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The relevance of the contemporary landscape-ecological and biogeochemical studies of the Ob floodplain

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We have systematized and summarized the results of the Ob River floodplain studies and have shown that the flood and the floodplain influence all the territory of Western Siberia due to the processes happening there. The floodplain at different times was the object of interest of many scientists, but the total level of study of the Ob and the associated ground and the lake network water resources and quality can be generally assessed as low. The waters of the Ob middle course are quite polluted according to bacteria content. It is possible that a significant part of organic and biogenic substances, microorganisms and some microelements come into the Ob floodplain waters from anthropogenic and natural sources distributed in the watersheds area. The soils of the Ob River floodplain can be considered to be clean and free of any chemical pollution. In these soils, the amount of trace elements is small. To study the floodplain changes after a flood the methods of landscape ecology are used, such as the collection and analysis of stock and descriptive materials, literature and maps; the preparation of a series of component and general landscape maps. Nowadays a complex research of the Ob River and the adjacent surface waters is relevant.

The article contains 2 Figures, 79 References.

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Introduction

The spring flood is the time when a river shows its strength and power. Melt water flows into the floodplain, creating new channels and lakes. A lot of different birds and mammals find temporary shelter and subsistence among spring waters. For several weeks every year the spring waters of the Ob inundate huge areas of the adjacent meadows and forests. During this period, the chemical content of the water and the content of dissolved gases change. This is partially due to the quick dissolution of nutrients and biogenetic components. Coloured organic compounds, microelements, silicon and accumulated heavy metals are transported by the current from shallow channels and flooded lakes into the Ob main watercourse and then to the ocean. The scale of such processes remains virtually unstudied. It cannot be excluded that they are decisive in determining the flood potential downstream, its nutritional character, and overall ecological balance. Western Siberia is little studied in the world science; however, the processes here have a significant impact on the climate of the planet, so such studies are always relevant.

The aim of the article is to summarize the data about the Ob floodplain and to show the relevance of the contemporary landscape-ecological and biogeochemical research for the middle course of the Ob River. The main result will be evaluation of the role of the floodplain landscapes in regulating the global climate and forming the global carbon balance. The results of the research will enable evaluation of the carbon balance and indicators of pools and emissions of carbon in different types of floodplain ecosystems. This will allow us to determine the main trends of their dynamics in the context of climate change. Discovering changes in the environment on both regional and global scale will assist mathematical and computer models, created on the basis of the obtained data. Thus, being a review of the Ob floodplain research, this article will become the basic support for planning new scientific research.

1. Site of research

The Ob River is a major river in western Siberia and is the world's seventh longest river. It is formed by the confluence of the Biya and Katun rivers 25 km southwest of Biysk in Altai Krai. The Ob is the largest river discharging to the Arctic Ocean in terms of watershed area (average annual discharge of 12,475 m^3s^{-1}), and the Gulf of Ob is the world's longest estuary (a 100-kilometer-long bay of the Kara Sea) [1-9]. The length of the Ob River is 3,650 km, a drainage area of 2,990,000 km^2. Its floodplain is tens km wide and is characterized by many tributaries and lakes [1, 4, 5].

The Ob zigzags west and north until it reaches 55° N, then it curves round to the northwest, and again north, running finally eastwards into the Gulf of Ob. The Ob splits into more than one arm; its tributaries reach into Kazakhstan, China and Mongolia, but the main course is within Russia. The noteworthy tributaries are the Tom, the Chulym, the Ket, the Tym and the Vakh rivers from the east; the Vasyugan, the Irtysh and the Sosva rivers from the west and south [3, 8, 9].

The Ob River can be divided into three parts: upper Ob, middle Ob and lower Ob. They differ in geographical, geomorphological and climatic conditions [1, 2]. The river basin of the Ob consists of all landscape zones of Northern Asia: tundra, forest-tundra, taiga, forest-steppe, steppe and semi-desert. In the north of the basin and in the mountains there is permafrost. The Ob is ice-covered at southern city of Barnaul from early November to late April, and at northern Salekhard from the end of October to the beginning of June. In the regions of the upper Ob they grow grapes, melons and watermelons and the lower reaches of the Ob are Arctic tundra. The most comfortable climate for the rest of the Ob is in the cities of Novosibirsk, Barnaul and Biysk [1-5]. For our research we take only the middle part of the river (and particularly at Kaybasovo station).

In the middle course of the Ob River studied in this work, the main factors influencing the element input from the surrounding mineral and organic substrate to the Ob River are i) the groundwater influx during baseflow and ii) plant and peat leaching, which depends on the flooded area size and spring-summer flood duration. To better understand the mechanisms regulating the contemporary fluxes of carbon, trace metals and major nutrients at the Ob watershed and to predict possible future changes, the use of the time series only at the gauging station is not sufficient. Rather, detailed, seasonal studies of water regime of different components of the watershed, such as small tributaries, flooded water bodies and adjacent lakes, are necessary to reveal the variation of chemical composition along a transversal flooding gradient [5].

2. Geomorphology and ecological features of the floodplain

The floodplain is a subject of study of many scientists. Different authors (RS Chalov, VA Zemtsov, VP Bolotnov, VS Khromykh, LF Shepeleva, GS Taran and AI Shepelev) at different times wrote about it. The floodplain as the environment has its own peculiarities. Those are the heterogeneity and dynamics of the morphologic and lithologic formations; periodic appearance of the specific territory's characteristics - frequency and duration of the floodplain inundation, thickness of alluvium, and the existence of the complex interdependencies of the contemporary and past processes of the floodplain formation [15]. The floodplain research relevance has significantly increased in recent years due to changes in the hydrological regime of the northern territories driven by climate change.

The exchange of greenhouse gases, dissolved organic carbon and associated metals between the topsoil, vegetation and melt water happens and influences the floodplain landscapes. Despite the fact that this exchange determines the overall removal of organic carbon from the water catchment area by more than 60% and to a large extent controls the flux of carbon dioxide into the atmosphere, the mechanisms of this process are practically unknown. Field experimental research enables us to discover the main physical and chemical factors that control the entry of substances into a river and evaluate the scale of changes in this streams when the initial conditions change, for example, if the amount of snow is increased or if the vegetation differs (such as from forest to tundra) [16].

As it has already been told, the spring flood is the most important period in the formation of the river flow, but its influence is still largely unstudied. Work on analysing its role in climate change has only just begun. The flood's height and duration decisively have an influence on the conditions of the riparian ecosystems' existence, providing both direct and indirect impacts not only on the individual habitat, but also on the whole floodplain natural complex [16]. The duration of floodplain inundation, water depth and alluvium thickness are the main specific ecological characteristics, defining the composition, spatial structure and properties of the floodplain vegetation. The inundation of the floodplain during the flood influences both vegetation and other components of the floodplain biogeocenosis. At the same time, there is water saturation of soil, acceleration of thawing, change of soil and air, and additional intake of mineral nutrients. There is an increase in soil biological activity and soil "rejuvenation" because of toxic products removal and organic and microflora intakes [15].

The river spreads wide during the spring flood, forming floodplain lakes and rivers. Figure 1 shows an extremely high flood in 2015. In the picture we can see the riverbed and the submerged floodplain. In the study of the floodplain of the Ob river middle course it is necessary to select the vertical cross-section that covers all natural formations. It is useful to analyze and compare the data: during the flood some depressions are completely flooded every year, and some ridges are inundated only once a few decades. The middle part of the floodplain is influenced by floodwater irregularly and unevenly, so it is the most interesting to study. In such a case, we talk about ecological valence. Ecological valence means wide ecological amplitude of the species, its plasticity, and the ability to adapt to a wide range of environmental conditions. Changing the composition of the dominant, differing environmental standards in different years with different moisture conditions is one of the characteristic features of the floodplain biota [16].

Fig. 1. The flood in the Ob River, 2015.
Archives of aerial photos of Centre of Excellence "Bio-Clim-Land"

The floodplain formation is a result of hydrodynamic nature events. So, we can divide the floodplain into three parts: riverine, central and near-terrace [2, 17, 18].

The riverine floodplain presents a beach between the level of water in the river and the swell of meadow terrace. This part of the floodplain can be developing in different ways. The central part of the floodplain is under meadows and different lakes. The most common are meadows on the low, where the floodwater stays for a long time. These are temporary ponds. Also, there are many wetlands and lakes with a high level of flooding. The near-terrace part of the floodplain is situated between bedrock slope of the valley and near-terrace bars. In the area of the near-terrace floodplain there are groundwater outputs [2, 4, 17, 18].

The Ob floodplain surface is not smooth. It is usually characterized by a higher elevation of riparian areas, while the central parts of the floodplain are the lowest. In the central floodplain, a lake and a low meadow system are often located [2, 17].

The peculiarity of the floodplain is a deficiency of dissolved oxygen in water. During summer, oxygen easily comes into the water from the atmosphere and its lack is not so significant. In winter, the oxygen inflow into the water stops. As the water goes downstream, it is replenished by groundwater and wetland waters deprived of oxygen. So, the process of oxygen decay begins. This process increases the amount of carbon that comes out after ice melting. The carbon can be emitted into the atmosphere or go downstream in water and be emitted in other regions. So the floodplain processes influence large areas [2, 4, 19, 20].

The character and the duration of the flooding determine natural floodplain features. The beginning of the flood period is the water level at which water leaves a river channel and floods the low places in the floodplain. From this moment the water starts to have an impact on the conditions of the existence of riparian plants and animals [2, 4, 21].

3. Research of the Ob floodplain

3.1. Previous research

Many scientists have been studying the Ob floodplain. The most important scientific generalizations at different times were carried out by VA Zemtsov, OG Savichev, VP Bolotnov, OA Alekhin, J.-M Martin, IA Shiklomanov, SL Shvartsev and other authors [22-74]. The biogeochemistry was studied by OS Pokrovsky, SN Vorobyev, DV Moskovchenko, OV Serebrinnikova, MA Zdvizhkov and OS Naimushina [28-32]. Scientists, studying chemical composition of the Ob basin water, were VV Paromov, LI Inisheva, NG Inishev and EYu Pasechnik [33-37]. PN Balabko, TP Slavnina, LA Izerskaya and AI Shepelev studied the floodplain soils [38-43]. LF Shepeleva, ZA Samoilenko and GS Taran are the most known scientists studying the floodplain vegetation [44-50]. Animals and birds were studied by AM Adam, SS Moskvitin and AA Maksimov [51-58]. Many scientists (NF Vyltsan, GD Dymina, AV Ogorodnikova, AI Boynov, VN Tyurin and PS Kuzin) studied the floodplain resources and hydrological peculiarities and problems [59-74].

Regime hydrochemical observations in the Ob River are based on the stationary points of the Hydromet network. They have their own peculiarities such as a small number of observation points; later onset of massive hydrochemical observations (with a significant increase in 1970-1980); a change in the water sampling regime in the 1980s. "The methodical support of hydrochemical observations and analysis is provided by the Hydrochemical Institute of Roshydromet, and the data are published in the "Annual Reports of Surface Water Quality" by region" [8. P. 391].

Analysis of geochemical and physicochemical characteristics of water of the Ob and its tributaries shows that river waters in the areas of forest steppe and taiga forest are fresh with salinity from very small to medium by calcium bicarbonate, and in the steppe area fresh with higher salinity or slightly salty by sodium chloride. The zonal increase in the concentrations of Na^{+}, Mg^{2+}, Ca^{2+}, Cl^{-} and the amount of total dissolved salts in the river waters in the direction from the steppe to the tundra is well expressed. In other hydrochemical parameters the trends are much less pronounced or completely absent [8, 9].

In river waters of the foothill and mountain areas, the content of dissolved salts is lower than in the taiga and forest tundra, but higher than in the tundra. It can be explained by a higher intensity of water exchange, and in the forest tundra by a decrease in the intensity of interaction in the "water-rocks" system in permafrost conditions. The concentration of organic matter rises because of mires, and their transformation products do the same, compounds of organic acids with a number of metals and low pH in river waters. By assessing the impact of wetlands, it is important to consider the overall waterlogging and the types of wetlands and their location. Especially waterlogged river valleys show the influent of a significant quantity of organic matter in the river during periods of high water content. In spite of big differences in chemical composition and salinity, surface waters of all natural areas in general are undersaturated in relation to primary aluminium silicates and capable of dissolving them to form clay minerals, if there is sufficient time of contact with water, which actually happens. More clear differences between the natural areas are marked in the case, when river water interacts with carbonate minerals. Therefore, in general, the chemical composition is in agreement with the zonal hydroclimatic conditions. It is determining the nature and timing of interactions within the "water–rocks" system and consequently the correlation of processes of accumulation and removal of substances from different components of the environment. In connection with the local sources of matter, the correlation makes the hydrochemical "background" in the Ob basin [8, 9, 32].

Most of these waters, entering the Ob river system, go from bogs. It is evident, that the mire waters of the region in their natural state are characterized as slightly acidic or neutral, fresh with salinity up to 200-500 mg/dm^3; the organic substances concentration is about 25-50 mgC/dm^3. In the vertical cross section of the peat, the least mineralization is observed in the upper part of the active layer, which is characterized by the highest flow through and filter coefficients [8].

The main characteristic of middle and lower reaches of the Ob is exceeding the maximum permissible concentrations of ammonium and nitrite nitrogen, iron, some trace elements, organic matter and pH level. Sometimes the excess of the maximum permissible concentrations of total dissolved salts is possible because of natural conditions. In the steppe, the evaporation process dominates in the formation of the salt composition of groundwater and river. In the middle and lower reaches of the Ob there is severe waterlogging of watersheds and, as a result, input of large amounts of organic substances and their products of transformation (with organo-mineral complexes) into the river network [8, 9]. "The anthropogenic influence on the chemical composition of surface water and groundwater is also observed in the Ob-Irtysh basin, mainly shown by the presence of trace elements in the water bodies from highly toxic industry, and the increasing loss of hydrocarbons, easily oxidized organic substances, inorganic nitrogen compounds, microorganisms, washed out from urbanized areas and polluted air" [8. P. 392].

The geochemistry of the suspended matter of western Siberia's large rivers was studied in 2000-2005 during the summer baseflow period; but still there is no information about the dissolved matter in river water. Only occasional data of some major element and nutrients and trace metals (such as Fe, Cu and Zn) are available for the mouth zone of the Ob River. The Cr, Cd, Cu and Ni concentration in the water column of the Ob during summer baseflow were reported. The range of metal concentrations (0.06-0.34 for Cr, 0.001-0.015 for Cd, 1.8-4.8 for Cu and 0.8-2.8 mg/L for Ni) is in good agreement with the baseflow and spring flood measurements (0.2, 0.005, 1.0-1.2 and 0.5-1.3 mg/L for Cr, Cd, Cu and Ni, respectively). The past decade a big amount of information on the major and trace element concentrations in the mouth zone of the Ob River was collected in the course of different programs [5].

Highly soluble and mobile elements: major anions (dissolved inorganic carbon, sulfate), cations (Na, K, Mg, Ca), other alkali (Rb, Cs), trace oxyanions (Mo, Sb), alkaline earth traces (Sr), U, have the influence of underground feeding in the time of baseflow. It is verified by an abrupt decrease in their concentrations with an increase in the dissolved organic carbon (DOC). In contrast, K, Rb, Si and Cu showed a strong increase in concentration with the DOC in the flooding zone, with the maximal concentrations in the flooded grass field. Probably these elements are controlled by lixiviation from the grass biomass that is enriched in Si, K and Rb. For example, Rb and K correlations with the DOC were the highest of the floodplain. K is a very important component of vegetation covered by flood water in baseflow period, and isomorphic Rb tightly follows this macronutrient [5].

According to LF Shepeleva, the floodplain flora communities are clearly divided into ecological groups according to location moisture, including the resistance to flooding duration. Long flooding is a powerful factor in the selection of species, ecotypes and life forms of plants that can dwell in floodplains. A wide spread of certain types of trees and shrubs in the riparian lands (poplar, willow) and a wide variety of herbal phytocenoses is related to this [16].

The importance of alluvial thickness for plants is the income of mineral nutrients, the impact of soil properties (indirect effects), and the soil covering by alluvial deposit (direct effect). Due to the formation of structural units during the drying, thin alluvial deposit beneficially effects on the water-air properties of soil. The layered sediment from alternating coarse-sand and fine-grained layers and sandy alluvial deposit of middle thickness improve aeration and water-holding capacity of the soil and promote the nitrification [15, 18].

3.2. Contemporary research

In spite of the importance of the Ob River, systematic seasonal studies of the river's dissolved load (carbon and metals) are limited compared to those of other great rivers (for example, the Lena and the Yenisei). The importance of the Ob River is triple. First, the Ob River, which has the second largest flooding area in the world, can be the largest contributor of dissolved carbon and related element transport from the land to the Arctic Ocean. The second is the majority of the Ob's watershed lies within a quite productive boreal taiga zone. The productivity of the terrestrial boreal biome is very high at the river banks and riparian zone, particularly in the permafrost-free region. The degradation of plant litter is one of the major factors regulating the overall export of chemical elements and DOC from the boreal watersheds. Plant litter's leaching is very fast, therefore the Ob's spring flood is a very important period for the biogeochemistry of the Western Siberia plain. Third, the Ob River watershed is most sensitive to permafrost thaw and climate change because the major part of its permafrost coverage is sporadic and intermittent permafrost. The former is known to be most sensitive to the ground temperature rise [5].

An important part of the floodplain ecosystem is soils. The Ob River alluvial soils play a big role in Western Siberia's landscape. These soils are more fertile; they provide favorable conditions required for plant growth and form the basis of the best natural foraging areas for both wild and livestock animals. B, Mo, Pb and Cd are accumulated in all parts of soils of all the geomorphological floodplain elements. There are higher levels of concentration factor for Cd and B. Mn is concentrated in the south-taiga and forest-steppe zones (floodplain central part), and Co is also found in south-taiga and mid-taiga zones. Cu and Sr in the alluvial soils dispersed independently of floodplain geomorphology. The level of trace elements is not connected with agricultural or industrial pollution. It agrees with its natural content. The trace elements' basic amount is in the potentially mobile form. According to the vegetation growth, alluvial soils have high amounts of Mn, Cu and Mo; B in average quantity, concentration levels of Co and Zn are low. There was observed a decrease in the content of trace elements in soils in the direction south to north, whereas it is impossible to differentiate between regularities that are caused by changes in the properties of the floodplain's soils from river's source to its mouth. It was shown that the changes of the local latitude coincide with the Ob's streamline, and the connection between trace elements and the latitude is loose. Such regularity is characteristic both for soils and for vegetation. The amount of Co, Mo, B, Sr and Cd is reducing in plants, but for Mn, Zn and Cu, the situation is the opposite [40].

Another question is carbon, pH and their interdepending in the ecosystem. The acidic and humic upland lakes show the lowest pH values, being influenced by atmospheric feeding of surrounding bogs, peat and moss leaching. The Ob and most floodplain lakes exhibited the pH above 7; it is most likely linked to groundwater feeding. Because of a clear trend of DOC concentration decrease with pH increase in the pH - DOC plot, the DOC can be used as the best indicator of different water objects and the main governing factor of trace elements migration [5, 73].

Total organic carbon in the region river waters is strongly varied, a wide range from 3-4 mg/dm^3 [32]. Several categories of the major and trace elements were distinguished by their affinity to DOC. The first group comprised the elements, which showed a general decrease in concentration with an increase in the [DOC]. These are dissolved inorganic carbon (DIC), specific conductivity, Na, K, Rb, Mg, Ca, sulfate, Cs, Sr, Mo, Sb and U. It is the lowest values in upland lakes, which are rich in DOC. For the Ob River the element concentration decreased with an increase in the DOC. In this group, various parts of the flooded zone are very interesting, because they presented a contrasting behavior for different elements. The major (Ca, Mg, Na and DIC) and trace elements (Sr, Mo, Sb, U) were independent of the DOC or their concentration decreased with the DOC. But K, Rb, and Si were correlated with the DOC in the flooding zone. The ground water-fed elements are mostly pronounced in flood lakes during summer baseflow. Although most of them (DIC, Na, Mg, Ca, and Sr) are usually independent of the DOC, some clearly decrease while the DOC increases, marking an abrupt decrease in the groundwater influence (Mo, Sb, and U) [5].

The second group consists of some elements that are irrelevant to the DOC concentration, without any clear pattern in the concentration-DOC trend among various water objects. These are B, Cl, Si and V. Apparently, these elements exhibit as neutral molecules or oxyanions that are weakly connected with dissolved organic matter and may originate from atmospheric deposits (B and Cl) or surface flow (Si and V) rather than groundwater [5].

The third group of elements includes those that are controlled by organo-mineral and organic colloids. "These are insoluble, usually low mobile elements (Al, Fe, other trivalent hydrolysates, Ti, Zr, and Hf) and some metals (Cr, Zn, Ni, Ba, and Pb). They presented a steady increase in concentration with an increase in the DOC, with the lowest values observed in the Ob and the highest values observed in small tributaries and organic-rich upland lakes" [5, p. 136]

One more studying question is microbiological composition. It is various in the Ob river. Different groups of heterotroph and lithotroph microorganisms were identified. They are:

1) saprophytic bacteria, which are responsible for mineralizing dead organic material;

2) oligotrophic bacteria, which develop at low concentrations of organic substances;

3) chemoorganotrophic bacteria;

4) denitrifying bacteria, which are able to reduce nitrates to gas;

5) nitrifying bacteria - autotrophic microorganisms receiving energy due to oxidation of deoxidized nitrogen compounds;

6) ammonifying bacteria, which decompose complex nitrogen containing organic compounds (proteins, amino acids and a number of various substances), resulting in ammonia, hydrogen sulphide and carbon dioxide isolation;

7) thionic bacteria, which receive energy due to oxidation of sulphur and its reduced compounds;

8) sulphate-reducing bacteria - anaerobic microorganisms, which are able to reduce sulphates to sulphides when in use metabolism [32].

The floodplain ecosystem is very environmentally important. At different times the study of hydrology and river run-off in the region was conducted by PS Kuzin, DA Burakov, LK Malik, AN Antipov, SP Nikitin, VA Zemtsov and others [27, 69-74]. A hydro-chemical study of the Ob's middle course, first order tributaries, temporary and persisting lakes, the large flood zone determined first-order factors controlling the dissolved organic carbon and related metal sources and sinks. Two contrasting seasons (spring flood and summer baseflow) were considered, and there were distinguished the elements controlled by the groundwater influx (DIC, Na, Mg, Ca, SO4, Sr, Mo, Sb, and U) and by surface runoff via plant litter and topsoil leaching, especially during the spring flood (Si, K, Rb, Mn, Zn, and Cu). Cl, SO_4, Zn, Cd, Sb, Cs and Pb in different lakes (upland and flood) during flood period could be much influenced by aerosol deposition (snow melt) [5].

The principal carriers of many insoluble elements (some divalent, trivalent, tetravalent) are organo-ferric colloids stabilized by dissolved organic matter. The Ob stream's dissolved chemical composition can be approximated within ±30-40% by that of the floodplain during the period of high water. We can say that the main autochthonous processes controlling the DOC and related trace elements transformation between different water bodies are phytoplankton uptake and the microbial heterotrophic and photodegradation of organo-mineral colloids. They strongly depend on the water residence time. May be under ongoing climate changing the groundwater-influenced soluble elements will remain unaffected and the autochthonous processes will influence the removal of colloidal trace elements from the water column of the flood lakes, large and small rivers and upland lakes of the Ob's middle course watershed [5].

4. Contemporary approaches to complex interdisciplinary study of the Ob floodplain

To study the floodplain changes after a flood the methods of landscape ecology are used. Landscape ecology is an interdisciplinary field that studies landscape structure, function and change and its ecological consequence. Landscape ecology is growing rapidly, its concepts, theories and methods are uniquely relevant in addressing large-scale issues in natural resource management. Most landscape ecologists agree that a landscape is a heterogeneous land area that is often hierarchically structured. One of the main principles of landscape ecology states that spatial arrangement of patches is the major determinant of functional movement across the landscape. Additional principles include the statement that local ecological conditions are affected by landscape context or attributes of the surrounding landscape [75]. Methods of landscape ecology include also the remote sensing and are described by many authors [76-78].

Research methods in landscape ecology include the collection and analysis of stock and descriptive materials, literature and maps; the preparation of a series of component and general landscape maps, clarifying individual landscape systems performance by field studies. The field studies include topography, soil and geobotanical works that are carried out by a group of specialists. The final step is to draw up the final series of maps: the forecast map, maps of natural factors of heightened tension, technical maps etc. [79]. While sampling and experimentation usually require researchers to be physically in field, remote sensing techniques collect information about an object without direct physical contact and have become an essential tool for obtaining large-scale spatial data in the forms of satellite imagery and aerial photography. Tools for data analysis and integration include geographic information systems, spatial statistics and modeling. Geographic information systems are arguably the most important tool for storing, manipulating, analyzing and integrating both spatial and non-spatial data. Spatial statistics or geostatistics are useful tools for analyzing landscape patterns [75].

The study of the Ob floodplain will be realized at Tomsk State University station Kaybasovo (fig. 2). This is the key area for research, where these methods will be applied. There exists an infrastructure: residence place, appliances and hydrometeostation. The hydrometeostation allows measuring the temperature of the air and soil, solid and liquid precipitation, thickness of snow layer and water level in the Ob. Wells for measuring groundwater levels are drilled.

The research should be based on the combined, multidisciplinary approach to understanding the modern evolution of the main chemical and biological components of the floodplain landscape. It includes full-scale pilot experiments in landscapes and laboratory experimental simulation. It is expected that such a combination of experimental and modeling approaches allows predicting possible physical, chemical and biological changes in the status of the key components of the landscape.

Fig. 2. Station Kaybasovo. Photo made by SN Kirpotin.

Experimental manipulation of ecosystems and their components are powerful tools to find cause-and-effect relationship and predict ecosystem responses to floodplain processes and carbon emission. It is assumed that only the controlled modification of a single parameter or a landscape component with other constant parameters allows approaching the quantification of possible effects of future climate changes and predicting the potential significance of these changes for human being. Despite the fact that the field experiments are crucial to the understanding of ecosystem responses to climate change, direct experimental data is not enough; in addition, little is known about the ecosystems' mechanisms of adaptation and optimization to changing.

To make good scientific research we need to have:

1) knowledge of the object of study and large tried and tested material available in the team.

2) originality and novelty of the proposed approach, allowing to achieve an integrated understanding of the evolution of natural systems with guaranteed practical applications in technology and innovation.

3) multidisciplinarity of approaches, combining with remote sensing, field surveys, laboratory simulation and integrated environmental development of the areas of biology, geochemistry, geography and the sciences of physics and mathematics cycle.

New knowledge about the dynamics of the biogeochemical processes in the floodplain system will be obtained based on these complex multifactorial laboratory and field experiments, and possible effects on the ecological condition will be predicted.

The mesocosm experiments will play the main role; this method will identify consequences of possible changes or nature disasters (like long flood or forest fire) in the floodplain vegetation, soils and water. The change of hollow waters interacting with different types of underlying surface of the floodplain will be studied on artificially flooded areas created at the Ob floodplain station. In mineral and peat soils' changes in the composition of the soil solution, soil organic matter and gases at different univariate and multivariate effects (temperature, humidity, and nutrient regime) will be studied. Information about the parameters will be obtained in the laboratory, under the direction and flow of various elementary processes and reactions.

Conclusions

The floodplain is a very important part of the river; and the most important factors of the floodplain landscape development are floods and the following processes. The structure and spatial differentiation of natural complex of the river floodplain depend on it.

The Ob floodplain has been studied for many years; nevertheless, there are still many unstudied aspects. The biogeochemistry is little known, and it is important to know the floodplain processes and the following carbon cycle. The contemporary research level needs combination of remote sensing and field and laboratory experiments. Thus, we have to organize these works at the new station Kaybasovo. The structure is already organized, now we expect the research and its results.

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