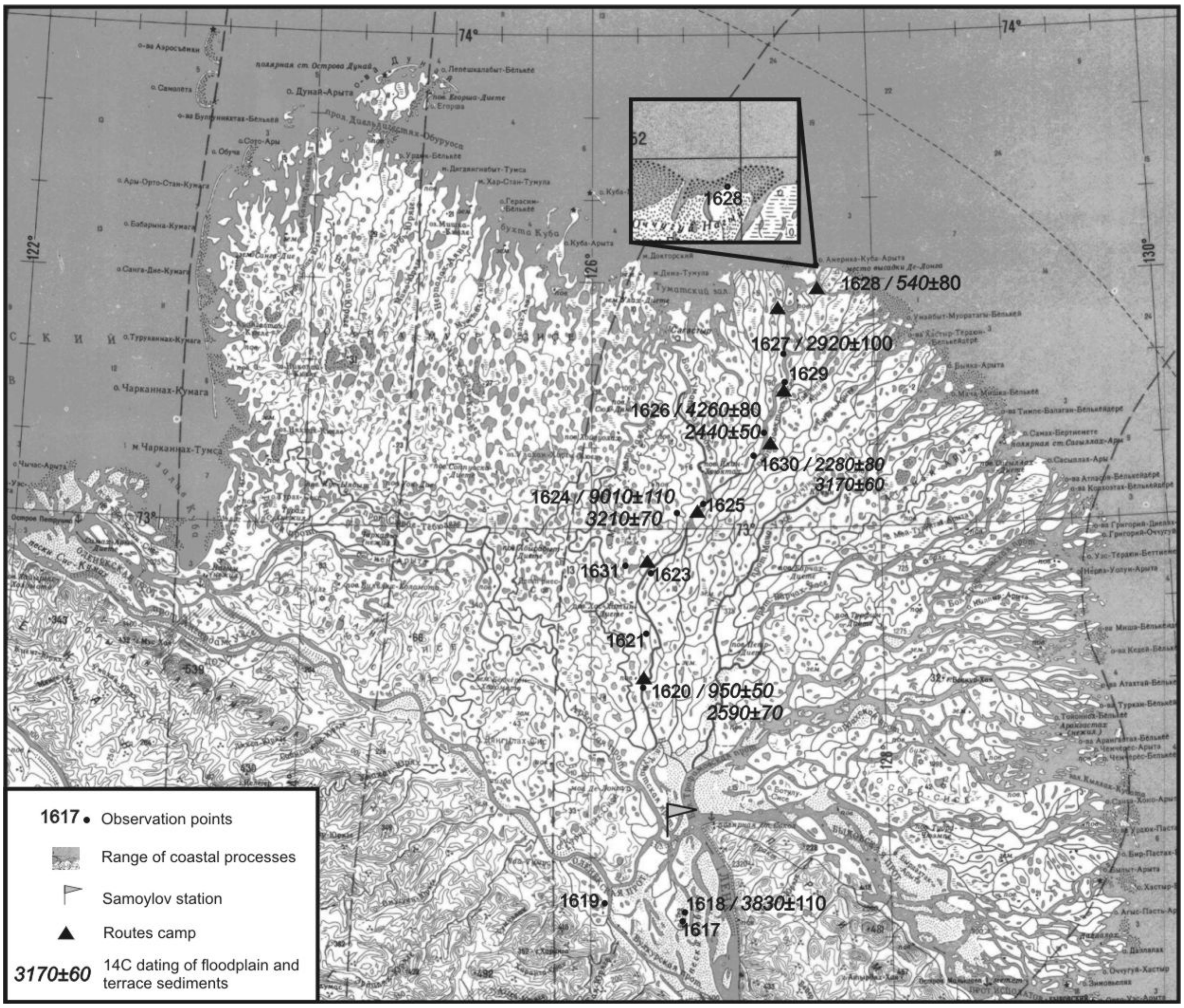

Figure 8-1: Investigation area.

For hydrological and geomorphological measurements the central channel Tumatskaya-Osokhtokh was used, going from the Samoilovsky Island to the marine edge of the Lena Delta (Alkhan Island).

The boat "Kazanka 5M" with Johnson 30 engine was used for this route. Along the channel, with a length of 165 km, morphometric characteristics have been measured on 5 gage lines, such as flow velocity and water turbidity. Measurements of sediment load transformation along main channels from the top of the Lena Delta to the seaside edge were started in the "Lena-2005" expedition and were continued in the last season. Hydrological measurements have been made at different stages of decreasing water level (Figure 8-2).

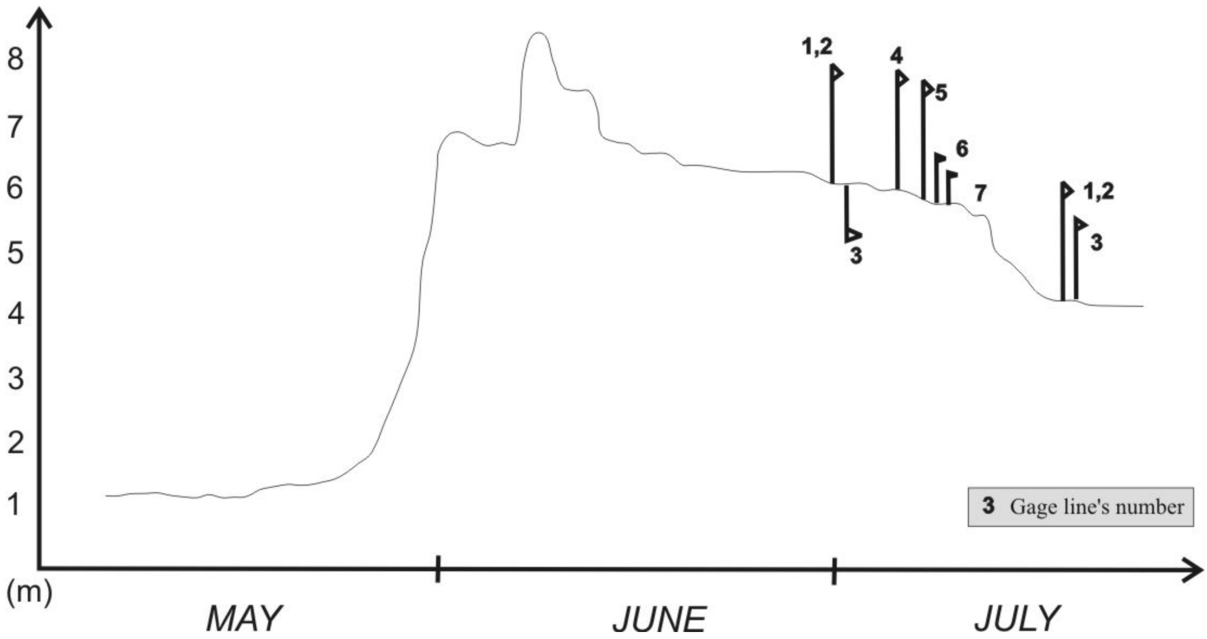

Figure 8-2: Water level changes (from the Khabarovo-Stolb Polar Station) during the spring-summer tide. Moments of hydrological investigations have been marked by small flags.

Measurements along the channel have shown a decreasing mean turbidity of water from the top of the delta to the seaside edge (from 46 to 22-26 g/l). This means that the stream looses nearly half of its suspended sediments on the way to the sea. This part of sediments constructs the modern delta of the Lena River.

Surface water temperatures have been measured along the Tumatskaya-Osokhtokh Channel (Figure 8-3). Water temperatures from the top of the Lena Delta to the seaside edge were decreasing 1°C each 30 km.

Along the Tumatskaya-Osokhtokh Channel samples have been taken of water for geochemical analysis and of lake sediments for paleoclimatic analyses. Sediments from different flood plain levels and terraces on islands were sampled for C^{14} dating (Figure 8-1).

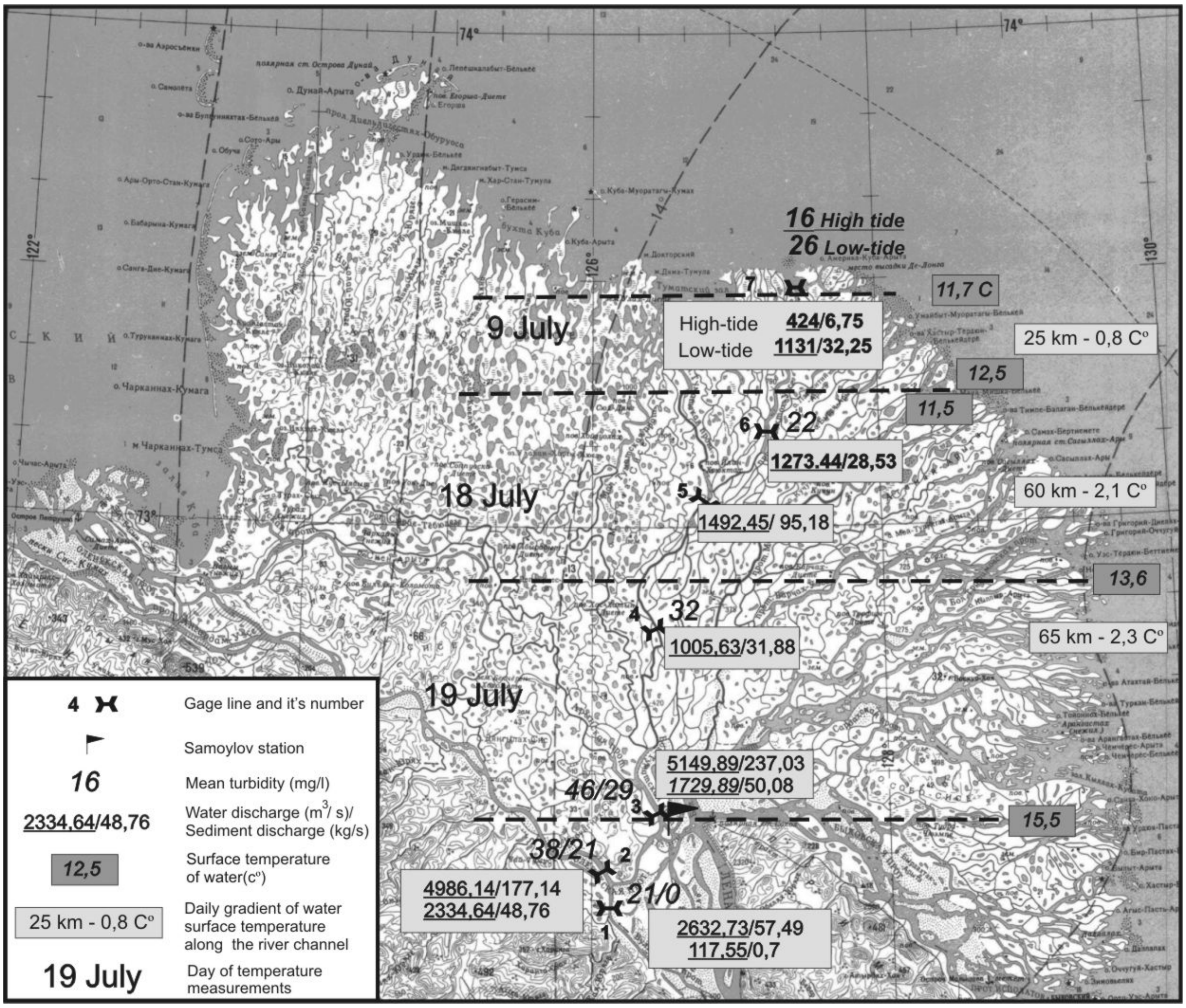

Figure 8-3: Results of hydrological investigations.

On the seaside edge of the Lena Delta (Alkhan Island) a map of the shoreline and its depth were made by using a tachymeter. Over a distance of 3 km, water depth was measured along 3 profiles from the shoreline to the sea. From these data, the shoreline was modelled (Figure 8-1).

Hydrometrical measurements were made twice on the bifurcation point of the Bulkurskaya and Olenekskaya Channels. On peak of a flood the Bulkurskay Channel gave most of its water to the Oleniokskaya Channel. The flow through the Bulkurskaya Channel was disconnected after a flooding event.

Table 8-1: Water discharge and sediment load measured in 2006.

Gage line and a channel	Date	Measured water dis-charges m^3/s,	Measured sediment load kg/s	Mean turbidity g/l
№1 Bulkurskaya Channel	1.07.06	2632,731	57,48747418	0,021
№2 Oleneokskaya Channel	1.07.06	4689,137	177,1359	0,0377
№3 Tumatskaya Channel	2.07.06	5149,894	237,028118927	0,046
№4 Tumatskaya Channel	5.07.06	1005,629	31,880909306	0,0317
№5 Tumatskaya Channel	7.07.06	1492,456	95,176020436	0,0637
№6 Osokhtokh Channel	8.07.06	1273,442	28,529424883	0,0224
№7 The mouth of the Osokhtokh Channel (high tide)	10.07.06	424,7797	6,745830012	0,0158
№7 The mouth of the Osokhtokh Channel (low tide)	10.07.06	1130,957	32,243976059	0,02581
№3 Tumatskaya Channel	23.07.06	1729,896	50,08495	0,02895
№1 Bulkurskaya Channel	24.07.06	117,557	0,704149	
№2 Oleniokskaya Channel	24.07.06	2334,635	48,7615	0,0208

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