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CONTENTS

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NATURAL FOCAL DISEASES IN RUSSIA: MONITORING AND MAPPING

ABSTRACT. The paper discusses a mapping method for compilation of maps for a medical-geographical Atlas of Russia "Natural Focal Diseases" and potential that this Atlas presents for assessment and monitoring of the epidemiological situation in a number of diseases. A series of analytical, integrated, and synthetic maps shows disease incidence in the population at both the national and regional levels for the last 15 years. The Atlas contains maps of the mean annual incidence of certain infections and maps of incidence dynamics and nosological profiles that allow detailed analysis of the situation for each of 83 subjects of the Russian Federation. The degree of epidemic hazard in Russia by naturally occurring is reflected in a synthetic medical-geographical map that allows one to estimate the risk of a disease manifestation in a given region.

KEY WORDS: natural focal diseases, atlas mapping, medical-geographical atlas, morbidity rate.

INTRODUCTION

The outcome document of the United Nations Conference on Sustainable Development, held in Rio de Janeiro on 20–22 June 2012, emphasized the notion that health is a fundamental condition, the result, and an indicator of sustainable development. People's health remains a vitally important criterion for measuring the impact economic, environmental, and social policy because its outcomes are readily assessable and health concerns are immediate, personal, and local [UN, 2012]. Therefore, special attention should be paid to research of environmental factors that may have an adverse effect on the health of the population.

Numerous natural focal diseases represent a serious risk to human health; while their agents and vectors are part of natural landscapes. Therefore, medical geography has an important task – to evaluate the risk of epidemic hazard of natural ecosystems and to provide public health authorities with recommendations necessary to prevent mass disease outbreaks and conduct activities for full remediation of the focal territory. In recent decades, increasing human activities (e.g., the economic development of new regions, intensive suburban construction areas around the cities, the expansion and growth of recreational pressure) have led to a significant increase of contacts among of the population and the natural foci and the creation of epidemiological conditions for the spread of natural focal diseases. "Humans have come closer to the like never before have approached sources of infections that exist in the nature as they have never done before" [Bogomolov, 2008]. In addition, there is a growing inflow of migrants from epidemic-prone areas, manyfold increase of tourist flows, and increase in international traffic that also elevate the risk of infections, due to natural conditions. Monitoring of the epidemiological situation and the development of sanitary measures to protect public health requires investigation of the geography of natural focal diseases, natural and socioeconomic background of their distribution, and spatial structure of the focal areas at different spatial and temporal levels.

Despite the increased attention to this issue in the past decade, many research questions of natural focal diseases remain unanswered. These questions include the development of the principles and methods of synthesizing the medical-geographical information and obtaining new knowledge about the spatial distribution patterns of natural focal diseases using mathematical and cartographic models.

One important aspect of such studies is atlas mapping, combining general scientific methods (system, integrated, historical, etc.) and specific (statistical, landscape, medical-geographical, etc.) approaches with geographic information technologies. The experience of the Soviet and Russian medical-geographic medical-geographical mapping is rather extensive. The scientific and methodological basis of medical-geographical mapping that uses the landscape approach, methods of mathematical statistics, multivariate analysis, conjugate mapping studies, and synthesis of the information is well developed [Vershinsky, 1964; Prokhorov, 1968; Malkhazova et al., 2001, Malkhazova et al., 2011b; Malkhazova and Shartova et al., 2011, etc.]. However, the scientific-methodological and practical experience of the national medical-geographical mapping, in particular, mapping of natural focal diseases is significant in the field of regional and local mapping only and is extremely limited in the overview mapping at the federal (national) level. In terms of the status of cartographic studies of natural focal diseases for Russia as a whole, it may be stated that the coverage of the territory is not consistent in reliability and level of detail of cartographic representation. Differences in quality and incompleteness of the initial information and the use of different methodological mapping approaches make it difficult to obtain a complete picture of the distribution of natural focal diseases within the Russian Federation territory [Malkhazova and Kotova, 2010]. Despite the existence of several cartographic products that reflect the distribution of natural focal diseases in Russia, a cartographic summary showing the geography of natural focal diseases for Russia as a whole, i.e., at the national level, is still lacking.

Currently, the Faculty of Geography at the Lomonosov Moscow State University is working on the compilation of a medical-geographical atlas of Russia "Natural Focal Diseases". The concept and the main issues related to the compilation of the atlas are described in a number of publications [Malkhazova and Kotova, 2010; Malkhazova et al., 2011a; Malkhazova et al., 2011b; Kotova et al., 2012; Malkhazova et al., 2012]. The purpose of the Atlas is to reflect the spatiotemporal distribution of natural focal diseases for Russia as a whole taking into consideration a set of conditions and factors that influence it. The main goals associated with the compilation of the atlas were as follows:

- systematization and analysis of the role of natural and socioeconomic factors in the spread of natural focal infections;
- mapping of natural foci of infections in the territory of Russia and some of its regions; identification of the most active foci and assessment of their potential danger to humans;
- analysis of the incidence of natural focal diseases in the population in Russia in general and in some model regions.

According to these goals, the atlas has seven thematic blocks and 110 maps:

1. Introductory section.

2. Natural conditions.

3. Demographic and socioeconomic conditions.

4. Agents and vectors of focal diseases.

5. Distribution ranges of natural focal diseases.

6. Disease incidence in the population.

7. Organization of public health system and preventive measures for natural focal diseases.

A significant part of the themes is implemented in the maps supplemented by charts, graphs, and text material. The main scales of the maps for the territory of Russia are 1:20 000 000 and 1:30 000 000, and for the maps of the individual regions are 1:4 000 000 and 1:10 000 000, respectively.

The work on the atlas includes several stages. To date, the maps on natural focal disease incidence have been compiled for Russia in general. This allows for analysis of the obtained cartographic material. This paper discusses the potential of the atlas to assess and monitor the epidemiological situation for a number of diseases.

DATA AND MAPPING METHODS OF SECTION "MORBIDITY RATE"

The background data for the atlas included the ROSSTAT statistics on socioeconomic indicators and the data of the Federal Service on Customers' Rights Protection and Human Well-Being Surveillance, representing the statistics on the disease incidence in the population (for infectious and parasitic diseases). In addition, the atlas used other materials available to the authors: mapping of the natural environment; previously compiled maps of the federal and regional atlases; field, report, and archival material; and the results of interpretation of satellite images.

The work on the section included the following steps: 1) preparation, update, and analysis of the database on infectious and parasitic natural focal diseases within the Russian territory; 2) selection of mapping methods; 3) mathematical-cartographic modeling; and 4) medical-geographical analysis based on the compiled maps. The process of the maps' compilation may be broken in two stages: compilation of analytic (inventory) maps and compilation of integrated and synthetic (assessment) maps.

Twenty two nosological units were covered in the maps: 14 infectious diseases (rabies, Lyme disease, brucellosis, hemorrhagic fever with renal syndrome [HFRS], tick-borne rickettsiosis of North Asia, tick-borne encephalitis, legionellosis, leptospirosis, Q fever, ornithosis, pseudotuberculosis, anthrax, tetanus, tularemia) and eight parasitic diseases (diphyllobothriasis, opisthorchiasis, beef tapeworm infection, taeniasis, toxocariasis, trichinosis, trichuriasis, echinococcosis).

The section "Morbidity Rate" includes several groups of maps; one of the maps shows the average long-term incidence of certain natural focal infections and another – its multiannual dynamics. In addition, the section contains six maps on the dynamics of the incidence of the natural focal infections, the most relevant to the Russian Federation, and one comprehensive map of nosological profiles of the administrative units (federal subjects of Russia).

The maps of the mean annual morbidity were compiled using the cartogram method and reflect the relative and absolute values for each administrative unit.

The maps of the multiannual dynamics of morbidity show variations in the number of cases in relation to the average annual value. The line diagrams for the federal subjects reflect the positive and negative deviations of the values of the incidence data from the mean annual values. Thus, each region has its linear diagram where each year is depicted with its own color, which makes it possible to compare specific years and variations of disease incidence at the national level.

The compilation of a series of maps on the types of dynamics was done using the data of mathematical-cartographic modeling, the analysis of the relative parameters of disease morbidity for 1996–2010, and the typological

Fig. 1. A fragment of the map "Nosological profiles of federal subjects of the Russian Federation"

classification of disease morbidity using the methodology introduced by V.S. Tikunov [1997]. At this stage of work, we have identified the main spatiotemporal patterns in the distribution of this parameter for the six diseases relevant to the territory of the Russian Federation: tick-borne encephalitis, Lyme disease, HFRS, beef tapeworm disease, opisthorchosis, and trichuriasis.

The map of the nosological profiles shows the sets of specific natural focal diseases in the context of the Federal subjects presented in the form of a matrix showing the presence or absence of a disease in the population for each year for 11 years. The matrices are arranged vertically by nosological units (diseases) and horizontally – by the years (Fig. 1).

RESULTS AND DISCUSSION

The maps included in Section "Disease Morbidity" are based on the national statistics. Because of the nature of the data collection and submission based on the administrative-territorial principle, the basic map units are the administrative units of the Russian Federation. These maps represent the level of disease incidence for a given period. With their help, one can evaluate the general characteristic of a specific disease in a particular area, identify the most affected regions, and improve the understanding of the natural confideness of the endemic territories. These maps can be easily updated with new temporal data.

Map "Nosological Profiles" shows characteristics of the distribution of the most important natural focal diseases at the national level and can be used in assessment of the representativeness of the nosological units and frequency of manifestation of certain infections in different regions. It reflects the most common natural focal

TICK-BORNE ENCEPHALITIS

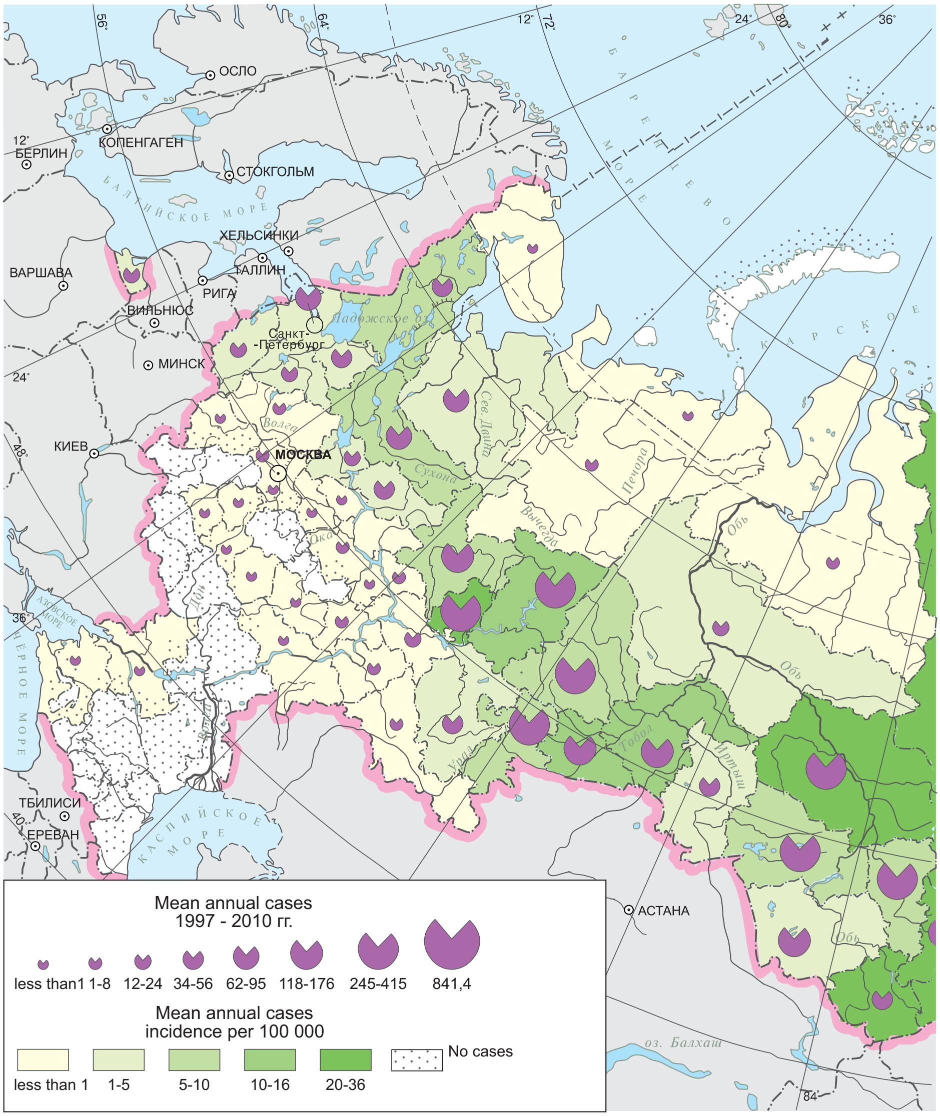

Fig. 2. The incidence of tick-borne encephalitis: A: mean annual incidence (a map fragment)

DINAMICS OF TICK-BORNE ENCEPHALITIS INCIDENCE. 1997-2010

SCALE 1:40 000 000

Fig. 2. The incidence of tick-borne encephalitis: B: the types of dynamics of the disease (a map fragment)

infections in Russia, among which, as the maps' analysis has shown, the leading role is played by Lyme disease, leptospirosis, and HFRS that occur in most parts of Russia, as well as by tick-borne encephalitis and opisthorchiasis.

For example, in order to analyze the incidence of certain diseases, let us consider the maps showing the incidence of tick-borne encephalitis, i.e., one of the most dangerous natural focal infections in the Russian Federation (Fig. 2).

The map (Fig. 2A) reflects the distribution of the morbidity over 14 years. The map on the typological classification of the Russian Federation by the dynamics of the encephalitis incidence parameters (Fig. 2B) reflects different subtypes of taxa derived from the estimated indices and semantic analysis of the results. Each subtype is characterized by the reference path of the dynamics of the disease incidence in the population for a given period (decrease, increase, with significant or insignificant fluctuations in amplitude, etc. – five taxa in total). This map gives an indication of the degree of uniformity of epidemic outbreaks of tick-borne encephalitis in different regions, which provides a tool for the optimization of planning control measures.

Mapping the morbidity for such large territorial units, as the federal subjects of the Russian Federation, is a necessary but not sufficient element in the assessment of the spread of natural focal diseases. This representation is the epidemiological characterization of the population rather than that of specific diseases, whose ranges are determined primarily by the parameters of the environment. However, the nature of the information on disease incidence in the population at a small scale (i.e., covering a large area) does not allow using the natural boundaries. In order to overcome this limitation, along with the maps on disease incidence, the atlas contains sections on the distribution ranges of the main hosts, vectors, and disease agents, and their natural and socioeconomic determinants. This approach allows creating maps of distribution ranges of diseases and, in the end, an integrated medical-geographical map of natural focal diseases in the territory of Russia. In the future, the maps at the federal level will be supplemented by the regional and more detailed maps with in depth assessment of the character of distribution of the foci and spread of the natural focal diseases.

CONCLUSION

The compiled series of maps "Disease Morbidity" allows to:

1) determine the spectrum of the most diagnosed natural focal diseases observed over the past 15 years at the level of the subjects of the Russian Federation and the country as a whole;

2) quantify disease morbidity in both absolute and relative terms;

3) forecast incidence based on the types of dynamics of disease incidence using mathematical-cartographic modeling for the current natural focal diseases;

4) identify the most visual ways of cartographic representation of the dynamics of disease incidence;

5) carry out medical and geographic analysis of the territory for the spread of the basic nosoforms of natural focal diseases in the regions of the Russian Federation and in the territory of Russia as a whole.

Taken together, the maps allow assessing the persistence in the manifestation of the diseases and the degree of specific diseases spread risk of the territories. The results of analysis can be used for the purposes of health monitoring and targeted preventive measures, especially in the areas of new development and the areas affected by the recreational load. ■

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CHANGE OF THE FLOODPLAIN AREAS ALONG SOME RIVERS OF THE VOLGA RIVER BASIN

ABSTRACT. The estimation of the area of the territories which are under the threat of flooding is of great importance. The technique, based on a principle of conformity of the area of a floodplain massif, averaged within the part of the river with a particular order, to this order has been proposed. The stream order, according to the Scheidegger scheme, were calculated for the mouths of 9907 rivers in the Volga river basin. For 96 rivers of the Volga basin, which has length of more than 200 km, changes of stream order within the entire extent were calculated and a map was compiled using the obtained results.

For several rivers in the Volga river basin, change of the average floodplain areas along the rivers was estimated. It allowed establishing dependences between the average floodplain areas and the stream order, with higher order corresponding to bigger floodplain areas.

KEY WORDS: Volga; floodplain areas; water regime.

INTRODUCTION

Spring high water period is a hydrological season of a year with a greater risk to hydroecological safety of the population and economy. River floods can cause considerable social, economic, and ecological damage. The loss increases with greater frequency, depth, and duration of flooding [Taratunin, 2000]. It also increases with growing population, settling area in valleys of the rivers, and growing cost of basic assets [Dobrovolsky, Istomina, 2007]. Though the territory of the Volga river basin includes the zones with rather small risk of flooding, annual damages from this dangerous natural and social phenomenon in the Volga river basin can reach 200 million Russian roubles and more.

FREQUENCY OF FLOODS IN THE VOLGA RIVER BASIN

Let us assume that, at some water level H_m, flooding of a river segment with the initial H_p water level starts. At $H_{mn} \leqslant H < H_p$, the water stream is limited with the low-water period level and is not a danger for the population and the social and industrial objects located on the floodplain. Difference $H_m - H_{mn} = \Delta H$ characterizes a natural range of change of water levels on the river segment. It depends on the size of the river (its rank N_{Sh}) [Nesterenko, Kositsky, 2010] and the watershed area F. In the Oka river basin, for example, at $F < 15\,000$ км^2, this difference is (in cm) $\Delta H = 0{,}04F + 160$ [Samokhin, 2006].

The value of ΔH depends on a geomorphological type of a river channel (broad-floodplain, altered, or incised). In the Volga river basin, there prevail (80%) broad-floodplain river channels, for which periodic or annual flooding of the both sides of the river is characteristic. The rivers with altered channels usually have a floodplain on one side (on the opposite bank, there is usually a slope composed of solid rocks). In the Volga river basin, altered segments of rivers occupy about 5% of the river network. Within the watershed area F = const and in the floodplain zones, ΔH of broad-floodplain and altered river channels changes slightly. Approximately 15% of the Volga basin channel network belongs to the extended incised channel type with a very small or completely absent floodplain. For the incised channels, there is no danger of flooding of the area because the slopes of such rivers are abrupt, and banks are high and can contain seasonal maxima of water levels that can cause flooding.

The type of water regime of the Volga basin (according to V.D. Zajkov) does not significantly influence the spatial change of ΔH because the overwhelming majority of the rivers of this basin have identical type of the intra-annual distribution of the river flow (East European type). Small- and medium-size rivers in the south and the southeast of the territory represent the exception; there, the water regime belongs to the Kazakhstan type. The intra-annual distribution of river flow defines, to a greater degree, the frequency and duration of water discharge and water levels at which flooding occurs on a high floodplain. According to the data [Morphology and dynamics..., 1999], the duration of flooding of the Volga basin floodplains does not exceed 50 days (Fig. 1).

For the most parts of the basin, short flooding of the floodplains (on average, it proceeds for less than 10 days) is characteristic. In the Kaluga, Kirov, Moscow, Ryazan, and Tver regions, the Perm territory, Republic of Bashkortostan, Tatarstan, Udmurtiya, and Chuvashiya, this period is longer (10–30 days). Only occasionally floodplains of some rivers (Vetluga, Mologa) are flooded for more than

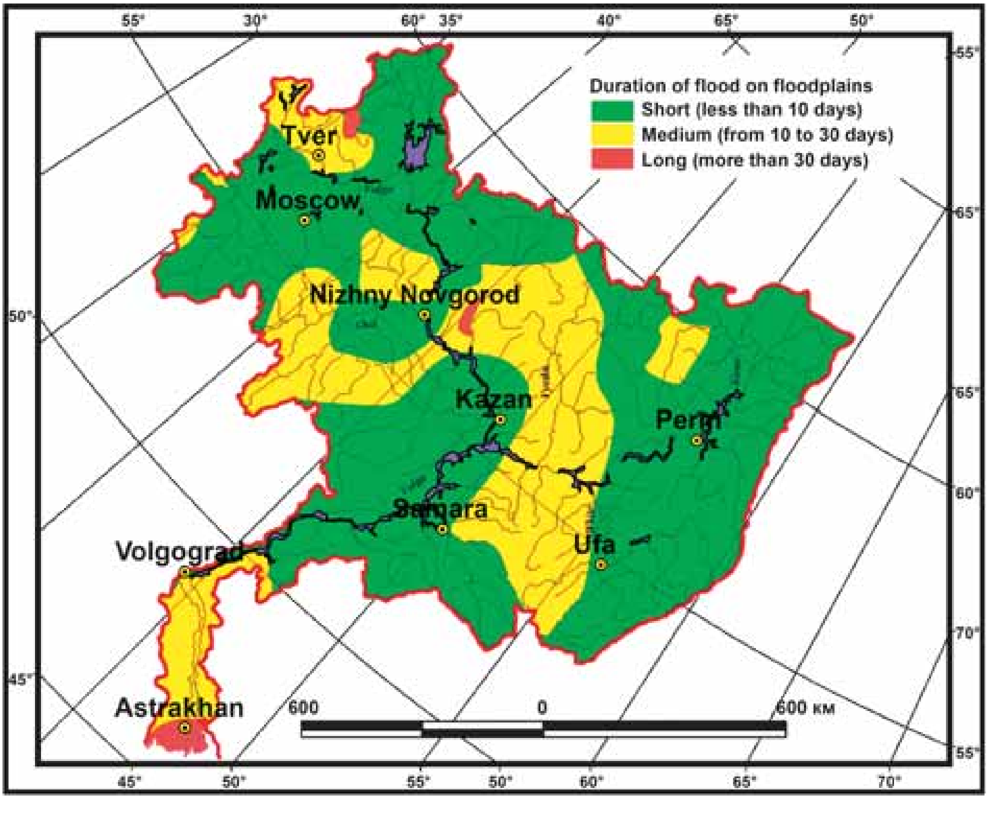

Fig. 1. The map of the duration of floodplain flooding in the Volga River basin

30 days. Floodplains of some small rivers in the Volgograd and the Samara regions are very seldom flooded in a high water periods or are not affected by flooding in the modern hydro-climatic conditions. The mountain and semi-mountain rivers of the western slope of the Ural Mountains have no floodplains or they are fragmentary, which allows considering them as rivers with no risk of flooding.

The frequency of flooding of the Volga basin floodplains can be estimated only for the territories with the hydrological posts. Only in this case it is possible to evaluate daily water discharge (long-term average) for conditions of steady flooding of a floodplain. This frequency corresponds to the highest interval of channel-forming water discharges Q_{bff} [Vlasov, Chalov, 1991], which, in long-term, is most objectively characterizes the regime of its flooding. Value of Q_{bff} is connected with the size of the river (its area, stream order N_{Sh}) by the power equation (Fig. 2):

$$Q_{bff} = 2^{1.76 N_{Sh}^{0.72}}.$$

Recurrence of the water discharge Q_{bff} and corresponding duration of the phenomenon characterizes average (for the long-term period) duration of flooding of floodplains. Data processing on 132 posts in river Volga basin in period from 1877 to 1980 has shown that duration of flooding of floodplains doesn't exceed 27 days. Recurrence of water discharges Q_{bff} varies from 0,01 % to 7,5 % [Vlasov, Chalov, 1991]. The maximal value of this parameter is characteristic for the rivers

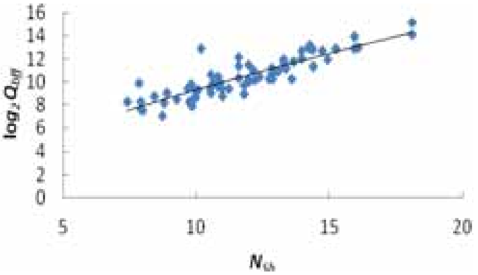

Fig. 2. Dependence of the size of the top interval of channel-forming water discharges Q_{bff} on stream order (N_{Sh}) in the Volga river basin

in the upper courses of the rivers White, Vyatka, Oka, and Kama. With an increase in the size (stream order) of the frequency of river water discharges, Q_{bff} increases somewhat. The frequency is much greater on broad-floodplain channels compared to adapted and incised channels.

THE CHANNEL NETWORK IN THE VOLGA RIVER BASIN

The information on the area of flooding F_f in the river valleys is of high importance for the evaluation of flooding damage. Such data allow estimating potential damage and economic efficiency of the investments necessary for flooding control. Other things being equal, the increase in this area is associated with a linear (or nonlinear) increase of social and economic damages. Nowadays, there are no methods of defining this important characteristic for large territories located in the valleys of small, average, and large rivers.

The problem analysis shows that for this purpose, it is necessary to identify regional (or basin) dependences between the area of floodplains F_f and the stream order. The existence of consistent dependences between the parameters (average area of floodplain for a river segment with N_{Sh} = const and the corresponding value N_{Sh}) and between the distribution of the rivers within the territory and their size (length, stream order) make it possible to identify potentially flooded parts of floodplain areas within the Russian Federation regions or individual river basins (and potential damages from this dangerous hydrological phenomenon).

In order to test this statement, we used the data on the number of tributaries shorter than 10 km in the Volga basin river network [The Hydrological scrutiny, 1966]. We estimated the stream order (according to A. Scheidegger scheme) using formula:

$$N_{Sh} = 1 + \log_2 S,$$

where S is the total number of the tributaries shorter than 10 km.

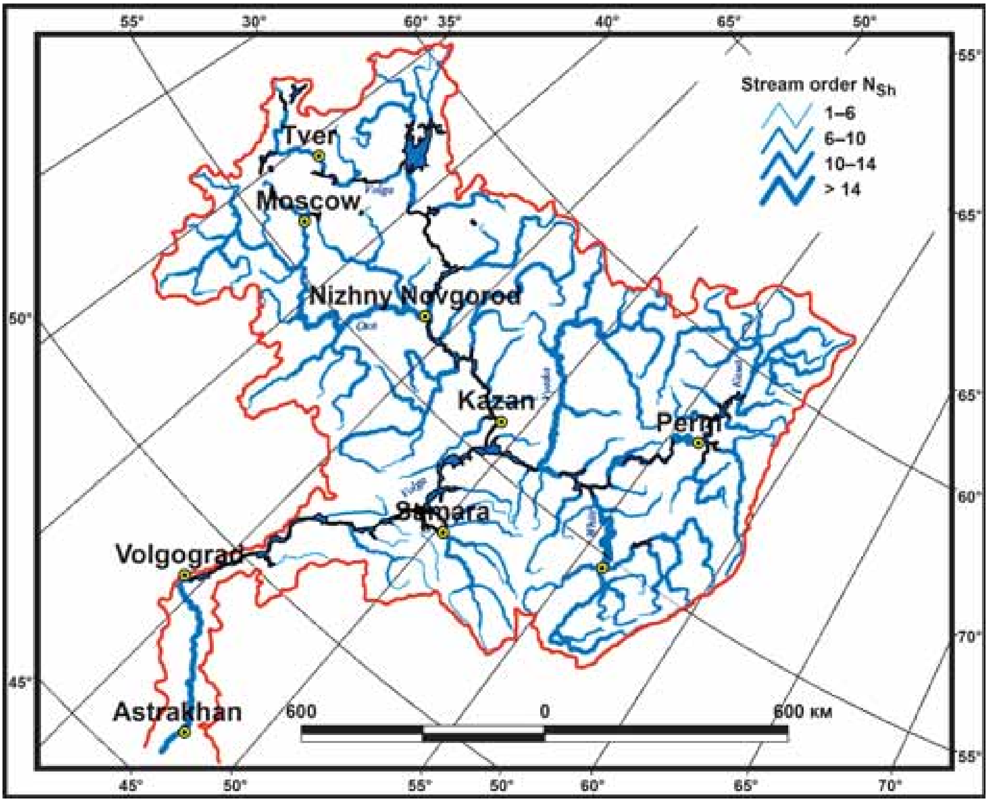

Fig. 3. The map of stream order in the Volga River basin

This procedure was conducted for the mouths of 9907 rivers in the Volga basin to estimate their hydrographic similarity.

For 96 largest rivers of the Volga basin (longer than 200 km), we estimated changes of the stream order (Fig. 3). The changes are associated with an increase of the

Table 1. Distribution of the rivers (according to the value of stream order in the mouth) in the Volga River basin

Value of stream order N_{Sh} in the mouth	Number of the rivers with the corresponding value of N_{Sh}	Value of stream order N_{Sh} in the mouth	Number of the rivers with the corresponding value of N_{Sh}
>18	1	8–9	158
17–18	1	7–8	384
16–17	0	6–7	695
15–16	2	5–6	1312
14–15	2	4–5	1918
13–14	5	3–4	1898
12–13	9	2–3	1282
11–12	23	1–2	698
10–11	41	1	573
9–10	89	Data is not available	816

majority of hydrological parameters of the rivers from their beginnings to mouths because of inflowing tributaries. Discharge through river branches is characteristic of the Volgo-Ahtubinskaya floodplain and the Volga delta. For the majority of the river mouths in the Volga basin, rank N_{Sh} does not exceed 7 (Table 1). The maximal number of the rivers have $N_{Sh} = 3 \cdot 5$. The number of the rivers with $N_{Sh} > 11$ does not exceeded 10.

FLOODPLAIN AREAS ALONG SOME RIVERS

For the calculation of the floodplain areas for segments of the rivers with changing size (stream order), 67 topographic maps, 1:50 000 scale, for the Oka river basin territory were used. The calculation was carried out using a software program AcrView GIS 3.2. In the program, the raster image (topographic map) was georeferenced to the geographical coordinates, then, according to characteristic features – relief, borders of settlements, and character of vegetation, the floodplain areas were delineated and the area was calculated automatically by the program.

The estimates of the floodplain areas of the tributaries of the Volga river depending on their length (the rivers Moskva, Pahra, and Oka) were obtained. If the stream order of the rivers for which the floodplain areas were defined, changed within unity (for example, from 5,1 to 5,7 or from 12,2 to 12,6), their average value was defined. It was compared according to the stream order (e.g., 5 or 12) (Fig. 4).

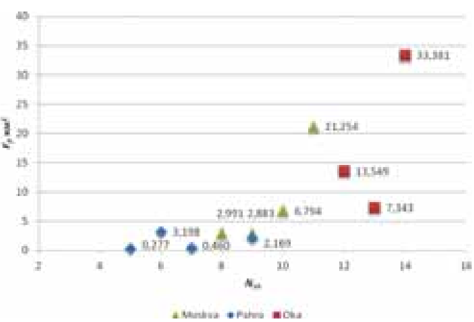

Fig. 4. Relation between the average area F_f of floodplains of the Volga basin rivers and their stream order N_{Sh}

Change of the average areas of the floodplains depends on the stream order and is described by nonlinear increasing function. Fig. 4 indicates that the increase of the average floodplain area coincides with the increase in the stream order. The existing dispersion of the points specifies the dependence of the floodplain area on the morphological features of the river valleys and geomorphological type of the river-segment channels. For example, the average area of the Oka river floodplain at N_{Sh} =12 is equal to 13,5 km^2, and for N_{Sh} = 13, is equal to 7,3 km^2, which is due to the change of the channel type.

CONCLUSION

The established dependency between the average areas of the floodplains and the stream order of the rivers opens prospects for defining the F_f for the unstudied parts of the river valleys with hydrographic information and data on the river channel geomorphological type. Using dependence $F_f = f(N_{Sh})$ it would be possible to estimate the areas of man-altered territories in the river valleys potentially affected by flooding. It is possible to objectively plan flood-control actions in different parts of the Volga river basin through assessing the frequency of floodplain flooding and potential damage considering the value of basic assets and the population in the areas of flooding risk.

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GEOINFORMATION TECHNOLOGIES IN THE STUDY OF ETHNIC ASPECTS OF URBANIZATION IN RUSSIA

ABSTRACT. The paper discusses the use of geoinformation technologies in studies of ethnic aspects of urbanization in Russia. It analyzes the level of urbanization, urbanization transition in ethnic groups, and changes in the geography of population settlement of the country with centrographic and other methods.

KEY WORDS: Geoinformatics, system, urbanization, ethnic processes, urbanization transition, modeling, geography of settlement.

INTRODUCTION

The transformation of the ethnic structure of the population of the Russian Federation is determined by the course of urbanization, the nature of migration, demographic processes, and other factors. At present, the ethnic factor has often a dominant influence on the socio-political, economic, cultural, and historical processes.

The modern world is a mosaic of different people coexisting with each other. Cities are particularly diverse. As noted by G.M. Lappo, "Cities concentrate much more mixed, in respect to the national origin, population compared to rural areas..." [Lappo, 2005]. Cities are the catalysts for social and ethnic processes.

To effectively address inter-ethnic issues, it is very important to monitor ethnic processes, synthesize knowledge, and integrate it in the social and state systems [Belozerov 2001]. GIS technology is an important tool in modern geographic studies of ethnic processes.

The problem of ethnic processes in Russia has been addressed by many national scientists: sociologists, ethnologists, and geographers. Many authors, such as L.A. Arutyunyan, V.A. Avksentyev, V.S. Belozerov, P.M. Polyan, V.A. Tishkov, O.I. Vendina, L.L. Rybakov, and other, are well known in this area. Many authors made significant contribution to the area of urban studies: G.M. Lappo, A.I. Treyvish, Ye.N. Pertsik, Yu.L. Pivovarov, R. Popov, N.A. Sluka, and others.

The research presented herein is based on the information contained in the following documents: the State Statistics Committee of the Russian Federation; the State Statistics Committees of the Stavropol Kray, of the Khanty-Mansiysk Autonomous Districts (AD), of the Yamal-Nenets AD, and of the Astrakhan Oblast; and material published in the scientific literature and periodicals. The set of the data used provided for the reliability of the results and assured valid theoretical conclusions.

RESEARCH METHODS

The creation of a GIS-based monitoring system is the priority goal in the study of ethnic aspects of urbanization in Russia. This system is based on knowledge about ethnic aspects of urbanization in Russia and other factors affecting the process. The system has specific features of the architecture and of its components [Belozerov, Panin, Cherkasov, 2012]. The main steps of the construction of this GIS application are:

1) selection of the logical structure and creation of the spatial geodatabase based of the material collected; preparation of cartographic framework;

2) compilation of the geodatabase on the ethnic structure of the population of Russia and its regions;

3) construction of the spatial-temporal models of the ethnic dimensions of urbanization in Russia and its regions;

4) assessment and monitoring of the ethnic structure at different territorial levels.

Multi-scale monitoring of ethnic processes using geospatial and statistical analysis utilizes geoinformation and mathematical software products and applies them to the information stored in a geodatabase [Butler, 2011]. This approach allows detailed study of ethnic processes, including the ethnic aspects of urbanization.

The software component of our system was based on *ArcGIS Spatial Analyst (ESRI)*. ArcGIS, like other powerful information systems, has a well-defined model for working with data, especially spatial. This product has a number of features that facilitate monitoring of multi-scale ethnic processes; the tools for modeling and mapping of processes have diverse functionality.

A geodatabase (e.g. file or personal) stores spatial and non-spatial data and enables efficient data retrieval. The data stored in the system can be accessed and rendered through geostatistical analysis. Our system utilized vector data formats (polygon, point, and line objects); the data in the database were organized logically and hierarchically, which improved data management because it integrated many different types of geographic features in a single space while preserving the initial characteristics of its elements. Spatial relationships within this data model were particularly important in solving complex analytical problems (Andrianov, 2004).

Data representation in a vector model is similar to traditional paper maps. Points represent geographic objects that are too small to be shown as lines or polygons; lines represent narrow objects that cannot be shown as polygons; polygons represent closed and homogeneous objects. All geographic objects that make up the spatial component are assigned a unique ID; the associated non-spatial information is stored in the attribute tables of ArcGIS.

A conceptual scheme of the GIS-based monitoring approach that we have developed and that comprehensively reflects features of the ethnic structure of Russia is presented in Fig. 1. The experience of the laboratory "Population and GIS Technologies" of the North Caucasus Federal University was instrumental in the creation of the conceptual schemes of the geoinformation monitoring of ethno-demographic [Panin, 2005] and demographic processes [Rauzhin, 2011]. As any working GIS system, the GIS-monitoring approach described herein includes five key components: hardware, software, data, users, and methods[1]. The spatial objects in our GIS

[1] Hardware: is a computer that is running GIS. Nowadays, GIS applications work on different types of computing platforms, from centralized servers to separate or connected by a network desktop computers (in our case).

GIS software: provides the functions and tools needed to store, analyze, and visualize geographic (spatial) information. Key components of the software are tools for entering and manipulating geographic information, a database management system (DBMS), tools supporting spatial queries, analysis and visualization (maps), and a graphical user interface (GUI) for easy access to tools.

Data: is the most important component of GIS. Data on the spatial position (geographical data) associated with tabular data can be collected and prepared by the user, purchased from commercial suppliers, or taken from other sources. In the process of spatial data management, GIS integrates spatial data with other types and sources of data, and can also use DBMS; DBMS is used by many entities to organize and support available data.

Operators: wide application of GIS technology is not possible without people who work with software products and design their application for solving real problems. GIS users can be technical experts, developing and maintaining the system, and regular employees (end-users) that use GIS to solve current issues and everyday problems.

Methods: the success and effectiveness (including socio-economic) of the GIS application depends on a well-designed plan and work rules prepared in accordance with specific tasks.

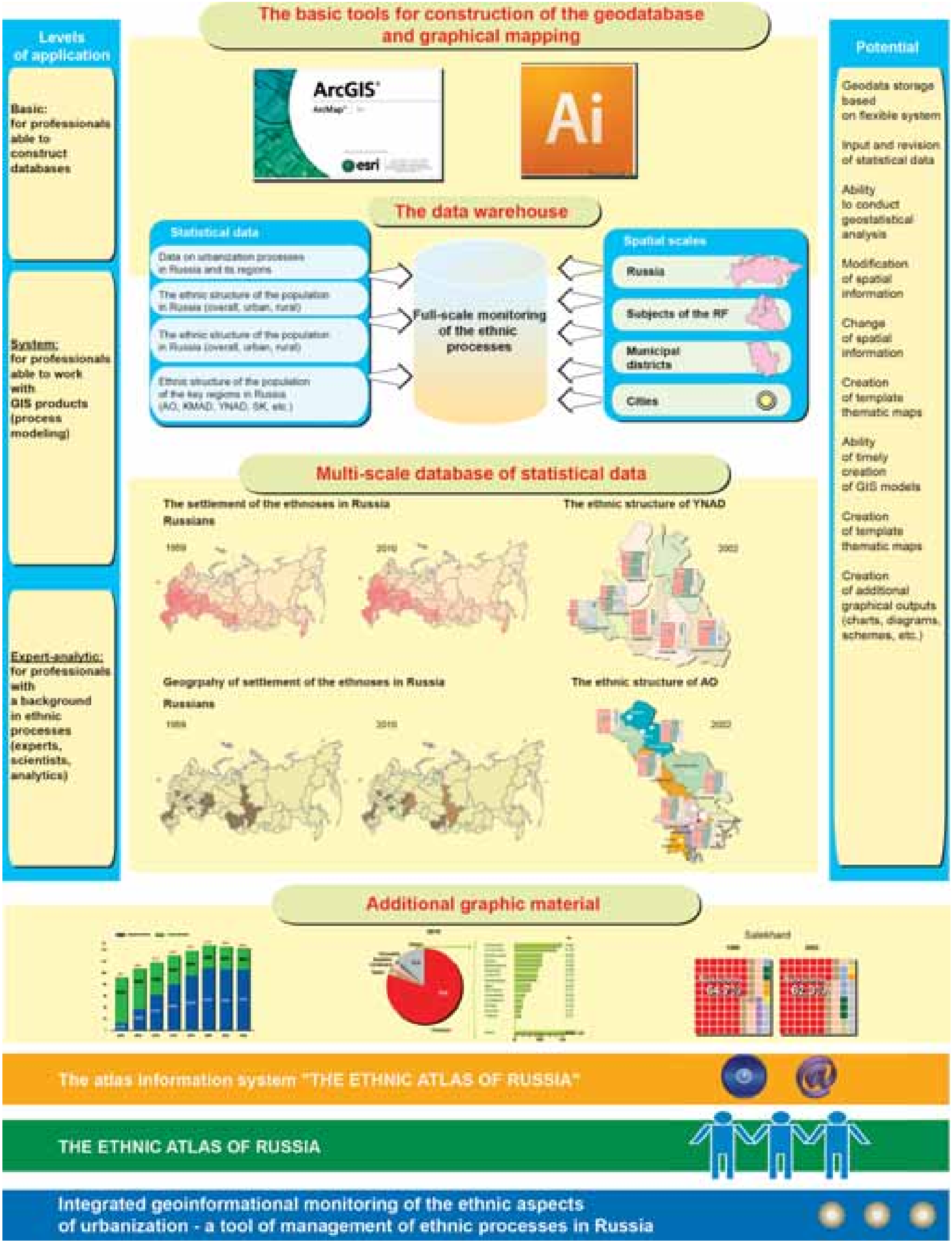

Fig. 1. The conceptual scheme of GIS for monitoring of the ethnic aspects of urbanization in Russia

approach are tied to the local conditions in the Cartesian coordinate system.

The GIS-monitoring approach for the study of the ethnic dimensions of urbanization in Russia was built on the administrative-territorial division (ATD) of the Russian Federation in 2010, since it is the most useful for comparing data in the GIS environment for 1959, 1970, 1979, 1989, 2002, and 2010, and allows most consistent analysis.

The cartographic GIS-monitoring approach is based on the territorial structure for the key regions (Astrakhan Oblast [AO], Stavropol Kray [SK], Khanty-Mansi and Yamal-

Nenets ADs [KMAD and YNAD, respectively], Karachai-Cherkess Republic [KChR], Moscow, etc.). The attribute database contains both the original and derived information. The original information includes statistical sources, each with its own characteristics. The statistical forms differ in regularity, consistency formats, parameters, and units of measure. This statement refers to the census data for RSFSR, Russian Federation, AO, SK, KMAD, YNAD, KChR, Moscow, etc.

The design of the logical structure required the identification of specific information available. This information defined the selection of its thematic blocks. We identified four blocks, each with a set of two-dimensional tables related to each other on the key fields (Fig. 2).

The blocks "Urbanization", "Dynamics of the ethnic structure of Russia", "Dynamics of the urban ethnic structure of Russia", and "Regional features of the ethnic structure" contain data for Russia and the regions (AO, SK, KChR, KMAD, and YNAD – at the level of cities and administrative districts; and Moscow).

The blocks "Urbanization", "Dynamics of the ethnic structure of Russia", and "Dynamics of the urban ethnic structure of Russia" are utilized in the GIS-application at different territorial levels of the Russian Federation ATD and provide statistical geodata on the population of the country's regions and the ethnic structure of the population in general and separately for urban areas.

The block "Regional features of the ethnic structure" is the most complex because it includes five additional sub-blocks. Each sub-block addresses a separate region in the research. The following regions were chosen as the study areas: the regions currently industrially developed and with intensive changes in the ethnic structure of the population [KMAD and YNAD], multi-ethnic centers of the capitals (Moscow, St. Petersburg), industrial-agro multi-ethnic regions – SK, AO; and agro-industrial national territorial districts (KChR). This structure of the GIS-monitoring approach determined the thematic divisions that include cartographic components on the ethnic aspects of urbanization in Russia. Table 1 presents the names and content of the blocks of the spatial database. The first three blocks are the cartographic models of the ATD of the Russian Federation (subjects and cities). The first block contains information on the urban network at the time of the censuses

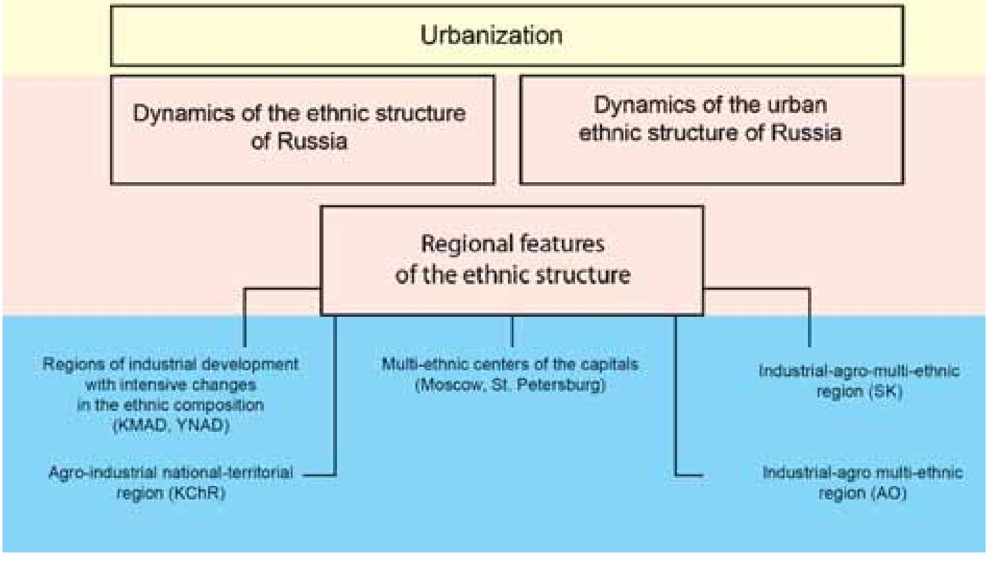

Fig. 2. The thematic blocks of the attribute GIS database for monitoring of the ethnic aspects of urbanization in Russia

Table 1. The structure of the thematic components of the GIS-monitoring approach for studying ethnic aspects of urbanization in Russia

Block	Territorial level	Level of operation	Data
1. Urbanization	RF	ATD of RF	Urban network 1897–2010, Number of agglomerations 1897–2010, Number of population, share of urban population
2. Dynamics of the ethnic structure of Russia	RF Regions	ATD of RF	Ethnic structure of population, Ethnic structure of urban population (1959–2010)
3. Dynamics of the ethnic structure of cities	West Siberia KMAD, YNAD	ATD of KMAD, YNAD	Ethnic structure of population of regions, Ethnic structure of urban population of regions
4. Regional features of the population ethnic structure	Territories of studied regions	ATD of cities, municipal districts, cities	Ethnic structure of population of regions, Ethnic structure of urban population of regions
4.1. Currently industrially developed regions	KMAD, YNAD	ATD of these regions, cities, and districts	Ethnic structure of population, Ethnic structure of urban population (1959–2010)
4.2. Multi-ethnic centers of the capitals	Moscow, St. Petersburg	City	Ethnic structure of urban population of regions (1959–2010)
4.3 Multi-ethnic industrial-agro regions	SK	ATD of regions, cities, and districts	Ethnic structure of population, Ethnic structure of urban population, (1959–2010)
4.4. Multi-ethnic industrial-agro regions	AO	ATD of regions, cities, and districts	Ethnic structure of population, Ethnic structure of urban population, (1959–2010)
4.5. Agro-industrial national territorial district	KChR	ATD of regions, cities, and districts	Ethnic structure of population, Ethnic structure of urban population (1959–2010)

and the share of the urban population in the regions. The next two blocks reflect the ethnic structure of the population in Russia, especially the ethnic structure of urban population and its regional features. The fourth thematic block includes the cartographic basis of the ATD of the regions under study (the ethnic structure of the population in these regions, especially the ethnic structure of the urban population).

ANALYSIS OF THE RESULTS

The use of this GIS-monitoring application enabled a comprehensive analysis of the ethnic aspects of urbanization in Russia. Based on the quantitative characteristics of the ethnic aspects of urbanization, we have developed a typology of ethnic groups in terms of the urbanization features and urbanization transition. This typology makes it possible to analyze the participation of different regions of Russia in the process of urbanization. The overall urbanization transition in Russia occurred in 1958 [Popov, 2005]. Each of the ethnoses participated, to a greater or lesser extent, in rapid urbanization of the territory of modern Russia in the XXth–XXIth centuries.

By the nature of participation in the urbanization process, the ethnoses may be divided into the following groups:

– **ethnoses with early urbanization transition that was recorded in the 1959 census or earlier** (Russians, Ukrainians, Belarusians, Georgians, Uzbeks, Armenians, Moldavians, Azerbaijanis, Latvians, and Lithuanians);

– **ethnoses, whose urbanization transition was recorded in the censuses of 1970 and 1979** (Ossetians, Tatars, Laks, Balkars, and Germans);

– **ethnoses with late urbanization transition recorded in the censuses of 1989,**

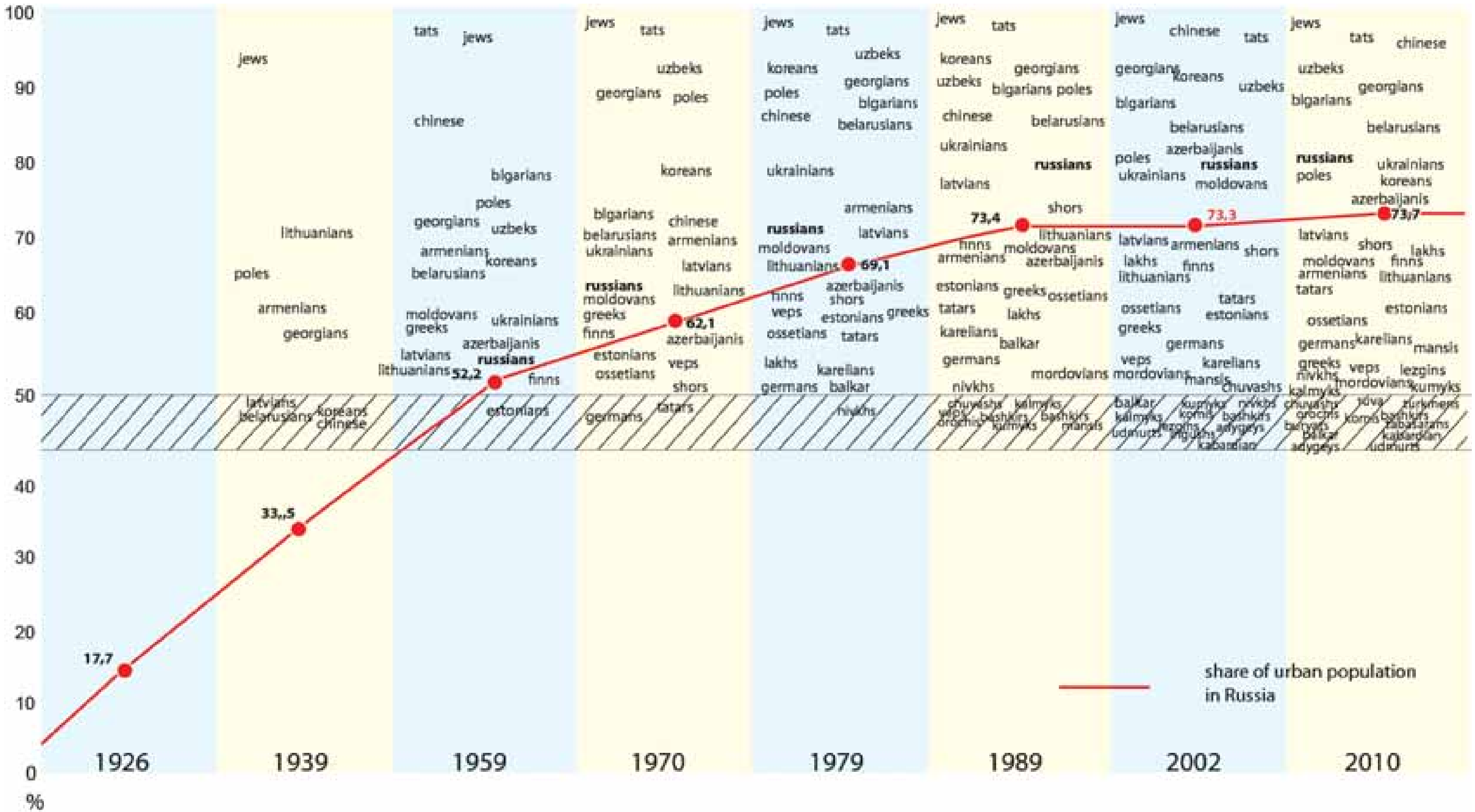

Fig. 3. The level of urbanization and the urbanization transition of the ethnoses in Russia

2002, and 2010 (Mordovians, Lezgins, Kumyks, and Kalmyks);

– **ethnoses with the failed transition to urbanization in 2010**:

a) **ethnoses approaching the transition to urbanization – urban population ranges from 45,1 to 49,9%** (Adyghes, Kabardians, Udmurts, Buryats, and Bashkirs);

b) **ethnoses with 45,0% share of the urban population** (Maris, Ingushs, Chechens, Dargins, etc.) [Belozerov, Cherkasov, 2012].

Analysis of the quantitative characteristics of the ethnic dimensions of urbanization revealed differences in urbanization level of the individual ethnoses in Russia (Fig. 3). Due to different historical and socio-economic factors, some ethnoses were included in the orbit of urban life earlier than others. However, the trend toward a greater involvement in urbanization processes was common to all groups. Overall, based on this typology, it is possible to state that urbanization in Russia was occurring with a phase-gate inclusion of the ethnoses in urbanization processes [Cherkasov, 2011]. Currently, the share of the ethnoses in Group I is 81,5% of the population. Together with Groups II and III, the people who underwent urbanization transition comprise 87,9% of the population of Russia.

The spatial-temporal and mathematical modeling is one of the key aspects of monitoring of the ethnic aspects of urbanization in Russia [Tikunov, 1997]. In the study, we used the centrographic method [Polian, Treyvish, 1990]. This method allows not only assessing whether the ethnoses living in the territory of Russia are in the state of "balance" or "imbalance", but also identifying the displacement vector of the center of gravity of the population groups that have deferent intensity of changes in geography of settlement. The following groups were identified with this approach:

– ethnoses with changing, over a long period of time, geography of settlement (Russians, Jews, Belarusians, Ukrainians, and Germans);

– ethnoses with rapidly changing, in the last decades, geography of settlement (Avars, Chechens, Armenians, and Azerbaijanis);

– ethnoses with a relatively stable center of gravity of the population (Tatars, Kazakhs, and Bashkirs). (Fig. 4).

Currently, the share of the urban population of the ethnoses with changing geography of settlement is high; all of them have undergone urbanization transition. In the ethnoses with rapidly changing, in the last decades, settlement geography, Armenians and Azerbaijanis comprise a high proportion of the urban population as they underwent urbanization transition in the early stages of urbanization. At the same time, Avars and Chechens have not yet completed the urbanization transition. The ethnoses with a relatively stable center of gravity of the population have a low share of the urban population; they have not yet undergone the urbanization transition.

Let us consider the center of gravity of settlement for Russians, as the ethnic group with settlement geography changing over time. The largest shift of the center of gravity of the Russian settlement to the east of the country took place in 1959–1970. The center of settlement shifted to the north-west of the Orenburg region on the territory of the Republic of Bashkortostan (the western part of the region) and, then, the shift to the east continued until 1989, when the center of the Russian settlement reached the central part of the country. After 1989, the center of gravity has changed its vector from the east to the west. Between 1989 and 2002, there was a shift to the west; the center of gravity of the Russian settlement in 2002 coincided with that in 1979. By 2010, the center moved to the level of 1970. These trends are supported by other models; thus, the point method showed the same trends in the distribution of the Russian population: a shift eastward until 1989 and to the west in the subsequent years.

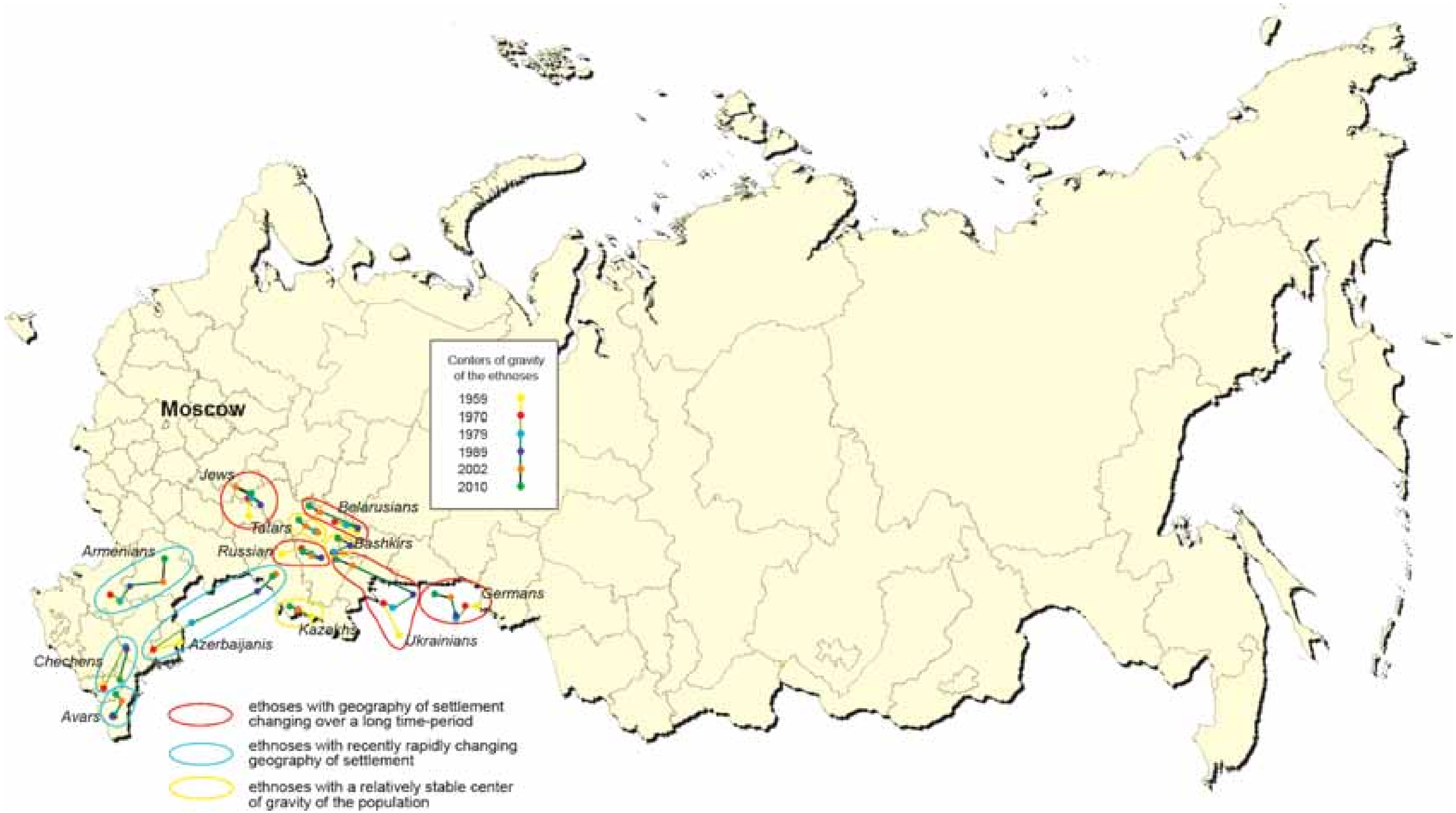

Fig. 4. The centers of gravity of the population settlement in Russia, 1959–2010

Ukrainians, for a long time, have also been included in the group of ethnoses with changing geography of settlement. This ethnos has had a significant shift in the center of gravity of settlement. From 1959 to 1970, the center moved to the north-west and stopped at the eastern border of the Chelyabinsk region in Kazakhstan. From 1970 to 1989, the center of gravity was moving east into the territory of Kazakhstan. After 1989, the center of gravity changed its vector to the north-west; during this time, its direction changed significantly and, in 2002, it moved to the boundary of the Chelyabinsk Region and the Republic of Bashkortostan. In the subsequent period, the trend continued and, in 2010, the center of gravity of settlement of Ukrainians in Russia was located in the central part of the Republic of Bashkortostan.

The titular ethnoses of the former Soviet Union Trasncaucasus republics have a rapidly changing, in the last decades, geography of settlement. For example, the center of gravity of Azerbaijanis underwent rapid change in the geography of settlement to the north-east of the country: in 1959–1970, there was a shift of the center of gravity of Azerbaijanis from the east of the Astrakhan region to its south-western part; in 1970–2002, the direction changed to the north-east and the center moved to the north-western part of the Orenburg region. In 2002–2010, the center of gravity reached certain equilibrium and remained almost at the same level with only a slight shift to the south-west.

Armenians also belong to the ethnoses with a rapidly changing, in the last decade, geography of settlement. The censuses of 1959, 1970, and 1979 indicate a consistent position of the center of gravity in the south-eastern part of the Rostov oblast. After 1979, the center of gravity of the Armenian settlement began to shift rapidly in the north-eastern direction. In 1989, the center was located in the south-western part of the Volgograd Oblast; in 2002 it moved to the central part; and in 2010, it was in the northern part of the oblast.

CONCLUSIONS

Geographic information technologies present a great opportunity for the use of mathematical methods in the construction of cartographic models; GIS provides for the flexibility to quickly update data as new statistics appears. This approach to the monitoring of the ethnic dimensions of urbanization in Russia allowed grouping the ethnic groups by their participation in the urbanization processes, modeling of the centers of gravity of the population with the centrographic method, and, with the method of settlement distribution modeling, analyzing the settlement patterns of the peoples of Russia.

The prospects for further research include creation of a unified specialized geographic information system for monitoring of the ethnic processes in Russia. This system would provide analytical support to decision-making aimed at regulation and stabilization of the inter-ethnic, ethno-demographic, and migration processes in the Russian Federation.

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ATMOSPHERIC MODELING FOR ADVANCE WARNING OF WEATHER DISASTERS IN THE BLACK SEA REGION

ABSTRACT. Means for operational regional forecast of catastrophic weather events in the Black Sea region are presented. It is shown that the flooding in Krasnodar Region, Russia, July 7, 2012 was predicted five days before the tragic events, and the catastrophic storm of November 11, 2007 off the coast of Crimea was also predicted three days in advance. Quality of the regional forecast and its advantages over the global forecast are discussed. The operational regional modeling of the atmosphere in the Marine Hydrophysical Institute (National Academy of Sciences of Ukraine) could become an important element of a possible early warning system for weather disasters in the Azov-Black Sea region.

KEY WORDS: forecast of weather disasters, regional mesoscale atmospheric models, early warning system of weather disasters, Azov-Black Sea region, mesoscale atmospheric processes.

INTRODUCTION

Nowadays, EWS (Early Warning Systems) are discussed at the scientific, national and global levels (see, e.g., [United Nations International Strategy for Disaster Reduction, 2006; Basher, 2006; World Meteorological Organization, 2012; Russian Federation. Ministry for Civil Defense, Emergency and Eliminations of Consequences of Natural Disasters, 2013; Shaw et al., 2013]). It is well known how much effort is made to create reliable early warning systems of earthquakes and tsunamis. The structure and principles of EWS are described in a number of papers and documents (see, e.g., [United Nations International Strategy for Disaster Reduction, 2006; United Nations, 2006; Waidyanatha, 2010]). The most successful implementations of the national EWS are given in [Golnaraghi, 2012; Shaw et al., 2013]. Early warning systems of regional and subregional disasters related to weather conditions traditionally focus on warning about violent storms, heavy rainfalls and thunderstorms dangerous for aviation (see, e.g., [Clark et al., 2012]).

Development of a regional early warning system of weather disasters in the Black Sea region would be a natural step both from the point of view of its relevance and of modern prediction capabilities. Flooding of 6–7 July 2012 in the Krasnodar Region, Russian Federation caused a loss of more than 170 lives and huge economic damage [Volosukhin, Schursky, 2012]. However, the forecast of rainfall intensity had appeared five days before the flood at free access on the Internet website [Marine Hydrophysical Institute, 2013]. Regional early warning system would have allowed to make a conclusion about the impending disaster in Krymsk and thus saved many lives.

Another impressive example is a hazardous storm of 11 November 2007 near the Crimean coast. As a result of this disaster, tanker "Volgoneft-139" spitted in half in the Kerch Strait and two thousand tons of fuel oil spilled into the sea. Dry-cargo ship "Volnogorsk" carrying more than two thousand tons of sulfur sank in Port-Kavkaz. Tanker "Volgoneft-123" loaded with oil was severely damaged. Dry-cargo ships "Kovel", "Khash-Izmail", "Nakhichevan" sank and more than 20 members of the crews were missing. This sad list can be continued [Ovsienko et al., 2008]. However, the forecast of the wave height appeared on the Internet in free access on the website [Marine Hydrophysical Institute, 2013] three days before the storm. That allowed to make conclusions about the extreme dangers for vessels in the Kerch Strait, Sevastopol Bay and other coastal areas where many accidents happened.

A key element of an early warning system of weather disasters is an atmospheric model capable of making a reliable short-term forecast of meteorological fields in the region of interest (see, e.g., [Clark, 2012]). Currently, the leading global weather forecast operational centres, such as *NCEP/NCAR* (*National Center for Environmental Prediction/ National center of Atmospheric Research)* and *ECMWF* (*European Center for Medium range Weather Forecast*), are implementing a global weather forecast with a spatial resolution of 50 km and 30 km. This can reliably predict development and movement of synoptic cyclones with a lead time of several days. However, global operational forecasting models underestimate extreme values of wind speed and intensity of precipitation due to their coarse spatial resolution [Clark, 2012]. This fact is critical for predicting regional weather disasters. To improve prediction of extreme weather phenomena, it is necessary to use regional mesoscale models with a more detailed spatial-temporal resolution.

This article aims to present the means of operational regional modelling of the atmosphere, which already exist in Marine Hydrophysical Institute of National Academy of Sciences of Ukraine (MHI), as a possible element of the future system of early warning of weather disasters in the Azov-Black Sea region. The MHI system of short-term regional meteorological forecast is described below as well as the advantages in terms of forecast of weather disasters in relation to systems of global modeling of the atmosphere. The examples above of the two disasters in the Azov-Black Sea region show that the forecast of MHI obviously contained their predictions. The capabilities and reliability of the regional forecast system are discussed.

SYSTEM OF SHORT-TERM METEOROLOGICAL FORECAST

Nowadays, the leading global operational weather centers, such as *NCEP/NCAR* and *ECMWF* make global operational weather forecasts with a lead time of up to 15 days. The forecast is made every 6 hours, four times a day. In order to analyze the state of the atmosphere all available data is used: ground-based measurements, vertical sounding of the atmosphere, satellite data and other (see forecast description given at the websites [Environmental Modeling Center, 2013; European Centre for Medium-Range Weather Forecasts, 2013]). Spatial resolution of the global atmospheric models used for forecast, is currently 50 km for the *NCEP/NCAR* and 30 km for *ECMWF*. This resolution allows us to predict the development and movement of synoptic cyclones reliably with a lead time of a few days. However, global operational forecasting models underestimate the extreme values of wind speed and precipitation due to their coarse spatial resolution.

In order to improve the forecast of extreme weather phenomena, it is necessary to use regional mesoscale models which are run for a single small region and have a spatial resolution up to 1 km. In this case, the results of global forecast are used as boundary conditions for the regional models. *MM5* mesoscale atmospheric model and its more modern variant, *WRF* (Weather Research and Forecasting), have been developed by the U.S. National Center of Atmospheric Research for both scientific research of mesoscale weather phenomena, and for operational forecasts and regional re-analyses [Skamarock et al., 2008]. Mesoscale atmospheric model describes air movement and transfer of heat and moisture in the atmosphere using the high-quality numerical schemes. It realistically accounts the transfer of IR and visible solar radiation, the process of clouds and precipitation formation, cumulus convection, turbulent fluxes of momentum, heat and moisture in the planetary atmospheric boundary layer and in the surface layer, the transfer of heat and moisture in the upper soil layer and other physical processes.

The mesoscale model must be adapted to a particular region, which implies selecting the most appropriate schemes for parameterization of physical processes, as well as a more detailed setting of properties of the underlying surface in the region, especially orographic peculiarities. Among the examples of such adaptation are synoptic and climate researches in the high latitudes of the Greenland and Antarctic [Box et al. 2004], as well as regional operational forecasts for the United States and some parts of Asia, Central and South America, which are given on the web pages [Mesoscale Prediction Group, 2013; Fovell, 2013; Wilson, 2013].

MM5 model, which was adapted to the Black Sea region in MHI, was used for retrospective studies of individual mesoscale atmospheric processes and extreme events – quasi-tropical cyclone of 25–30 September 2005 [Efimov et al., 2008], breeze circulation [Efimov, Barabanov, 2009], precipitation leading to extreme floods in the Crimean rivers [Ivanov et al., 2012b]. The results of *MM5* and *WAM* models calculations were used to analyze the conditions of formation of the 12-meter rogue waves on 1 February 2003, near Gelendzhik [Ivanov et al., 2012a]. Verification of models using direct measurements in the Black Sea region was discussed in [Shokurov, 2011].

Mesoscale operational forecast is made with the use of *MM5* model with a spatial resolution of 10 km. Computational area covers the whole Black Sea (39°–49° N, 25°–45° E) and allows to analyze both weather patterns and mesoscale features. We use the results of the *NCEP/NCAR GFS* operational forecast with the resolution of 0,5°–0,5° for every 6 hours as lateral boundary conditions. Forecast results were repeatedly tested by hindcasts using the *WRF* model.

MHI started to perform the operational weather forecast in the Black Sea region in 2007 using *MM5* model. Spatial resolution for the entire Black Sea region was 10 km with the forecast lead time of 3 days. In the beginning of 2011 we also started making forecasts for the Crimean region with a resolution of 3 km, and in the middle of 2011 the lead time was increased to 5 days. In addition to the weather forecast, wind waves forecast for the whole Black Sea area is made using *WAM* model of wind waves (see, e.g., [WAMDI Group, 1988; Holthuijsen, 2007]. Forecast results are available in graphical and digital formats in open access on the Internet at http://vao.hydrophys.org [Marine Hydrophysical Institute, 2013]. This site shows the fields of pressure at the sea level, air temperature at the height of 2 m, wind speed and direction at the height of 10 m, intensity of rainfall, also heights, periods and direction of waves with discrete time of 3 hours.

During the period of forecast performing, the two above-mentioned major regional natural disasters happened in the Black Sea region – the severe storm of 11 November 2007 off the Crimean coast and the flood of 6–7 July 2012 in Krymsk, Russia. Predictions of both disasters in the form of prognostic fields of wind speed, wave height and precipitation intensity were obtained and presented on the Internet in free access. The information about this catastrophic storm was published 3 days before the event, and the data about the hazardous precipitation rate was published 5 days before.

The forecast system described above can be used as an element of an early warning system of weather disasters in the Azov-

Black sea region. We will use two examples to show that the results of the forecast presented on the site unambiguously mean the predictions of disasters. We will also show that the results of the global forecast did not allow to draw conclusions about the impending disasters.

DISASTROUS STORM OF 11 NOVEMBER 2007

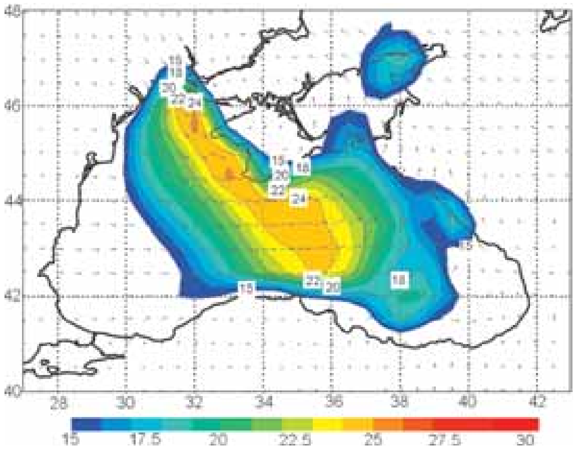
Synoptic situation during the storm was discussed in [Ovsienko et al., 2008]. As follows from the standard maps of operational meteorological analysis based on ground-based observations and satellite images of cloudiness from Meteosat satellite, the disastrous storm of 11 November 2007 was connected with a cyclone passage, which belongs to a category of the so-called "southern" cyclones. Having emerged over the Aegean Sea, it moved to the North-East over the Western part of the Black Sea and the Crimea. Such synoptic situation is typical of the Black Sea region – "southern" cyclones pass over the Western part of the Black Sea quite often. Sometimes they are intense, but they result in catastrophic storms quite seldom. Examples of such extreme events are storms of 9 October 2003 and 9–10 November 1981.

Currently synoptic processes, such as occurrence and movement of cyclones, are reliably predicted for up to three days and even more in the international and national centers of global analysis and forecast of atmospheric circulation. The shape and movement trajectory of the considered cyclone in the global and regional forecasts were almost identical. This is because the cyclone is fairly large in size, and its behavior inside the computational area of the mesoscale model is determined by the boundary conditions, which are taken from the global model of operational forecast. However, coarse resolution of global models (50 km) leads to an underestimation of extreme wind speeds. The use of low wind speeds over the Black Sea as input data for the wave model causes underestimation of the energy of the surface waves and, consequently, underestimation of the danger such storm represents.

Fig. 1a shows a map of wind speed at 10 m above the Black Sea level according to the model of the global operational analysis and forecast of the American center NCEP/NCAR with a resolution of 0,5°–0,5° at the time of 06:00 UTC on 11 November 2007 [NOAA Operational Model Archive Distribution System, 2013]. As it follows from the figure, and also from the calculations using global models for the other time points, wind speed over the Black Sea does not exceed 25 m/s. Fig. 1b shows a map of the wind speed over the Black Sea obtained from the *QuikSCAT* satellite scatterometer at the time of 03:35 UTC, 11 November 2007 [Ocean Surface Winds Team, 2013]. It is obvious in comparing the figures that the real wind speed significantly exceeded the results of calculations with the global model. It is confirmed by standard measurements at the meteorological stations (see Table. 1). These measurements were carried out every 3 or

Table 1. Maximum wind speeds 11 November 2007

Meteorological station	WMO Code	Wind speed, m/s	Time UTC
Simferopol	33946	23(32)	6:00
Chernomorskoye	33924	24(28)	6:00
Kerch	33983	20(27)	9:00
Ai-Petri	33998	27	6:00
Genichesk	33910	35(38)	12:00
Mariupol	34712	20(28)	15:00
Tuapse	37018	10(23)	6:00, 9:00
Sulina	15360	20(28)	00:00
Feodosia	33976	12(25)	6:00



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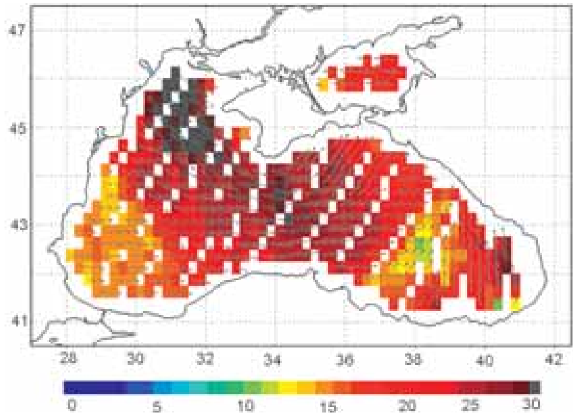

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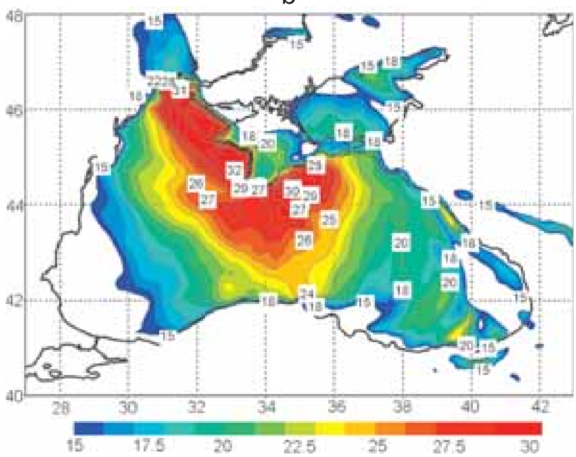

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Fig. 1. Wind field during the catastrophic storm.

a – Map of wind speed resulting from global operational forecast NCEP/NCAR GFS with 0,5°–0,5° spatial resolution at a time of 06:00 UTC on November 11, 2007. [NOAA Operational Model Archive Distribution System, 2013].
b – Map of wind speed derived from satellite measurements of November 11, 2007 (QuikSCAT scatterometer, 12,5 km spatial resolution) [Ocean Surface Winds Team, 2013].
c – Map of wind speed resulting from regional operational forecast using MM5 model with 10 km spatial resolution at a time of 06:00 UTC on November 11, 2007. [Marine Hydrophysical Institute, 2013].
Only contours of wind speed exceeding 15 m/s are shown in fig. 1a and 1c

6 hours and lasted for 10 minutes. The table shows the average and maximum (in parentheses) values. The measured values of wind speed reached and exceeded 30 m/s. In particular, the maximum wind speed in Genichesk equaled 35 m/s. Fig. 1c shows the results of the regional forecast for wind speed at 10 m level at the time of 06:00 UTC on 11 November 2007 [Marine Hydrophysical Institute, 2013]. This figure proves that the maximum wind speed reached 32 m/s. For other time points, the wind speed was also higher than in global models.

Results of the atmospheric forecast were used to predict the wind wave field with a resolution of 10 km using the *WAM*. Fig. 2 shows two variants of significant wave height calculations for various inputs of WAM at a time of 10:00 UTC on November 11, 2007. In Fig. 2a the wind speed of *NCEP/NCAR GFS* global model of 0,5° resolution was used as an input. Fig. 2b shows the wave forecast presented on the Internet 3 days before the storm based on the operational forecast of *MM5* mesoscale model of 10 km resolution. Note that the same color scale is used in both figures. According to the figure, the maximum significant wave height in Sevastopol area reached 5 m for the global model and 7 m for the mesoscale model. In the Kerch Strait, where many ships sank, the maximum wave heights were 5 m and 9 m respectively.

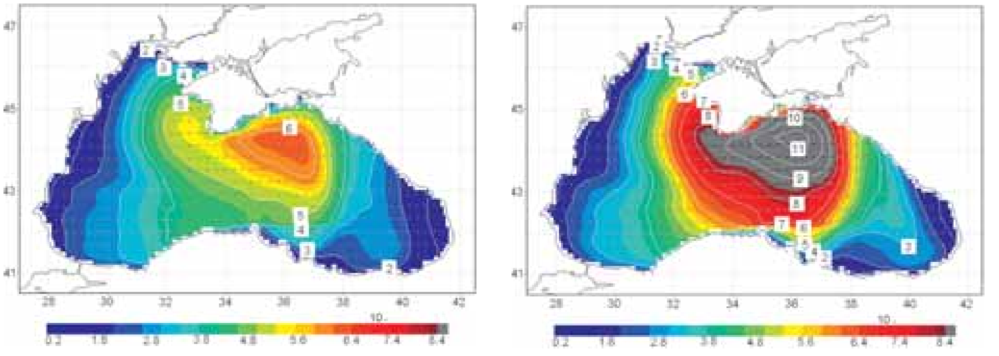


Fig. 2. Results of the forecast of wind waves for November 11, 2007, 10:00 UTC.
a – wind from global operational forecast; b – wind from MM5 forecast with 10 km resolution. Contours show significant wave height, arrows indicate direction of the waves

The maps of wind waves parameters obtained through the forecast allow tracing the evolution of the wave field for the Black Sea basin with 1 hour discreteness. As follows from such analysis, the waves that arrived at the Kerch Strait travelled from the region adjacent to the Bosporus. Note that Fig. 1 and 2 show the fields of wind and waves at 06:00 and 10:00 respectively. However**,** the waves travelled over about 800 kilometers for approximately 24 hours. During this period the cyclone significantly shifted to the North-East. As a result the waves remained under the impact of South-West wind along the entire wave fetch. Thus the wind waves off the Crimean coast appeared as a result of long-term wave development from Istanbul to Kerch. As it is known the significant wave height is approximately proportional to the square of the wind speed (see, e.g., [Holthuijsen, 2007]). Therefore, in this case underestimation of wind speed in the global forecast caused a far more significant underestimation of the wave height. As a result, the global forecast did not contain predictions of an extremely hazardous storm, while the regional forecast based on *MM5* and *WAM* models clearly indicated the impending disaster.

DISASTROUS FLOOD IN KRASNODAR REGION OF 6–7 JULY 2012

Synoptic conditions of the disaster in Krasnodar Region was discussed in [Kuklev et al., 2013] on the basis of baric maps of the global forecast. The cyclone, which caused extreme precipitation in Krasnodar Region, was formed to the East of the Black Sea and slowly moved to the South-West. During 6–7 July, the center of the cyclone almost didn't shift. The authors of [Kuklev et al., 2013] consider this circumstance as the main cause of the heavy rains on a limited area, explaining the "halt" of the cyclone by a process of convection over the heated Sea of Azov. It will be shown below that regional atmospheric modeling allows to obtain a deeper and more adequate interpretation of meteorological reasons of the flood.

Fig. 3 shows a standard weather map of the cyclone, a map of the average intensity of precipitation over two days, which depicts the localization of catastrophic rainfall, and *Meteosat* satellite images of cloudiness, which describe the evolution of the cyclone in the period under consideration. The map of precipitation was made using the Giovanni online data system [Goddard Earth Sciences Data and Information Services Center, 2013]. The satellite images were obtained from an open site [Dundee Satellite Receiving Station, 2013]. The large-scale features of such synoptic conditions were predicted by both global prognostic models and regional forecast. However, the *NCEP/NCAR GFS* global prediction models showed insignificant quantities of precipitation. It is shown in Fig. 4a where the 2 days sum of precipitation in the vicinity of Novorossiysk is about 60 mm. The

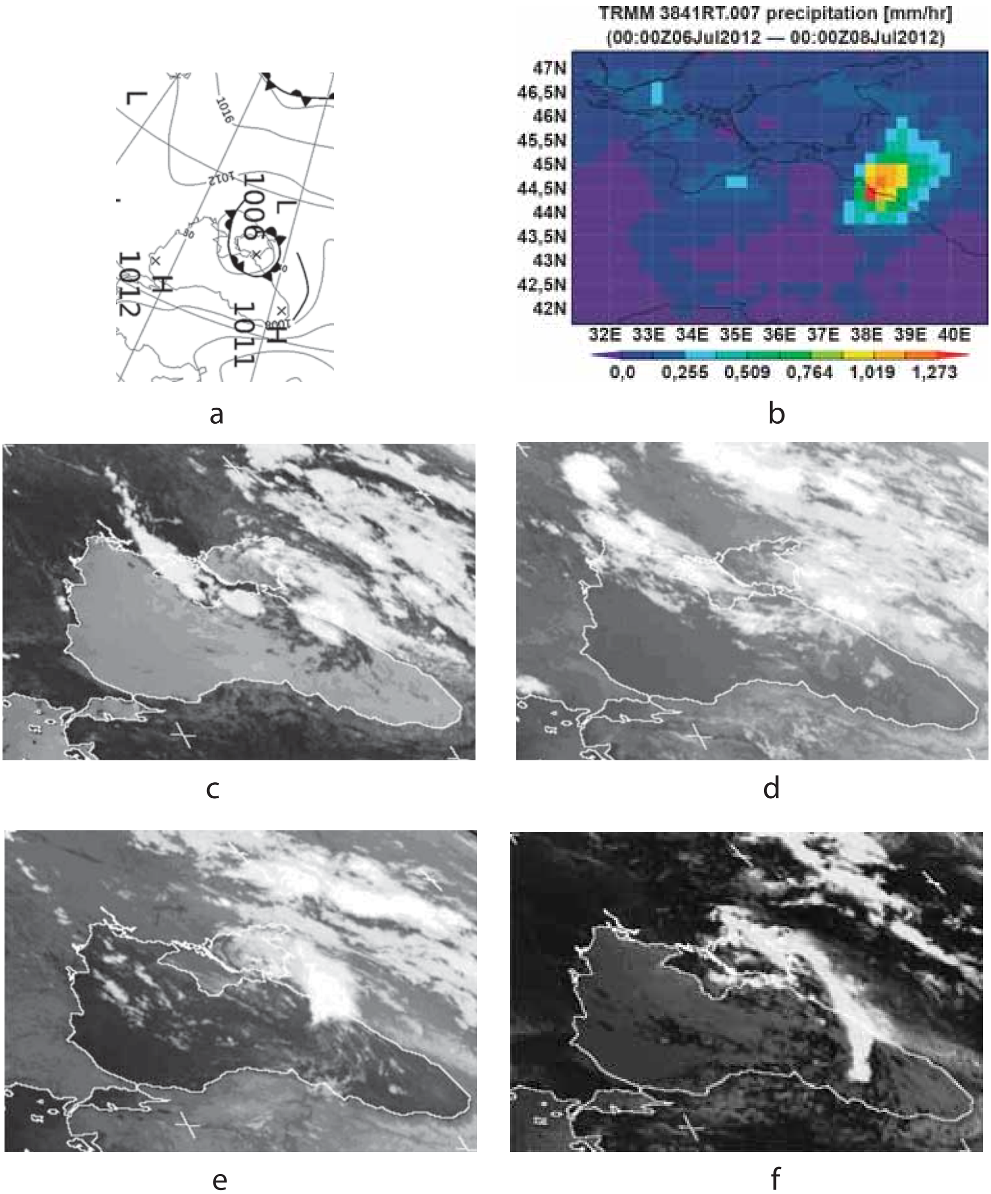
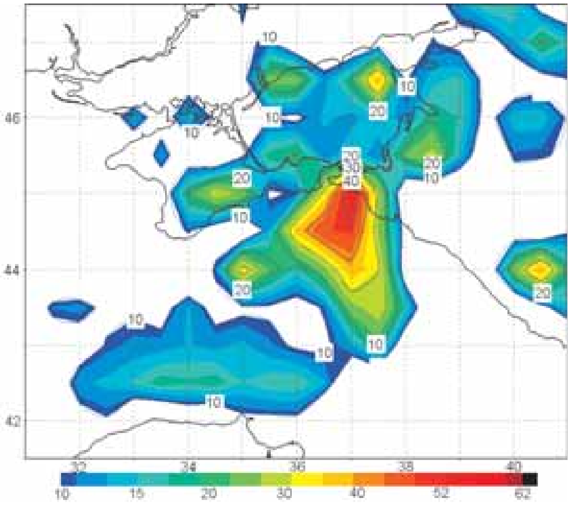


Fig. 3. Characteristics of synoptic situation.
a – Standard map of operational meteorological analysis for 6 July 2012, 12:00 UTC;
b – Map of average intensity of precipitation for two days
[Goddard Earth Sciences Data and Information Services Center, 2013];
satellite images of cloudiness in the thermal range [Dundee Satellite Receiving Station, 2013] for time points (UTC):
c – 6 July 2012, 12:00, d – 6 July 2012,18:00, e – 7 July 2012, 00:00, f – 7 July 2012, 06:00

same quantity of precipitation follows from the map in Fig. 3b. It should be emphasized that this map was obtained through indirect estimates based on the IR-radiometer data [Goddard Earth Sciences Data and Information Services Center, 2013]. However, according to the direct measurements at the meteorological stations, the 2 days sum of precipitation was much higher. It reached 283 mm in Novorossiysk, 275 mm in Gelendzhik, and 171 mm in Krymsk.

Results of mesoscale operational forecast of *MM5* model with 10 km resolution are



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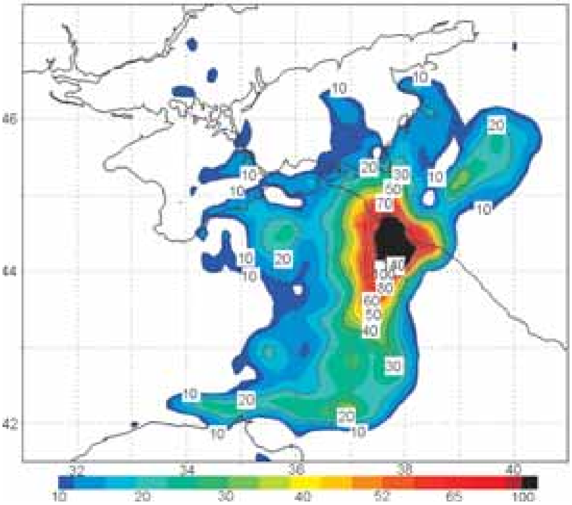

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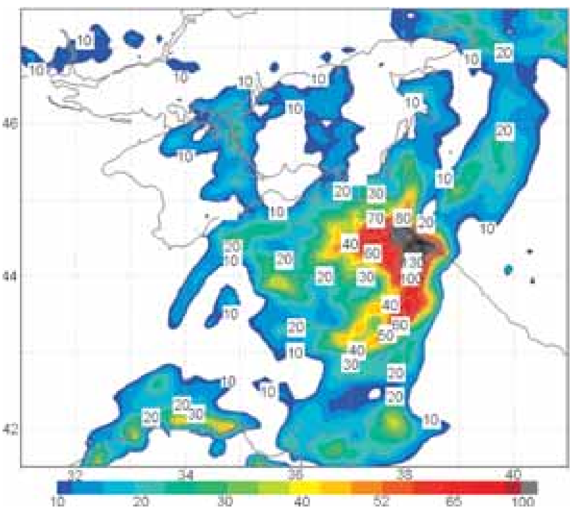


c

shown in Fig. 4b. Exactly the same precipitation map was presented in free access on the Internet 5 days before the disaster. It shows the two days sum of precipitation in the vicinity of Novorossiysk which is three times higher than the predictions of global models and are consistent with the measurements at meteorological stations during the disaster.

Unlike global models, where the processes of cumulus convection are parameterized, regional models perform direct calculation of these processes [Clark et al., 2012]. Apart from clarifying the forecast, it also allows to thoroughly investigate the physics of the phenomena. Such analysis, in turn, allows obtaining an adequate meteorological interpretation of the disastrous weather event. In this case, as follows from the analysis of the calculated three-dimensional fields of atmospheric physical characteristics, the South-West air flow started to move upward after encountering the Markhotsky ridge near Novorossiysk. This air lifting initiated deep cumulus convection and local heavy rainfalls which lasted for several hours. It was this that caused the catastrophic flood.

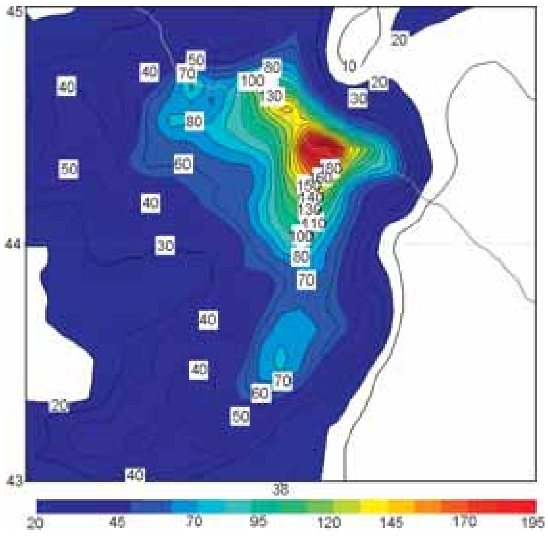
This explanation of the phenomenon under consideration disagree with the conclusions of [Kuklev, 2013] based only on standard meteorological analysis. This explanation is also impossible in the framework of global modeling, because it requires

Fig. 4. Forecast results of 2 days precipitation sum for 6–7 July 2012.

a – global operational forecast of 0,5°–0,5° resolution;

b – MM5 operational forecast of 10 km resolution;

c – WRF hindcast of 5 km resolution



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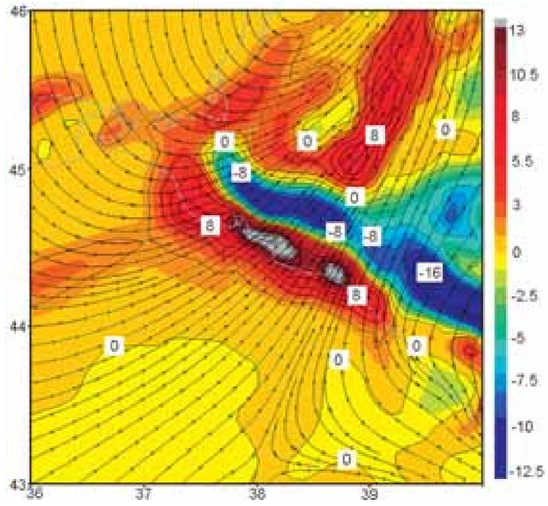

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Fig. 5. Localization of catastrophic rainfall and its mechanism

a – zoomed fragment of Fig. 4c (2 days sum of precipitation);
b – air flow speed at the level of 400 meters above the underlying surface for synoptic time of 7 July 2012 00:00 UTC.
Horizontal wind speed is shown using streamlines and vertical velocity is shown in color and contours

accounting for the regional orography. At the same time, this interpretation of the situation is well consistent with the satellite images of cloudiness (see Fig. 3). The brightest areas of the images correspond to the dense cumulonimbus clouds, which visualize the process of deep cumulus convection. According to the figures, deep cumulus convection continued for at least 18 hours, from 12:00 on July 6 up to 6:00 on July 7. It was in this period that the heavy rainfall took place in the area of Novorossiysk.

To illustrate and verify the conclusions which follow from the results of regional forecast, we made a hindcast using the *WRF* model of 5 km resolution. The obtained map of 2 days sum of precipitation is shown in Fig. 4c, while Fig. 5a shows its zoomed fragment. Note that the forecast gives a very small area of localization of extreme precipitation. As it can be seen from Fig. 4c and 5a, the characteristic size of the area, where the two days sum of precipitation exceeded 100 mm is 50 km. However, the heaviest rainfalls, with the two days sum exceeding 200 mm, were localized into only about 20 km area. This circumstance might have led to a quantitative underestimation of rainfall from satellite IR-radiometer data (see Fig. 2b), because the spatial resolution of radiometer is 0,25°–0,25° that is not enough to identify such a small area. At the same time, significant localization of extreme precipitation events was observed actually [Volosukhin, Schursky, 2012, Kuklev, 2013].

Fig. 5b illustrates the mechanism of heavy rainfall on a small area. It shows the field of the air flow speed at the level of 400 meters. Horizontal speed is shown with streamlines while vertical speed is shown with color scale and contour lines. The air flow related to cyclone had South-West direction near Novorossiysk. When the air volumes arrived at the Markhotsky ridge, they started rising at a high vertical speed up to 14 cm/s. This, in turn, initiated the deep cumulus convection and heavy local rainfalls. Since the cyclone hardly moved during 6–7 July, the mechanism described above kept working for several hours and it resulted in a disastrous flood.

Thus, the regional forecast taking into account the microphysics of the atmospheric processes presented a correct prediction of disastrous rainfalls in the vicinity of Novorossiysk. At the same time, in the frame of the global forecast or traditional meteorological analysis, such prediction was impossible.

DISCUSSION AND CONCLUSIONS

We shall consider the quality of short-term forecasting for the Black Sea region for all the time of operation of the system in MHI. Fig. 6 shows the results of forecasting of rainfall intensity in the area of Novorossiysk since 2007 till present days (the system temporarily did not work in the period from December 2007 to July 2008). The daily sum of precipitation for the model grid point closest to Novorossiysk is presented depending on time. As follows from the figure, the forecast system does not issue "false alarms". At the same time the graphs leave no doubt that the forecast of abnormal

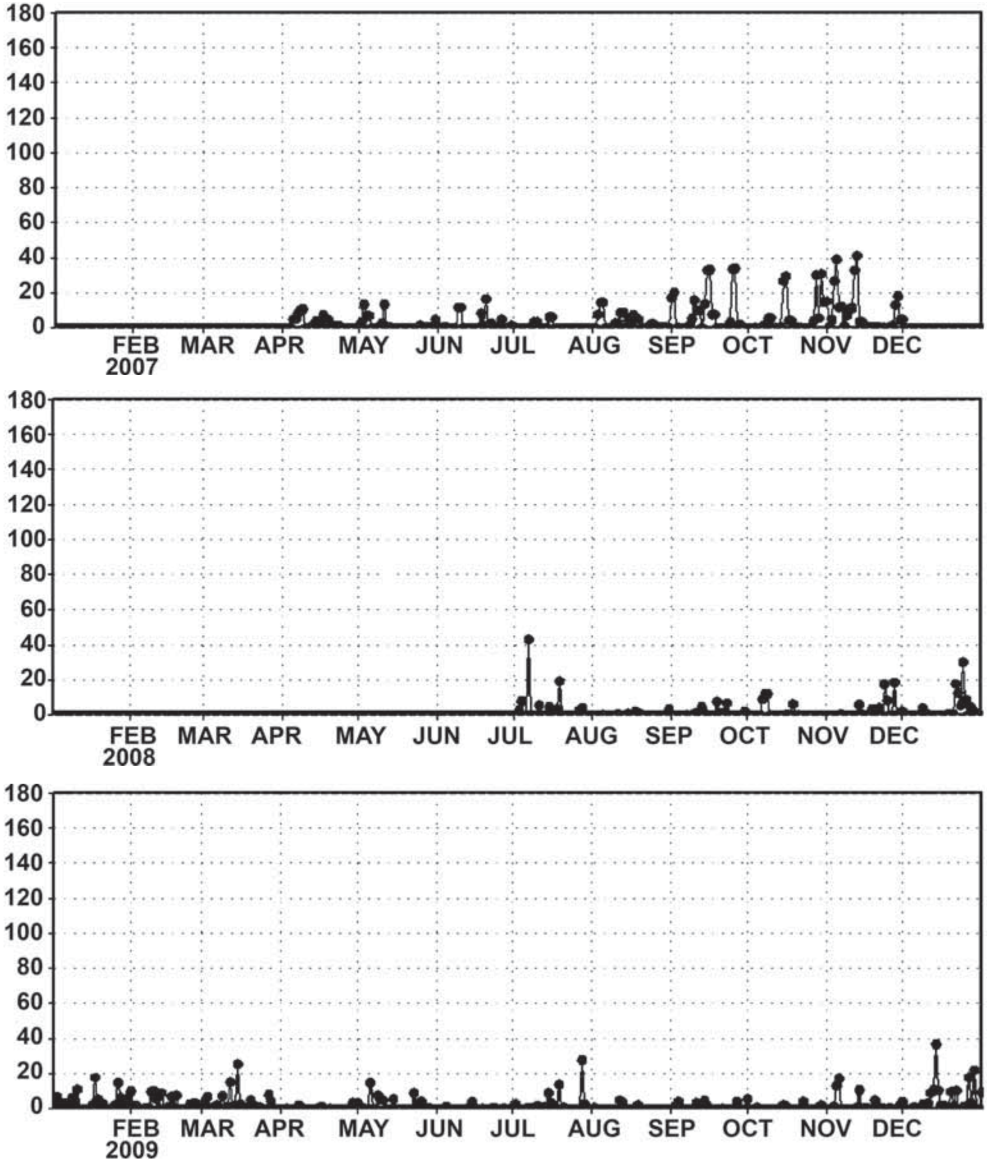
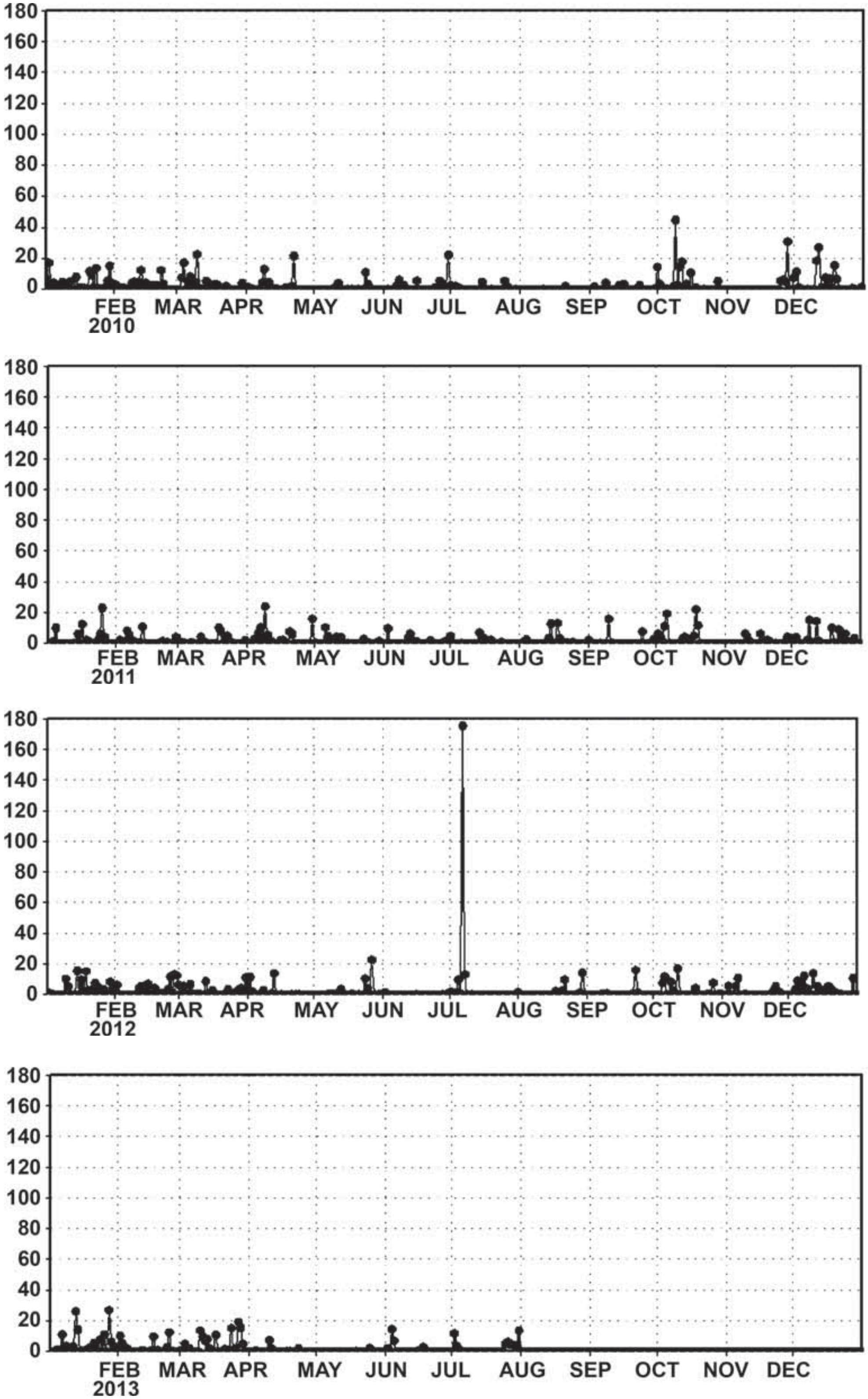


Fig. 6. Results of the operational forecast of MHI for 2007–2013. →



Daily precipitation totals in grid point of the model which is the closest to Novorossiysk

rainfall intensity on 7 July 2012 could be easily identified. Fig. 7 shows the results of forecast of significant wave height near the Kerch Strait in the point with coordinates 45° N, 36,6° E. As can be seen in the figure, the catastrophic storm on 11 November 2007 is easy to detect in the form of abnormal values of the forecast. Fig. 6 and 7 confirm high reliability of the system for short-term regional forecast implemented in MHI.

It is known that the quality of the forecast can be improved using parallel calculation of several variants of numerical models [Clark et al., 2012]. At present, MHI has already implemented a short-term weather forecast for the Azov-Black Sea region with the

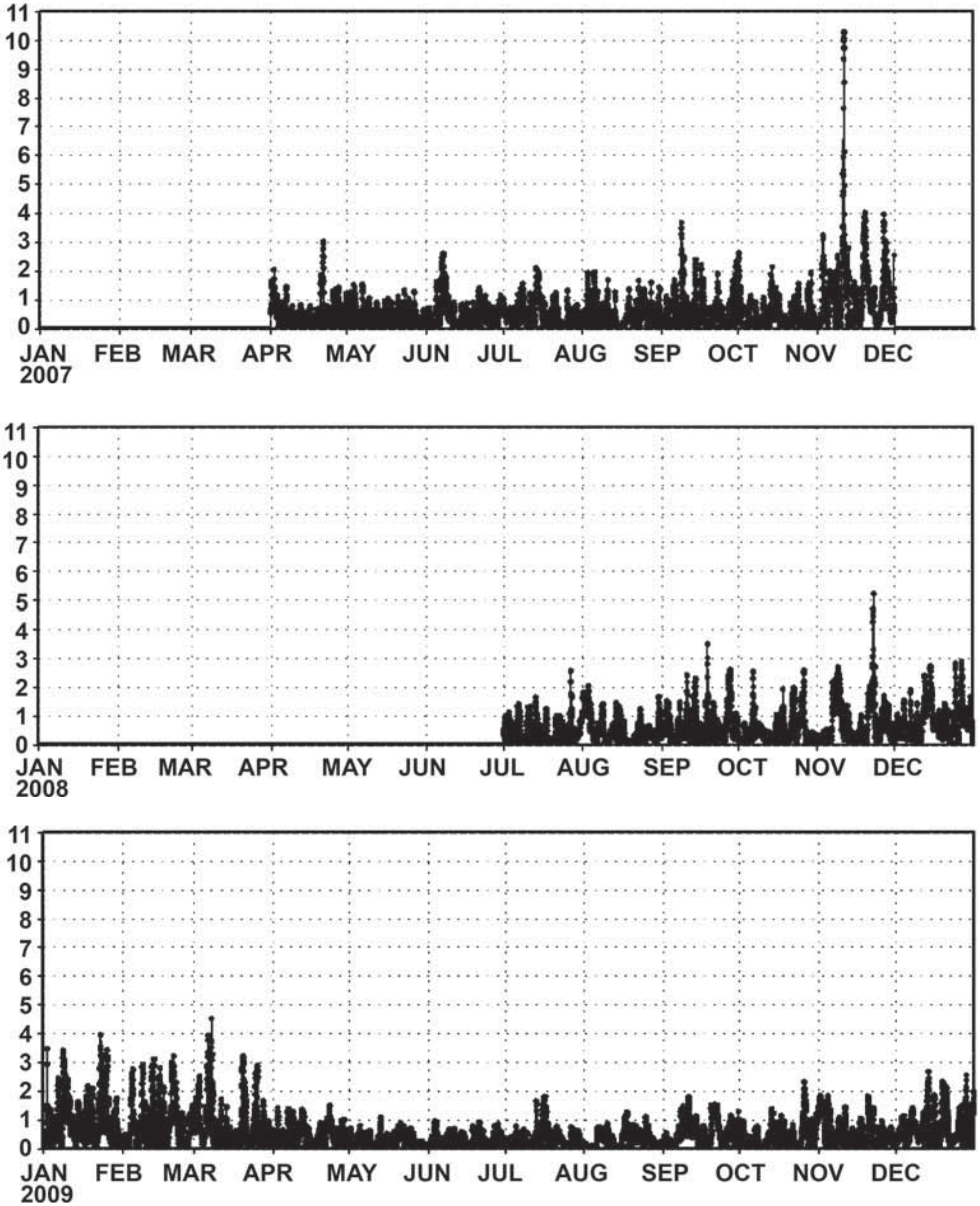
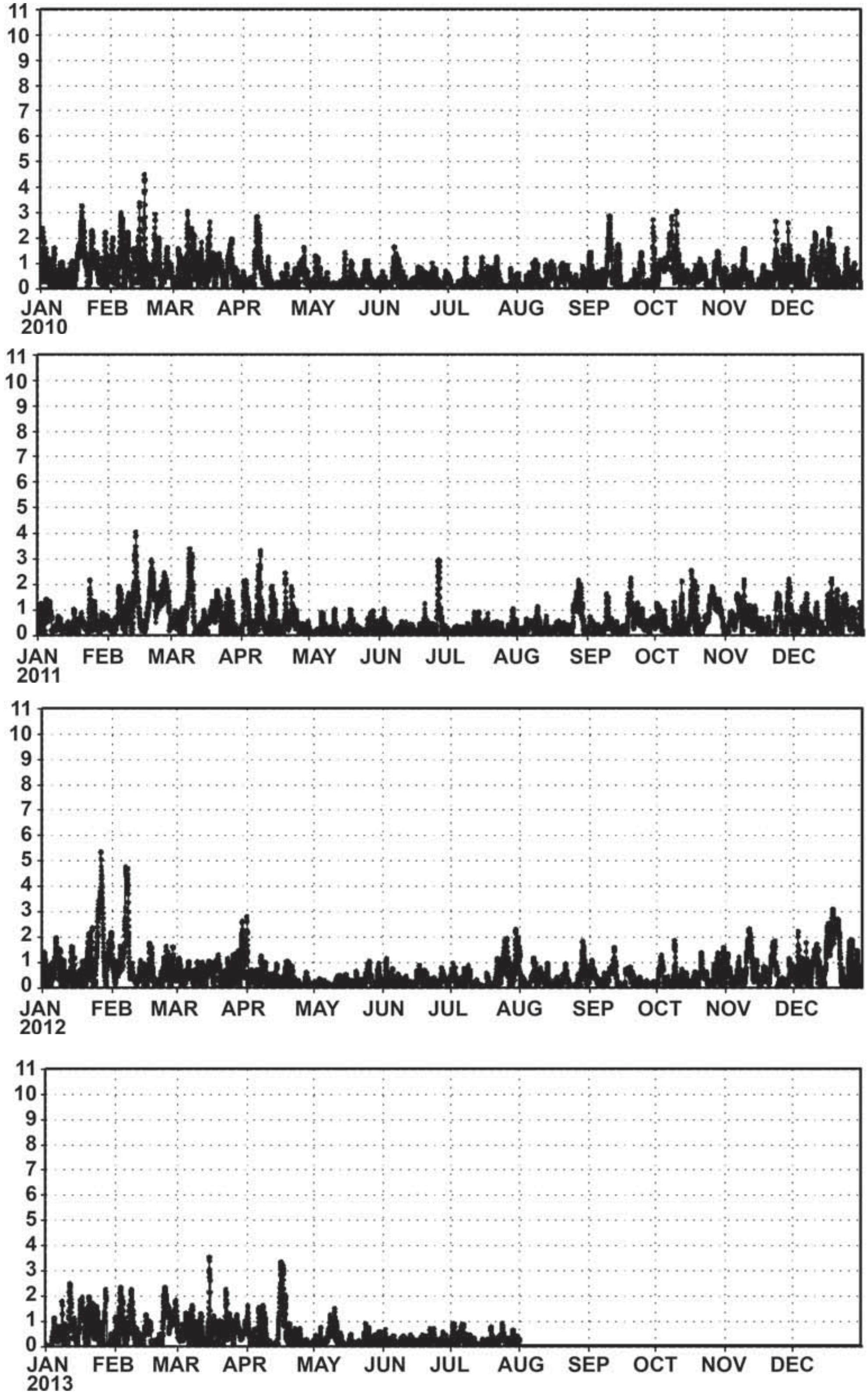


Fig. 7. Results of the operational forecast of MHI for 2007–2013. →



→ **Significant waves height in the Black Sea in area near the Kerch Strait** parallel use of *MM5* and *WRF* mesoscale atmospheric models.

It should be stressed that for flood forecasting in mountainous areas, precipitation forecasts with a high spatial resolution are not enough. In addition to the results of the forecast, a realistic model of river flow is needed, which uses the results of mesoscale atmospheric modeling as an input. Such system is already implemented for the South Crimea area (see, e.g., [Ivanov, 2012b]). It should also be noted that *WAM* can only be applied for wave forecast in the deepwater part of the Azov-Black Sea basin, where the depth exceeds half the length of dominant surface waves (see, e.g., [Holthuijsen, 2007]). In order to involve the Azov Sea and North-Western part of the Black Sea in the forecast area, the wave model should be supplemented by appropriate *SWAN* or *WAVEWATCH* models [Holthuijsen, 2007]. These are the obvious directions of improvement for the MHI forecast system.

This paper uses the examples of two catastrophic weather events in the Black Sea region to demonstrate the high quality and reliability of mesoscale atmospheric predictions, and their advantages comparing to the global forecast. The use of such forecasts could lead to significant reduction in human losses and economic damage from catastrophic weather events. The means of operational regional modeling of the atmosphere in the Marine Hydrophysical Institute of the NAS of Ukraine could become an element of a prospective early warning system for weather disasters in the Azov-Black Sea region.

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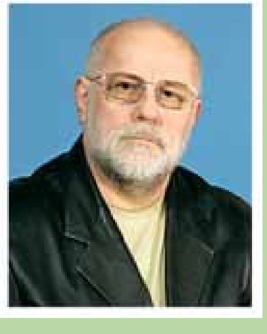

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CHANGES OF MAMMAL BIODIVERSITY IN THE EUROPEAN RUSSIA (THE END OF THE XVIII CENTURY – XXI CENTURY)

ABSTRACT. The paper investigates the data on the fauna of the European Russia at the end of the XVIII century, contained in the materials of the General Land Survey, in comparison with contemporary data. The distribution ranges of the majority of large mammals observed in the study area two centuries ago, have not changed significantly, but the biological diversity has increased due to the emergence of new species.

KEY WORDS: General Land Survey, biogeographical and historical research, mammals, human impact on nature.

INTRODUCTION AND BACKGROUND

One of the key processes of the Russian history of the XVI–XIX centuries is its fast territorial expansion, which has helped to partially offset the adverse natural impact of the country's historic center on the agriculture [Milov, 2006]. This feature dramatically distinguishes Russian history in the early modern period from the history of other European countries, and makes it very interesting from the point of view of the study of how the human impact changed the environment. Rapid population growth, while maintaining almost exclusively agrarian nature of the economy, was secured by involving in the agricultural use a vast lands and developing new agricultural areas, especially in the South and East of the country. Since the beginning of the XVII century and until the end of the XVIII century, the total area of arable land increased almost 4 times [Vodarskii, 1988] and this process continued into the next century. The main growth occurred in the European part of the country where the boundaries of agricultural settlement moved many hundreds of kilometers to the South and East.

The question of how it affected the composition of the fauna has not been previously discussed by the historians of Russia, although similar works in other regions of the world exist and constitute a rapidly developing interdisciplinary research direction of environmental history [Rackham, 2001; Extinctions ..., 2010; Ouchley, 2010, etc.].

In the public opinion, there is a fairly stable view that the economic development has led to a sharp decline of biological resources. This idea was carried out in Russian classical literature, for example, in the books by S.T. Aksakov, P.I. Melnikov-Pechersky, N.I. Nekrasov, and I.A. Bunin. Having become quite common, it also had a visible impact on the historians. V.O. Kluchevskii [1987] singled out the massive deforestation and the reduction of the number of wild animals as one of the characteristic features of the process of the Russian colonization. This trend was most fully embodied in the works of M.K. Lubavskii [1996, etc.].

Thus, in the fiction and historical literature the view has formed that the diversity of fauna of the European territory of Russia (hereinafter, ETR) decreased significantly in the XVIII – first half of the XIX centuries, and this was directly linked with the agricultural development of the territory and deforestation. Sources allow testing the validity of this opinion only in part. Only limited information is available on the number of animals that lived on that territory. However, the information on their spatial distribution can be collected from the historical sources from the second half of the XVIII century onwards. In particular, they are systematically presented in the materials of the General Land Survey (hereinafter, GLS).

Started in 1765, the GLS continued for more than 50 years and was the largest archival complex of pre-revolutionary Russia, consisting of more than 1,3 million units. The survey description covers the major part of the ETR, and both the primary documents (field notes of land surveyors and plans of dachas), and the generalized materials of all levels were supplemented with well-preserved different-scale maps [Golubinsky et al., 2011].

For us, it is particularly important that, in addition to its purely utilitarian task – to distinguish the borders of land holdings, the surveyors had to gather an extensive range of data on each of the surveyed settlements, based on the reports of the local population and on their own observations. In the generalized textual documents of each uezd (district), called "Economic Notes" (hereinafter, EN), in addition to the information on the lands, human settlements and population, the lists of *animals*, *birds* and *fishes* presented it the area were recorded. It is crucial that all this information is gathered with the purposes that we would now identify as scientific, which designates its rather high reliability.

Unfortunately, this "additional" information is not cited in all volumes of the EN. According to the typology of L.V. Milov [1965], it is available in the "Notes to the General Plan", and "Full" and, partly, in the "Cameral" sections of the EN. In the "Concise" and "Pavlovian" sections that make up the majority of the surviving volumes, they are omitted.

Data on the wildlife that we find in the 'Full' section of the EN were collected in the following way. The review of the "internal situation" of each of the landholdings was the task of a Junior Surveyor; this work was considered less important then the survey itself, and, unfortunately, was poorly regulated and almost not documented. We can suggest, however, that the surveyors often received information directly from the local population, according to the so-called "*skazki*" (reports) of the peasants who served as witnesses during the survey process ("*poverennye krestyane*"). Unfortunately, only a small number of these interesting documents survived – now, only 400 of them are found [Milov, 1960]. The most detailed type of these documents describes the status of agriculture, forestry etc. "*Poverennye*" were elected among the most informed and educated peasants, often the headmen of the peasant communities or the bailiffs of local landlords.

The list of wildlife species is given in the 'Full' EN in the form of the description of each "*dacha*" (i.e., a landholding); sometimes it had a notation: "the animals and birds in the forests, and fish in the rivers are the same as it is written in the description NN". In many cases, in neighboring dachas, these lists coincide. The special research revealed that the differences mainly concern the dachas with few forests when the surveyors excluded the species in the forests from the list. It seems unlikely that the information on the fauna was collected specifically for each of the surveyed landholdings. The "*skazki*" were composed, as a rule, for the settlements, where the form of the description required the data on crafts, rental obligations, and other information. We can assume that for the non-populated holdings, as well as the small villages, the data from the large neighboring estates were copied. Moreover, as a rule, the number of variants of the list of animals was limited to 3 or 4 per uezd.

This paper is the first in a planned series of studies of the historical changes of the wildlife of the ETR based on the materials of the GLS.

The EN mentions three classes of wildlife: *Mammals*, or *animals* (Mammalia), *Birds* (Aves) and *Fishes* (Osteichthyes). At the first stage of the work, the *mammals* were selected as a research object, being a component of the fauna, small enough (in terms of species number) for the convenience of the analysis and important for the humans in different aspects.

The purpose of the study is to estimate the changes in the composition of the mammals fauna of the ETR from the late XVIII century to the present day using the data contained in the EN. The main objectives were:

1. To compile a list of names of animals (the same name in the EN may refer to more than one species), mentioned in the EN, and to evaluate the frequency of occurrence of each of them.

2. To distinguish the animals that particularly attracted the attention of the surveyors, or on the contrary, were ignored by them, despite the obvious importance and to attempt to explain this.

3. To compare the data on the distribution of animals in the EN with the data on their modern distribution and to analyze the revealed changes.

MATERIALS AND METHODS

This paper explores the information on mammals of the ETR contained in the EN. The provinces of the ETR, where we have complete or nearly complete sets of the EN containing information of interest to us, in the Survey archive in the Russian State Archive of Ancient Documents (RSAAD), Moscow, Russia. For each of them, only part of the existing data is examined here.

Keeping in mind the structure of the data discussed earlier, it seems unnecessary to handle each volume of the EN entirely – a representative sample is sufficient for achieving our goal. It is possible that (1) the lists of animals, specific to the uezd, may be incomplete due to the structure of land use in a particular dacha (e.g., the forest species may be excluded in the treeless or sparsely wooded landholdings) and (2) in some cases, the differences in the lists can reflect the real state of affairs – the presence of the species in one part of the uezd and its absence in another. So, a mechanical sample was made: every 25th–35th landholding was selected from each volume of the EN (one record per 25 pages of the manuscript, on average). For small volumes, the number of selected dachas was increased, especially for the uezds with the low fragmentation of land ownership.

Only the populated dachas were selected, with the percentage of forests no lower than the average for the uezd and with the description containing the list of species (the references to other descriptions were excluded). This technique has allowed us to compile a sufficiently complete list of mentioned animals. A control sample, which included 4 randomly selected records from each volume, confirmed this – no new species of animals were found.

The sample includes 7 provinces, 33 uezds within them, and 330 dachas. The territorial distribution of the actual material is shown in Fig. 1. Although it doesn't cover the whole territory of the ETR, the sample provides a set of zoogeographic observations, unique for the period of the XVIII – early XIX centuries, regarding its level of detail and territorial coverage. It should be noted that the EN were previously used by the zoologists as a source of data on historical changes of the wildlife of Russia (for example, the works of S.V. Kirikov [1959; 1966, etc.]). However, the data used by them were fragmented in terms of area coverage or set of species analyzed.

Fig. 1 shows that the territory in the sample includes almost all the modern vegetation zones (subzones) within the territories covered by the GLS. Accordingly, the sample should, to some extent, reflect the state of the animal world of the whole ETR (except for the extreme northern and southern areas).

For each dacha, a list of mentioned animals was compiled. It should be mentioned that the transcript was quite accurate, as the names of the species didn't change much since the time of the GLS. On the contrary, for the fishes, the surveyors often use the obsolete local names. It presents some difficulty to identify them, which will be a subject of the further research.

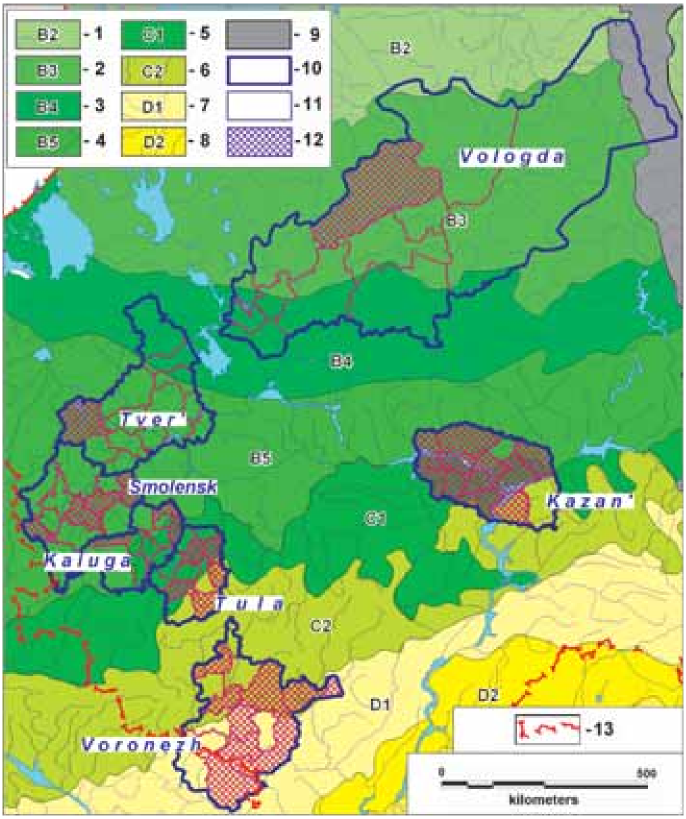

Fig. 1. The studied sample on the map of the modern vegetation zones and subzones of the ETR (Vegetation zones and types ..., 1992, modified).

Vegetation zones and subzones. 1–5 – Taiga zone. Subzones: 1 – northern taiga; 2 – middle taiga; 3 – southern taiga; 4 – sub-taiga (mixed forest); 5–6 – Broad-leaved forest zone. Subzones: 5 – broad-leaved forest; 6 – forest-steppe; 7–8 – Steppe zone. Subzones: 7 – northern (bunch-grass-turf) steppe; 8 – middle (dry) steppe; 9 – Mountain areas; 10 – Borders of provinces included in the sample; 11 – Borders of uezds; 12 – Uezds included in the sample; 13 – Modern border of Russia

The primary lists of species were aggregated at the uezd, province, and, finally, the whole sample levels. At each stage, the number of mentions of each species was calculated. Finally, the database was compiled containing also modern scientific names of the mentioned animals.

All mentions of each specie were located on the map (at the uezd level) by means of GIS MapInfo Professional. Then, the results were compared with the data on the present territorial distribution of these animals, known from the literature and other sources.

RESULTS AND DISCUSSION

In the sample, 24 names of mammals are mentioned, belonging to 11 families and 5 orders. Their list, correlated with the modern system of mammals, as well as the frequency of occurrence of each, on the province, uezd, and dacha levels, is shown in Table 1. Here, we must make some clarifications.

1. Currently, more than 250 species of terrestrial mammals live in Russia, belonging to 7–8 orders and more than 30 families [Dinets, Rothschild, 1996, etc.]. More precise calculations are impossible because of the many discrepancies in interpretations of the taxonomic categories. System of the wildlife is ambiguous and is constantly changing, especially in recent decades. We should also take into account that a significant proportion of the species live outside the ETR or in the ETR not covered by the GLS and are not present in our sample.

2. The scientific names (English and Latin) of species and higher taxonomic categories can be different in different sources. Especially it concerns English names, for which, unlike Latin, there are no strict rules of taxonomic nomenclature.

3. The individual names of animals in the sample can match two species – for instance, *hares* and *polecats* (see Table. 1). This issue will be discussed in more detail below.

The results of the analysis of occurrence (number of the mentions) of species on the three levels of aggregation are presented in the Fig. 2.

In the Fig. 2, animals can be divided into 5 groups according to the number of references to their names in the sample:

- ***a*** – maximum frequency of occurrence. These are: *hares* (312 references), *wolves* (226), *foxes* (186) and *squirrels* (184) mentioned in all provinces and almost all uezds.

- ***b*** – relatively high frequency of occurrence. These are *stoats* (93) and *bears* (42) mentioned in almost all provinces and more than a half of uezds.

- ***c*** – average frequency of occurrence. These are *martens* (17), *marmots* (13) and *polecats* (11) mentioned in 2-3 provinces and 4–7 uezds.

- ***d*** – low frequency of occurrence. These are *mooses*, *otters*, *wild goats*, *weasels*, *lynxes*, *deer,* and *chipmunks*. For each of them, we have 2–5 references in 1–3 provinces and 1–3 uezds.

- ***e*** – minimum frequency of occurrence. These are *hedgehogs*, *moles*, *wolverines*, *badgers*, *minks*, *sousliks*, *beavers*, *hamsters*. Each of them is mentioned once in the sample, i.e., 1 province and 1 uezd.

Cartographic analysis was used to compare the locations of animals according to the EN to its modern areas within the ETR. The modern boundaries of areas, not defined precisely for all the species, were specified using available literature and, largely, on the basis of materials contained in the database of the Information System "The communities of terrestrial vertebrates of Russia" developed at the Department of Biogeography of the Faculty of Geography, MSU [Rumiantsev, Danilenko, 1998; Danilenko, Rumiantsev, 2008].

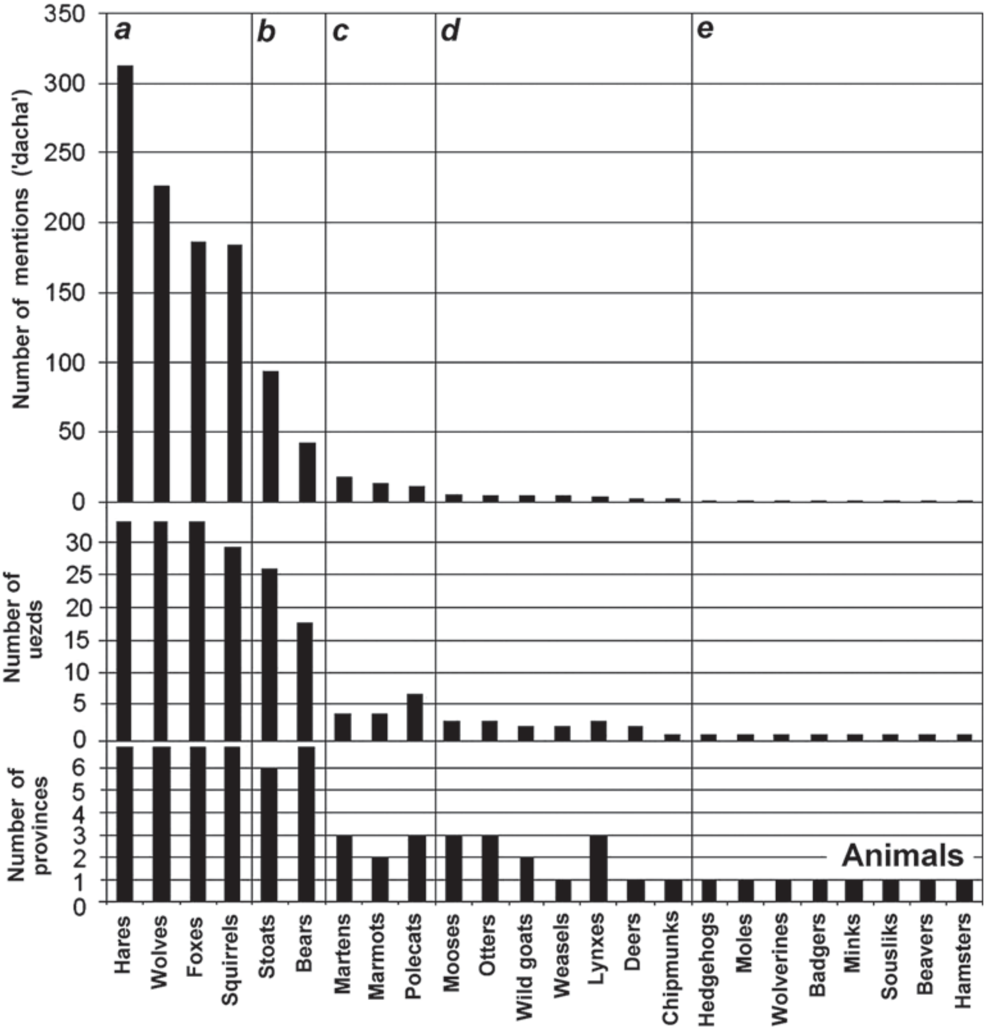

Fig. 2. Frequency of the mentions of animal names in the sample (ranged by the decrease of frequency).

a–e *– groups of animals conditionally chosen on frequency of their mentions (discussion in the text)*

The analysis revealed the fact that almost all of locations of the animals mentioned in the sample are within their modern distribution ranges. The only apparent exception is *brown bear*. According to the EN, in the period of the GLS its areal extended far to the south beyond the modern southern border of the range (Fig. 3). There are several other, less visible examples – so, *lynx* is recorded in Masalsk uezd in the Kaluga province. This territory is now nominally included in the range [Bobrov et al., 2008 a.o.], but actually the *lynx* does not live there, only rare visits are possible.

Two general assumptions are made when discussing the results.

1. If the animal is mentioned in the EN, then it lived in this particular area. Thus, the reliability of the surveyor's observations is postulated and the possibility of errors is ignored.

2. If the animal is NOT mentioned in the EN, this does not mean that it did not live there. It is already obvious that the numerous species, important for the humans, significant and common today, were never or very rare recorded in the EN.

Table 1. The frequency of mentions of animal species in the sample of "Full" EN (the animal names are given in systematical order)

Animals			Provinces																
Name in EN (24 names)	Modern name		Vologda (1/75)		Voronezh (8/53)		Kazan (11/87)		Kaluga (3/50)		Smolensk (4/30)		Tver (1/5)		Tula (5/30)		TOTAL (33 uezds, 330 dachas)		
	English	Latin	Uz	Lh	Uz	Lh	Uz	Lh	Uz	Lh	Uz	Lh	Uz	Lh	Uz	Lh	Pr	Uz	Lh
ORDER INSECTIVORA																			
Family Erinaceidae																			
Hedgehog	European hedgehog	*Erinaceus europaeus*	–	–	–	–	–	–	1	1	–	–	–	–	–	–	1	1	1
Family Talpidae																			
Mole	European mole	*Talpa europaea*	–	–	–	–	1	1	–	–	–	–	–	–	–	–	1	1	1
ORDER CARNIVORA																			
Family Canidae																			
Wolf	Gray wolf	*Canis lupus*	1	29	8	39	11	71	3	35	4	23	1	5	5	24	7	33	226
Fox	Red fox	*Vulpes vulpes*	1	22	8	45	11	58	3	14	4	22	1	5	5	20	7	33	186
Family Ursidae																			
Bear	Brown bear	*Ursus arctos*	1	11	3	3	9	20	1	2	2	3	1	2	1	1	7	18	42
Family Felidae																			
Lynx	Eurasian lynx	*Felis lynx*	1	1	–	–	–	–	1	1	1	1	–	–	–	–	3	3	3
Family Mustelidae																			
Wolverine	Wolverine	*Gulo gulo*	1	1	–	–	–	–	–	–	–	–	–	–	–	–	1	1	1
Badger	European badger	*Meles meles*	–	–	1	1	–	–	–	–	–	–	–	–	–	–	1	1	1
Marten	Pine marten	*Martes martes*	1	10	–	–	2	3	1	2	–	–	1	2	–	–	3	4	17
Polecat	European polecat Steppe polecat	*Mustela putorius* *M.eversmanni*	–	–	5	9	1	1	-	-	1	1	–	–	–	–	3	7	11
Mink	European mink	*M.lutreola*	–	–	–	–	–	–	1	1	–	–	–	–	–	–	1	1	1
Weasel	Least weasel	M.nivalis	–	–	–	–	2	4	–	–	–	–	–	–	–	–	1	2	4
Stoat	Stoat (Ermine)	*M.erminea*	1	11	8	19	10	35	–	–	3	18	1	2	3	8	6	26	93
Otter	European otter	*Lutra lutra*	1	1	–	–	–	–	1	1	–	–	1	2	–	–	3	3	4

Animals			Provinces																
Name in EN (24 names)	Modern name		Vologda (1/75)		Voronezh (8/53)		Kazan (11/87)		Kaluga (3/50)		Smolensk (4/30)		Tver (1/5)		Tula (5/30)		TOTAL (33 uezds, 330 dachas)		
	English	Latin	Uz	Lh	Uz	Lh	Uz	Lh	Uz	Lh	Uz	Lh	Uz	Lh	Uz	Lh	Pr	Uz	Lh
ORDER ARTYODACTYLA																			
Family Cervidae																			
Moose	Moose	*Alces alces*	1	1	–	–	–	–	–	–	–	–	1	2	–	–	3	3	5
Deer	Red deer	*Cervus elaphus*	–	–	–	–	2	2	–	–	–	–	–	–	–	–	1	2	2
Wild goat	Western roe deer	Capreolus capreolus	–	–	1	2	–	–	–	–	–	–	1	2	–	–	2	2	4
ORDER LAGOMORPHA																			
Family Leporidae																			
Hare	White hare European hare	*Lepus timidus L. europaeus*	1	64	8	49	11	85	3	50	4	30	1	4	5	30	7	33	312
ORDER RODENTIA																			
Family Sciuridae																			
Squirrel	Eurasian red squirrel	*Sciurus vulgaris*	1	44	5	9	11	60	3	30	4	24	1	3	4	14	7	29	184
Chipmunk	Siberian chipmunk	*Tamias sibiricus*	–	–	–	–	1	2	–	–	–	–	–	–	–	–	1	1	2
Marmot	Steppe marmot	*Marmota bobak*	–	–	3	12	1	1	–	–	–	–	–	–	–	–	2	4	13
Souslik	Large-toothed souslik	*Spermophilus major*	–	–	–	–	1	1	–	–	–	–	–	–	–	–	1	1	1
Family Castoridae																			
Beaver	Eurasian beaver	Castor fiber	–	–	–	–	1	1	–	–	–	–	–	–	–	–	1	1	1
Family Cricetidae																			
Hamster	Eurasian hamster	Cricetus cricetus	–	–	–	–	1	1	–	–	–	–	–	–	–	–	1	1	1
Mentioned animal names in the sample from EN – in total			10		10		16		11		8		10		6		24		

Notes: "8/53" – number of uezds / number of landholdings ("dacha") in the sample for given provinces; Uz- number of uezds, for which the EN mentions the given species; Lh - number of landholdings ("dacha"), for which the EN mentions the given species; Pr - number of provinces, for which the EN mentions the given species.
The animal names taken from the EN are generally used further in the text.

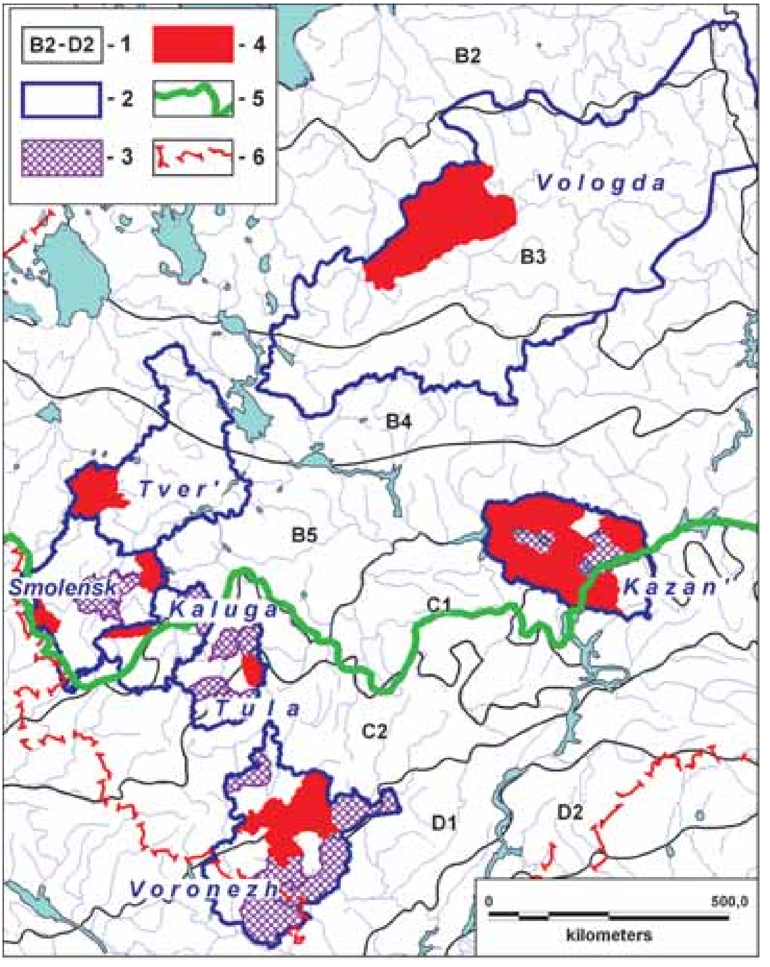

Fig. 3. The distribution of brown bear in the sample.
1 – Vegetation zones and subzones (see Fig. 1). 2 – Borders of provinces included in the sample. 3 – Uezds included in the sample. 4 – Uezds, for which the presence of bear is marked. 5 – Approximate modern position of the southern border of the bear distribution. 6 – Modern border of Russia

The frequency of occurrence of certain animals in the EN can presumably be explained by the following factors.

1. Significance for humans. The animal might be a hunting resource, a pest for agriculture, etc.

2. Visibility. Most animals are quite concealed, and many of them, even quite ordinary ones, are rarely observes by the humans. On the other hand, the notable animals may be mentioned, even having no economic significance.

3. The link with the specific phenological milestones in the life of nature (for example, certain species may be important for the "peasant calendar". This criterion is more important for birds, possibly, for some mammals, too.

Let us consider the species listed in the sample, starting from the most frequently mentioned (see Fig. 2).

The absolute leaders is *hare* (312 references in 330 dachas). We should remember, however, that we are talking about two species – *white hare* and *European hare*, not separated in the EN (see Table 1). *White hare* is a species of taiga and tundra and, accordingly, originally inhabited the northern part of the region. *European hare* tends to open spaces and originally dwelt in its southern part. Now in the vast territories of the ETR, they live together, dividing the territory biotopically: *white hare* in the forest areas, *European hare* in the fields. It is likely that the same situation could have occurred in the times of the GLS in the forest-steppe zone (see Fig. 1) where the hybrids of these species popularly called "*tumak*" have been known for a long time. Hares fully meet the criteria of relevance and visibility. As the object of hunting, they always attracted attention, and they could be trapped, without the use of remote weapons, which is important for the peasants. Hares are pests of a number of vegetable and horticultural crops to the present day. The role of hares in the life of the Russian peasants is widely reflected in the literature and folklore. Therefore, the high number of references in the EN is quite natural.

Next are *wolf* (226), *fox* (186), and *squirrel* (184). Their high statistics does not raise any questions also. Up to the present day, they live almost throughout the entire ETR; the number of wolves is obviously much smaller today than in the period of the GLS, but foxes are common, and sometimes numerous.

Wolf is a traditional object of hunting, a serious threat for cattle breeding, and, in the past, a real danger to humans. It can rarely be observed, but in the areas of habitation, it is often heard (howling). Fox is, too, important for hunting, and a well-known threat for the poultry. It is more noticeable than wolf, and is often observed near human habitation. Fox, at the time, was the main reservoir of the most dangerous infections – rabies. The infected foxes interacted with domestic dogs that could pass the disease to humans, and represented a real danger in the XVIII century, when medicine was nearly powerless against rabies.

Squirrel is noticeable and economically important. In the Soviet Union, it held the leading position in the fur production (regarding the number of pelts, but not their value). Of course, squirrel was an object of hunting at the time of the GLS, and, as in the case of hare, mainly by traps, making this resource potentially accessible to everyone.

The high frequency of mentions of *stoat* (93) presents some interest. Stoat lives almost everywhere in the ETR, but are not too numerous and noticeable. In the past, it was a valuable fur resource – as a "royal" fur used for the mantles of monarchs. But it is doubtful whether its production was widespread. On the other hand, *weasel* (4), is mentioned very rarely, although it is distributed as widely as stoat and is more numerous. These animals look alike, both in summer and winter; the most clearly visible difference is black "brush" (terminal hair) of the stoat's tail, which weasel does not have. Weasel, which is not a fur resource, is known as a malignant pest of poultry. Sightings of this animal should have been much more frequent than those of stoats.

Bear (42). As it was said earlier, *brown bear* is the only specie referred in the sample, for which we have the observations of the GLS located far enough outside the current range (see Fig. 3). Bear is mentioned in one uezd of the Tula province and, what is particularly interesting, in three uezds of the Voronezh province. These territories lie within the forest-steppes and northern steppes, while bear needs large forest areas for the stable existence of its population. It was noted earlier that the range of bear in the past reached the steppes [Dinets, Rothschild, 1996, etc.]. Today in Voronezh region, there are two State Nature Reserves – Voronezhsky and Khopersky that include mainly the forest ecosystems. But there is no bear even in these large protected forest areas [Reserves ..., 1989].

The particular attention of the surveyors to bear can be easily explained. Although its practical importance for the population was hardly very significant, bear was (and remains) one of the most well known animals. It can be assumed that the presence of bear in the three uezds of the Voronezh province was connected with the fact that vast woodlands were preserved there, considered as protected in the XVII – early XVIII centuries. Anyway, it is obvious that this question deserves a special study.

The group of animals with the average frequency of occurrence (see Fig. 2) includes *martens* (17), *marmots* (13), and *polecats* (11),

Marten was once an important object of the fur trade, but by the time of the GLS, its economic significance in the major part of ETP was probably lost. These animals are not very cautious, nor do they present any threat for the peasant economy. Perhaps, marten was mentioned in the regions where they still retain some commercial value. All these mentions are within the modern range of the species.

Marmot (*steppe marmot*, or *bajbak*), on the contrary, is extremely noticeable, both the animals themselves, and the traces of their activity (holes, etc.). Marmot, in the period of the GLS, was probably not of great practical importance for the humans, as it neither caused any significant damage to agriculture, nor could be systematically hunted [Bibikov, Rumiantsev, 1997]. However, the surveyors apparently could not but mention marmots, where they lived, due to their cautioness. In addition, marmot is one of the few animals that meet the "phenological" criteria mentioned above. Seasonal events in the life of marmot (in spring, it comes out of holes and makes "the first whistle" and in autumn, it starts hibernation) could serve as important indicators of certain natural phenomena for the rural population. In the sample, marmot is mentioned in all the territories where they could live at the time and where they live today.

Polecat. As with *hare*, two species are called by this name in the GLS materials – *European* (*black, dark*) and *steppe* (*light*) *polecat*. Their areas correspond to their names and, in the forest-steppe belt, they can live in one area, but in different biotopes. Not being an object of hunting, they were (and are) some of the worst pests of poultry. Getting into a coop, the polecat often kills all the birds, although it obviously cannot eat them. The attention of the GLS respondents to polecat is quite understandable, and they are mentioned in the same areas where they are common today.

Of particular interest are the animals, now common in specific areas, often significant, but very rarely mentioned in the EN. This category includes 15 names (see Table 1, Fig. 2). First, for some of them, the low frequency of mentioning is understandable. These are *hedgehog* and *mole*. It is hard to imagine a peasant who does not know these animals. But on the other hand, they were, apparently, considered to be self-evident, and not deserving special attention.

We have already discussed *weasel*. *Otter* and *mink*, although they are quite widespread valuable fur-bearing animals, are not numerous and are very rarely seen by the people who have no special interest in hunting them.

Lynx, *wolverine,* and *chipmunk* are taiga animals, although *lynx* (see above) can penetrate quite far to the south. All of them have no discernible economic value in the ETR. *Wolverine* in the sample (see Table 1) is mentioned only in the territories where it lives in the present. *Chipmunk is* mentioned only in the Kazan province (see Table 1); today, they penetrate farther to the west, and may be encountered in many taiga areas of the ETR.

Souslik and *hamster*. Judging by the localization of the only reference (the Kazan province), we are talking about *large-toothed souslik* and *Eurasian hamster*. They are quite common in the areas noted in the sample. Souslik originally lived on the left-bank of the Volga river, but now, it penetrated into the right bank of the Volga. Hamster originally dwelt almost everywhere in the steppe and forest-steppe zones of European Russia, but now spread far to the north in the forest zone. Both of these species can cause some damage to agriculture, but are not numerous and are not objects of hunting. Therefore, their absence in the EN materials is understandable. But why is *speckled souslik* (*Spermophilus suslicus*) not mentioned? It is very widely found in the steppe and forest steppe zones (to the Volga river), in the Voronezh province, and to the south of the Tula province within the borders of the sample. This specie is detrimental to the crops much more than those mentioned above, and very noticeable. But there are no mentions of the specie in the sample.

Bardger is widespread, although not very visible. They are objects of hunting (the badger fat is widely used in the traditional medicine). They are mentioned only once (in the Voronezh region), which is difficult to explain.

Beaver. *Eurasian beaver,* since ancient times, was one of the most important fur-bearing animals of Russia. The value of fur and the relative ease of hunting resulted in almost complete disappearance of beaver on the ETR, but in recent decades, it again becomes common and even numerous everywhere where suitable conditions exist. In the sample, it is mentioned once in the Kazan province, despite the obvious importance and high visibility. The sample includes the territories, where in the XX century, beaver was there even during the peak period of depression (the Voronezh region); the EN does not mention it, however. It can be assumed, that by the GLS period, the number of beaver in the EPR has decreased so dramatically, that almost everywhere "only toponyms remained" (quite common in the ETR).

Artiodactyl is mentioned in the sample very rarely: *deer* (2), *moos* (5), and *wild goat* (4).

Deer (*red deer*) is extremely rare at the ETR today. They are animals of deciduous forests, now nearly lost in the study area, at least, in the areas, sufficient for the existence of stable populations of deer. In addition, in the XX century, *sika deer* (*Cervus nippon*) was introduced from the Far East, making a strong competition for the aboriginal species. Supposedly, deer was extremely rare in the times of the GLS, too, but in the Kazan province, where it is mentioned by the EN, it lives even now.

Moose originally inhabited nearly the entire forest and forest-steppe zones of Russia, and from the middle of the XX century, due to the intensive planting of forest belts, have moved far to the south. Today, it is common, even in densely populated areas of the European part of Russia, and one of the main objects of sports hunting. In the period of the GLS, moose was probably equally common in forests, although its importance for the population is difficult to assess. Moose still lives in all the territories where it was recorded in the sample; it is somewhat surprising, however, that the mentions are rare or even absent in some instances (for example, in the Smolensk province).

The term "*wild goat*" supposedly means *western roe deer* in the EN. The other contenders for this title are not present in the wildlife of the ETR. The natural optimum of roe deer habitats lies in the forest-steppe subzone, but today, the area extends to the north and south. Roe deer is also one of the most important objects of sport hunting. It is more visible than moose, though we can not assess its relevance to the population during the GLS. In the sample, the mentions of deer are associated with the Voronezh and Tver provinces. It is not clear why there is no mentions in, for instance, the Kaluga and Tula provinces, where it is now quite common.

And finally, the animals, generally not mentioned in the sample. Based on the total number of modern mammal species in the ETR (see above), they are much more numerous, than those mentioned. For the vast majority of such species the explanation of this fact is quite obvious.

The mammalian fauna of the ETR (and Russia as a whole, and other areas) is much more than 50% formed by the species belonging to the category of having no taxonomic status, and traditionally, although quite arbitrary, are called "*Small mammals – Micromammalia*." These include (in the ETR) the following groups of animals:

– In the *insectivorous* – *shrew* (*Soricidae*).

– In the *rodents* – so-called "*mouse-like rodents*". There are actually *mouse*, *rat*, *birch mouse*, *dormouse*, *vole*, *small hamster*, etc. (the Latin names of the groups are not shown).

– All the *bats* (*Chiroptera*).

The reasons for the lack of references to the animals in this category are easy to explain. Sometimes, their presence is self-evident; sometimes, they do not deserve the attention; and sometimes, both. It should be taken into account that even today, a rare non-specialist knows the differences between mouse, vole, and birch mouse. Bat, among the mammals are so aloof, that the question arises, if they were supposed to be animals at the times of the GLS. (что вы хотели сказать? [они были, конечно же представителями животного мира?] но жили ли тогда?)

Certain species of this category could be mentioned in the EN, for example, *garden dormouse* (*Eliomys quercinus*), *greater mole rat* (*Spalax microphtalmus*), and some others. Dormouse is quite common in most of the areas covered by the sample and, today, often causes considerable damage to fruit crops. Mole rat is widely distributed in northern steppes and forest-steppes of the ETR. Although the animal itself is almost impossible to observe, the traces of its life (soil emissions – что здесь имеется в виду?) are extremely noticeable. In addition, mole rat can cause significant damage to truck crops – especially root. In any case, these animals are well known for the contemporary rural population of the territories. However, the lack of mentions of these species in not surprising.

There are very few species left, that could or should be mentioned in the EN, but such mentions are not found in the sample. We have already discussed the case of *speckled souslik* (see above). In addition, *wild boar* (*Sus scrofa*), *Russian desman* (*Desmana moschata*) and *European bison* (*Bison bonasus*) should be mentioned.

Wild boar is now common in almost all the ETR, except for the northern regions. But originally it was spread far west of this area. Active natural expansion of boar to the east and northeast began in the XX century and continues to this day. This process is traced in detail in the literature [Bobrov et al, 2008, etc.]. At the time of the GLS, boar did not inhabit the territories covered by the sample.

Russian desman is a valuable fur-bearing animal; it originally dwelt only in the ETR (west of the Volga river), but during the XIX and early XX centuries, its number and area have drastically decreased, both because of uncontrolled hunting and deterioration of the environment (pollution of rivers and lakes leading to the deterioration of food resources). In the XX century in the Soviet Union, extensive work was carried out to restore desman in the areas of former habitat and to advance its area beyond. As a result, the modern area of desman is noticeably larger than the original, but in general, it is still quite rare. In the period of the GLS, desman could still be quite common in some territories covered by the sample. This animal can not be considered prominent, but where the desman population was sufficient, it was almost certainly an object of hunting. Accidentally, desman could be observed in different situations too, for example, it could get in fishing nets. However, it is not mentioned in the sample.

European bison in the distant times inhabited almost the entire middle belt and the south of European Russia. However, by the time of the GLS, it was, apparently, completely extinct, although there are indications of its presence in the XVIII century within the territory of the Voronezh province [Bobrov et al., 2008, etc.]. Currently, wild European bison is not found anywhere. Due to the efforts to restore the specie, the semi-wild populations exist in a number of reserves.

CONCLUSION

24 names (26 species) of mammals are found in the studied sample. They are mentioned at different rates – from very high to a single mention. This, apparently, is determined by two main factors, namely, the importance of animals to the humans and their visibility. Nearly all the species that could attract the attention of the surveyors are mentioned.

The analysis revealed that all the species mentioned in the sample inhabit the corresponding territories and today, and many of them are quite common or even numerous. Almost all the locations of animals found in the sample are within their current ranges. No specie has disappeared from the ETR.

At some territories included in the sample, certain significant and noticeable species are present, not mentioned in the EN either generally or for those specific areas. This may be due either to the natural expansion of the areas of some species (*wild boar*, *moose*, *chipmunk, etc.*) or due to the human activities on their breeding widely conducted in the XX century. For example, at least 4 mammal species, intentionally imported from other regions of Russia or from abroad live in the ETR today.

In some cases, it is hard to give an unambiguous explanation to the low frequency of mentions or even to its absence. Perhaps, this is due to the insufficient sample size at the province level. However, one should take into account the fact that the real state of the mammals in the period of the GLS is generally very poorly known.

Thus, our analysis leads to the main conclusion, which directly opposes the prevailing (as noted above) ideas about the reduction of the abundance of the ETR fauna since the end of the XVIII century. The faunal diversity in the study area is much greater today than in the time of the GLS, at least for mammals, both for the entire ETP and for specific regions. Of course, certain species could have disappeared from certain locations, but the sources do not allow us to observe these changes.

For an environmentalist, the explanation of this fact is quite obvious. The postulated depletion of the fauna is usually associated with the agricultural development of the territories and the accompanying deforestation. But for animals, this factor is rather positive than negative. The species, requiring the large continuous forests, are rare in the ETR (brown bear). The majority of the species are most comfortable within a highly mosaic territory, i.e., when forest and open areas alternate. Some species (e.g., roe deer) are inherently "marge" animals. Initially, these biotypes were forest-steppe, but, now, they have extended far to the north. Agriculture also offers many new kinds of food, nutritious and plentiful. On the other hand, the field-protective afforestation actively carried out in the south of the study area in the middle of the XX century, has created the conditions for the expansion of the forest species (such as moose) to the south. As a result, today in the ETP, we can observe a mix of southern and northern faunas, which greatly improves the overall faunal diversity.

In addition, in the XX century, one more important factor came into effect, specifically, the governmental programs for conservation, restoration, and enrichment of Russian (USSR) fauna. Their result was the revival of many species disappeared completely (zubr) or almost completely (muskrat, beaver, marmot, and others), as well as the introduction of new species. Now, the Central regions of the ETR by the diversity of terrestrial vertebrates occupy one of the leading places in Russia – along with some districts in southern Siberia and the southern Far East [Rumiantsev, Danilenko, 2007].

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FROM PONDS TO MAN-MADE SEAS IN RUSSIA

ABSTRACT. Russia has more than 2200 reservoirs and large ponds. As time went by, ponds lost their importance in some aspects of human life, while newly created man-made seas impacted the nature and the people in two ways. The costs involved in designing, constructing, and operating the artificial seas, especially on the plains, have been too high to consider them as an undisputed achievement of the Soviet scientists transforming the nature. This paper discusses the problem of ponds and man-made seas in Russia.

KEY WORDS: mega projects, quantum leap, overflowing, giant reservoir, large industrial complex, environmental damage, drift wood, abrasion, landslide processes, intensification of karst, disintegration of family relationships.

INTRODUCTION

Construction of ponds was wide-spread in Russia before the 1917 revolution. At the turn of the 20th, city ponds were mostly used for recreational purposes. Water released from the ponds in rural areas of Nechernozemye provided power for mills and sawmills. This was the main function of local ponds, although they were also used in goose and duck breeding and for other purposes. Ponds became widespread in the arid areas primarily because of the need to supply the agricultural lands with water. Construction of ponds played a significant role in the economy and recreational infrastructure of the Tsarist Russia.

The post-revolutionary period after October 25, 1917, saw hard times for pond development, which was only natural under the existing totalitarian regime. The Civil War of 1917–1922, confiscation of food by the government, crop failures and famines in the early 1920s and 1930s, dekulakization and collectivization, and industrialization aimed at developing the military industry took place amid the repressive crackdown and GULAG camps. Under the circumstances, the authorities had to make some highly questionable decisions relating to land ownership and the public. Josef Stalin and his henchmen took extremely tough social and economic measures to make a quantum leap in the military and industrial development using coercion, punitive measures, and propaganda. Providing economy with electric power was one of the main problems facing the country at that time. Large hydroelectric power stations were regarded as a way of dealing with this issue. Man-made seas were created with this purpose in mind. This looked more like an obsession with gigantic projects. It was forced upon and imposed by Josef Stalin. In the 1930s, the country had about 60,000 water engines. By the 1950s, almost all water and wind engines were out of operation due to wear and tear, as well as massive overflows of reservoirs, which caused the agricultural lands to be flooded. Many ponds, though still remaining in the rural areas, gradually fell into disuse due to lack of proper care. Therefore, their recreational potential also diminished. Urban ponds were not managed in the best way either. Some of them were scrapped altogether.

In 1956, the cult of Stalin was exposed and shortly after that, the GULAG network was abandoned. More benevolent totalitarian regime meant fewer possibilities for exploiting convicts. However, technological power of the country, which won the World War II, grew significantly. With the help of the propaganda campaign, the construction of the tallest dam in the world or the creation of an enormous man-made sea was made to look almost like an achievement equal to the first human space flight of Yuri Gagarin. In this way Russia became the country with the largest man-made seas that flooded hundreds of settlements, several cities, huge areas of arable land, grasslands, steppe, woody, and even tundra pasture lands, as well as vast areas of marshes, forests, archaeological sites, ancient monuments, churches, bridges, and civil engineering structures.

The return to capitalism in the 1990s did not bring any improvement to the pond sector of the Russian Federation. Even in Moscow, the quality of water from ponds now is more likely to be poor than good. Most ponds have lost their natural capacity for self-purification, while the banks are not protected against washouts and sliding. However, the program of ponds reclamation recently got underway in Moscow, and it is being implemented, though partially. The tradition of conquering the nature did not change in terms of major rivers. It has become increasingly difficult to attract funds to finance mega projects in the water industry. However, there is no guarantee that fragmentation of the great Russian rivers and overflowing of man-made seas, which were disastrous for wildlife and damaging to the population, are a thing of the past. Meanwhile, the biosphere mechanism controlled by the fine-tuned interaction between the planetary biota and non-living matter is already very much disturbed by the unbridled exploration of the planet.

PONDS

There were far more ponds in the past. To give you an example, Moscow ponds were used for breeding fish. They provided water for fighting fires. People used them for washing clothes and even for bathing. During the last few centuries, the city authorities shut down about 700 ponds. Now, many of them can only be found in historical records or on the pages of works of fiction. The present-day Moscow's Yaroslavsky Railway Station is located at the site of the ancient Red Pond, which was also called the Great Pond. That was one of the oldest ponds in Moscow, which was referred to as the Great in the Annals since 1423. Later, a royal village called Krasnoselskoye was founded not far from the pond, so from that time on the pond became known as Krasnoselsky. Its area was 23 hectares. However, it has being shrinking gradually. In the 19th century, the Krasnoselsky Pond was used for sewage disposal and in 1910 it was shut down.

In the 17th century, the Zhivotinny Dvor slaughterhouse was located next to Chistoprudny Boulevard. Wastewater was discharged into the pond called Pogany (Rotten) for that reason. During the reign of Peter the Great, Prince Alexander Menshikov bought this land plot. The building on the corner of the street at the Myasnitsky Gate had belonged to him since 1699. The Prince built a church deep in the courtyard, which was nicknamed Menshikov Tower, cleaned the pond and ordered to stop polluting it. Since then, the pond is referred to as Chistye Prudy (Clean Ponds) (Fig. 1).

Nowadays, Moscow has some 76 ponds (Fig. 2). They are mainly used for recreation. Some ponds are reserved for swimming. Ponds are filled with surface-, subterranean-, and rainwater. The quality of water in Moscow's ponds is often rather low. Most of the ponds have lost their natural capacity for self-purification and the banks are not protected against washouts and sliding. Activities aimed at keeping the ponds within the sanitary standards include: pumping of polluted water, collecting litter, dredging, covering the bottom with gravel and sand, protecting from sewage waters, landscaping the banks, filling with fresh water, reclaiming

Fig. 1. Chistye Prudy in Moscow

the adjacent terrain, introducing aquatic organisms, installing feeders for birds, and a number of other activities [Moscow Ponds ..., 2007].

Both in the Tsarist Russia and during the Soviet era before the collectivization, which led to the compulsory formation of collective farms, watermills and sawmills running on water from the ponds were commonly used in the agricultural sector. The Nechernozemye region, since it was well-supplied with water resources, had the best potential for the creation of pond engines.

Ponds were in especially high demand in arid areas of Central and Southern European Russia since the 19th century due to the increased damage from severe droughts and crop failures. These disasters were especially devastating in 1890–1892. V.V. Dokuchayev offered to capture and accumulate moisture in agricultural soils: a) by compacting snow on the fields; b) by creating forest strips to accumulate snow and to prevent snow from being blown away by wind; and c) by accumulating water in the ponds during the thaw, after which this water is redirected to the lowland meadows and fields to temporarily flood them. Deployment of these and some other emergency measures in such arid regions as Voronezh, Kharkov, and Dnepropetrovsk proved to be efficient. Experimental fields showed improved microclimate and increased yields. About 60,000 water engines were still in operation in the country in the 1930s. By the 1950s, almost all water and wind engines were out of operation due to wear and tear, and because of massive overflows of reservoirs, which caused the rural lands to be flooded [Shipunov, 1988].

MAN-MADE SEAS

The idea to tap the power of the largest Russia's rivers has originated a long time ago. The project of the Zhiguli Hydropower Station (presently the Kuybyshevskaya

Hydropower Station) on the Volga was developed in 1913 by G.M. Krzhizhanovsky. The Bratsk Hydropower Station project on the Angara was presented to the governor-general of Irkutsk by A. Krutikov as early as in 1906. The political situation in Europe in 1920s–1930s forced Josef Stalin and his entourage to use tough social and economic measures in order to make a quantum leap in the field of military and industrial development using coercion,

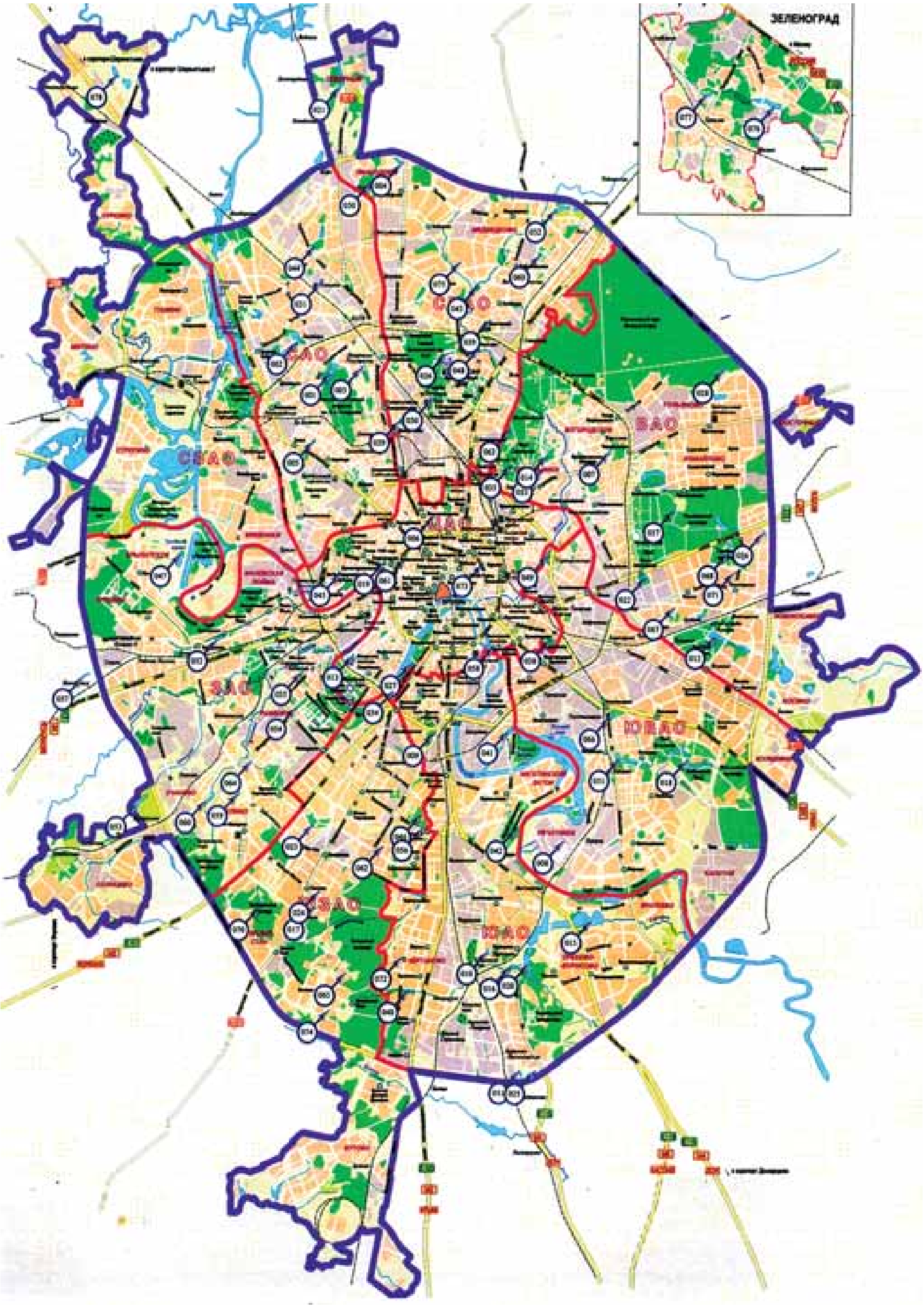

Fig. 2. Map of Moscow ponds [Moscow Ponds ..., 2007]

punitive measures, and propaganda. Providing industry with power supply was one of the top priorities. Large hydroelectric power plants (HPP) were regarded as a way of dealing with this issue. This signalled the advent of man-made seas in the country. The plan was to build the plants with maximal capacity. It is rumoured that Stalin personally adjusted the designs, and his corrections often meant that power stations capacities exceeded the limits established by common sense and science. At the same time, man-made seas were becoming even more boundless and were beating all of the world records [Cherkasova, 1989, p. 20].

The Volga River basin. The rise in power supply for industrial enterprises in the Central and Eastern parts of the European area of the USSR is largely associated with the construction of the Volga-Kama cascade of HPP. The priority was given to its construction firstly in the Volga upper reaches due to the need for electric power in the country's center, including Moscow.

The Ivankovskaya, Uglichskaya, and partly Rybinskaya HPP that were constructed before the World War II provided power supply to the military plants and other facilities in Moscow, Moscow region, and several neighbouring cities. Out of those three, the Rybinskaya HPP was the main power generating facility. The Rybinsk man-made sea of 4,6 thousand sq.km was the world's largest at that time.

Its construction proved to be a real tragedy for the people living in the Upper parts of the Volga River. This project ruined the lives of people who had been living in the area for centuries. For example, 130 thousand people were relocated from the Mologo-Sheksna interstream area and 20 thousand had to move out from the Upper Volga valley. People had to leave their old comfortable houses that they worked very hard to build and graves of their family members and loved ones. The Rybinsk Sea dam gates were shut down on April 13, 1941. Spring waters of the Volga, the Sheksna, and the Mologa rivers overflowed the banks, flooded the plain and the Mologo-Sheksna interstream area together with the city of Mologa. Almost 27,000 households went to the bottom of the Rybinsk reservoir, and over 4,000 households got into the flooded area. About 800 villages had gone under water, thousands of hectares of fertile land, the famous flood plain meadows, pastures, oak forests, 3,675 sq. km of woods, ancient monuments, and cultural sites had also gone. The Mologo-Scheksna area, once a land of plenty, was turned into a huge grave of water. When water level in the Rybinsk sea falls, one can sometimes see street pavements, house foundations, and a cemetery with gravestones. In commemoration of this disaster, the Mologa Region Museum was opened in Rybinsk [Danilov, 2003].

By some miracle, the Rybinskaya, Uglichskaya, and Ivankovskaya HPP were not destroyed by bombing in the autumn of 1941 [Burdin, 2010]. All three hydroelectric power stations were in the near-front zone. In the above-mentioned case, the Upper Volga gigantic dams became one of the factors which helped saving Moscow from the German troops. Moscow needed electric power, which was produced converting the energy of the Great Volga. The true cost of construction and miraculous preservation of these three HPP, which were vital for defending Moscow, was immeasurably high. In addition to the above-mentioned environmental and social damage and sufferings of local people, one should take into consideration that the power stations were constructed basically by the GULAG convicts, many of whom died of this grinding toil and awful living conditions.

Construction of hydroelectric power stations continued in the Volga basin after World War II. The largest of those, Kuybyshevskaya HPP, was constructed between 1950 and1959. In October 1958, N.S. Khrushchev participated in its commissioning (Fig. 3). The Kuybyshev sea area is 6,500 sq. km and it is the second largest water-storage basin in the world among the valley reservoirs. Its gross storage capacity is 58 cub. km and reservoir live storage is 34 cub. km. Backwater level near the dam is 29 m high. The HPP provides 27% of power generated by the Volga-Kama cascade.

Fig. 3. N.S. Khrushchev at the opening of the Zhigulevskaya HPP in October, 1958

Professor of the Kazan State University, V. Yakovlev, emphasized in 2005 that 50 years of existence of the Kuybyshev sea had resulted in more harm than good, as claimed by many scientists and experts. Water quality in the Volga River worsened with the construction of the reservoir and still continues to deteriorate. The banks of the mighty Russian river are being destroyed, fish is dying, buildings and structures are being flooded, and people are suffering. There are dozens of magnificent islands that were considered natural sanctuaries, churches, cemeteries, and entire villages and even cities, for example, Spassk that are now at the bottom of the giant reservoir. Was it correctly decided on the construction of the Kuybyshev water-

Fig. 4. Map of the Volga-Kama cascade of reservoirs

storage basin and the whole great Volga-Kama cascade? In the opinion of V. Yakovlev, this is not only an environmental issue. It refers to our history as well.

The entire area of the Volga-Kama cascade reservoirs is around 26,000 sq. km (Fig. 4). Dams, reservoirs, and the HPP are located on the rivers of the Volga basin, the Moskva-Volga Canal and on the Don River at the lower end of the Volga-Don ship canal. By the beginning of the 2010s, the total rated output power of the cascade exceeded 12,870 MW, and the annual average primary power output was 38,5 billion kWh, which is equivalent to almost 4% of the country's output and is the most valuable on-peak energy. It is also 22% of renewable energy of the country.

The Ob River basin. The activities there represent an obsession with gigantic projects aimed at taking immediately from nature as much as anyone, anywhere, and at any time could. The projects followed. A meeting of the governmental expert Commission of the State Planning Committee took place in Moscow in January, 1963. The meeting had to decide about the construction of the HPP in the lower reaches of the Ob River. The experts expressed a preference for the option of the Nizhne-Obskaya HPP with a dam of 42 m high, a reservoir area of 113,000 sq. km, and a volume of 1,600 cub. m, with the annual runoff of the Ob of 400 cub. km per year, producing 35 billion kWh of power per year, which is just as much as the power generated by the whole Volga-Kama cascade [Novosti Yugry ..., 2011]. N.S. Krushchev banned this construction at the request of the President of the Siberian Branch of the USSR Academy of Sciences M.A. Lavrentyev. The scientist appealed that the monstrous-sized man-made sea would flood the area, where geologists promise to discover soon the richest deposits of hydrocarbon crude, which in fact was done shortly after the project was banned.

The Ob was blocked off in Novosibirsk. The sea of Novosibirsk has an area of 1,082 sq. km, its gross storage capacity is 8,8 cub. km, its reservoir live storage is 4,4 cub. km, and the dam height is 28 m. The hydroelectric power station was built in 1953–1959.

The HPP capacity is 455 MW with the power output of 1,7 billion kWh per year. The water-storage basin flooded low and some elevated areas mostly covered with black earth. The floodland in the tailwater pool of the reservoir was made suitable for boat traffic and lost its forage value, as well as the Don River floodland in the tailwater pool of the Tsymlyansk reservoir. Signs of boat traffic in the floodland can be tracked within 300 km downstream below the dam. The Zaysanskaya HPP (banked-up lake) and the Kamenogorskaya HPP were constructed in the Irtysh River (left tributary of the Ob River).

The Yenisei River basin. Rich in hydropower and other diverse natural resources, the Siberia to the East of the Yenisei River interested hydraulic engineers more than other regions. Here, in addition to the Yenisei River, there is the Angara River which has always been the most attractive one for engineers for it has a relatively regular annual run-off due to the fact that the river flows from the Baikal Lake.

In 1920, A.A. Velner suggested constructing a HPP cascade in the middle reaches of the Angara River as a contribution to the GOELRO plan. Professor N.N. Kolosovsky associated the development of the Angara energy resources with the creation of a large industrial complex in the Middle Angara region. The idea was implemented in the post-war years.

In pursuit of a momentary super-efficiency, hydraulic engineers tried to have a stab at the integrity of the Baikal Lake in 1957. They thought it possible to spend part of the ancient lake water resources. They suggested making a 25-meter slot in the headwater rocks of the Angara by means of explosion. The Baikal Lake water level could have been lowered by 4 m. However, as you can see from the previous figures, it was also possible to drop the untouchable lake's water level by the larger amount of water. N.A. Grigorovich, working at the Moscow Gidroenergoproyekt, was the author of this project. The biologists managed to ban this dangerous project [Plyusnina, Dalzhinova 2008].

At present, the statistics on the Angara Cascade HPP (Fig. 5) is as follows:

The Irkutsk man-made sea: 31,965 sq. km with Baikal Lake (31,500 sq. km to the storage pond). The height of the Irkutsk dam is 44 m. The level of the Baikal Lake was raised by 1 m, sometimes it goes up by 1,4 m. The HPP was constructed between 1950 and 1958. Its capacity is 662 MW with the power output of 4,1 billion kWh per year.

The Bratsk man-made sea: Its area is 5,470 sq. km, the gross storage capacity is 169 cub. km, reservoir live storage is 35.4 cub. km, and drawdown level is 7 m. The construction occurred between 1954 and 1967. The dam height is 147 m. The HPP capacity is 4,515 Mw. It generates from 19,0 to 26,5 billion kWh of power per year.

The Ust-Ilimsk man-made sea: its area is 870 sq. km, the gross storage capacity is 59,4 cub. km, reservoir live storage is 2,8 cub. km, and drawdown level is 1,5 m. the construction of this HPP was done

Fig. 5. Map of the Angara cascade of HPP (construction of the Boguchanskaya HPP is not completed)

between 1963 and 1980. The dam is 105 m high. The HPP capacity is 3,840 MW, the average annual production is 21,7 billion kWh.

Here are the losses that occurred due to the construction of the Angara cascade:

– 7,600 sq. km of land was flooded, including 2,300 sq. km of plough-lands and pastures, 5,000 sq. km of forests, and 300 sq. km of other lands, including residential areas with the cities of Balagansk and Old Bratsk, as well as more than 300 villages. The bridge over the Angara River went underwater together with 110 km of the railway track.

– Several hundred thousands hectares of forest and steppe-forest lands were transformed into urban and rural areas in order to accommodate 102,000 residents relocated from their previous places of residence, which were flooded due to the construction.

– Forests were cut during preparation of the reservoir beds; there were some attempts of burning the forest in humid weather; part of the cut wood and living forests (35 mln. cub. m) were submerged, the waters of the Bratsk and Ust-Ilimsk man-made seas were clogged by drift wood, and bottom waters of the water body were contaminated with hydrogen sulphide from wood decay. Eutrophication took place. Valuable fish species such as sterlet, sturgeon, cisco, grayling, taimen, and lenok disappeared.

– Over 5,300 ha of the reservoir coastland was destroyed and lost due to abrasion, landslide processes, land masses detachment, as well as to flooding, intensification of karst, and subsurface erosion. Over 500 houses and farms were either destroyed or relocated. Several thousands residents had to move. Over 3 mln. cub. m of wood went underwater.

- The biosphere lost almost 100 mln. tons of phytomass due to the flooding of 5,000 sq. km of taiga and 2,300 sq. km of steppe-forest. There was also environmental damage caused by out-migrants moved from the flooded area.

- The Angara cascade of reservoirs affects the climate and phenological phases of the adjacent areas, extending the cold period in spring and the warm period in autumn.

– The Angara River does not freeze in winter: polynyas stretch from the Irkutsk, Bratsk and Ust-Ilimsk HPP dams. The above-mentioned facts are the reason for high air humidity and fogs, accumulation of pollutants in urban air, deterioration of health of the Siberians, and transport operation issues [Gorshkov, 2001].

– Coastal abrasion of the choked Baikal Lake which stretches for 1,800 km with the water level raised by 1 m. The coastline moved back by 4–20 m. The Trans-Siberian railway subgrade was washed out in some places. Spawning conditions deteriorated on the coastal shelf and fish yield fell by 2,5 times.

Two man-made seas were created on the Yenisei River.

The Krasnoyarsk sea: its area is 2,000 sq. km, gross storage capacity is 73,3 cub. Km, reservoir live storage is 30,4 cub. km, and the dam is 124 m high. It was constructed between 1956 and 1972. The maximum level fluctuation rate is 19 m. The HPP capacity is 6,000 MW. The power output is 20,0 billion kWh per year.

Violent fluctuations of the water body level sometimes bring about earthquakes in the city of Krasnoyarsk. Low water temperature (around 12 °C degrees) in summer makes swimming in this sea impossible. Increased air humidity coming from the Yenisei, embraces the whole city throughout the year but especially in winter, causing fogs and smog. During warm winters, polynya in the tailwater pool of the reservoir stretches for 500 km downstream below the dam. Choked ice floodings are quite often in winter and spring during the seasonal flood. This is dangerous for the coastal residential areas. There are some other negative effects of the river fragmentation caused by the HPP dam [Gorshkov, Mochalova, et al., 2010].

The Sayano-Shushenskoye sea area is 633 sq. km, gross storage capacity is 31,3 cub. km, and reservoir live storage is 15,3 cub. km. The HPP dam height is 245 m. It was constructed between 1963 and 2000. The HPP provided 22,8 billion kWh per year in 2000 and only 12,0 kWh per year in 2010 after the accident that happened on August 17, 2009.

Social changes caused by the HPP man-made seas in Siberia, according to L.A. Bezrukov and S.P. Yelin, are as follows:

– The situation becomes very complicated when the would-be bed of a reservoir is being prepared for flooding due to the relocation of penal colonies, deforestation, and other preparatory activities. Areas populated by released convicts have increased crime rate, alcohol abuse, debauchery, and disorderly conduct.

– Relocation of people from the area to be flooded by a reservoir unwittingly activates the disintegration of family relationships.

– It is particularly hard for the elderly: old people hold on to their homes and gardens literally until the last moment. They feel themselves aliens at the new places being torn from their homes and the graves of the ancestors.

– Economic activities of the local residents are brought to an end or significantly limited if we consider farming combined with cattle-breeding, fishing and hunting, as well as homemade crafts [Gorshkov, 2001].

Looking ahead, we should note that the major concern is the giant Evenkiyskaya HPP on the Nizhnyaya Tunguska River, to the East of the Turukhansk village put forward in the 1980s. Taking into consideration the maximum dam height of 200 m, the flooded area would cover almost 10,000 sq. km and the water body would stretch for 1,200 km. According to a moderate option, the dam height would be 140 m. In both cases, flooding would cover the north taiga subzones of reindeer pastures. High valley slopes of the river and its tributaries would remain above water. Mostly they are covered with lifeless rock streams. Here, permafrost is underlain by cryopegs and that is the bed of a would-be reservoir. These are brines with mineralization of up to 300–400 g/l [Borisov, 1996]. There is a risk of their increasing penetration into the lake-sea. Signs of this can be seen even now. Therefore, water with salt content can be found in winter in the Nizhnyaya Tunguska River near the Tura village, the capital of the Evenk Autonomous Area. Its salinity level is 1,5 g/l. Estimates show that the Evenk sea will have water with significant salt content. With regard to unstable temperature conditions during winter, which have been typical of Central Siberia for the last 20 years, there can be icing-up of wires and even power-transmission towers. Industrial accidents are highly probable. A similar situation happened in Quebec in the late 1990s and early 2000s within the overhead lines connecting the HPP cascade on the La-Grande River to the cities located down to the south of the province. Consumers of the cascade were to buy electric power from the USA in wintertime. The Quebec cascade disaster was reported at the World Climate Conference that took place in Moscow in 2003. The HPP construction on the Nizhnyaya Tunguska River is not feasible, taking into consideration that oil and natural gas deposits are located in a close proximity to the Turukhansk village.

CONCLUSIONS

Construction of ponds was a prominent part of the economy and recreational development of Tsarist Russia. No changes to the better took place during the totalitarian regime era after the revolution of October 25, 1917. The civil war, confiscation of food by the government, crop failures and famines in the early 1920s and 1930s, dekulakization and collectivization, and industrialization aimed at developing the military industry took place against loss of life in World War II amid repressive crackdown and the GULAG camps. All the above-mentioned influenced negatively the governmental strategy aimed at interaction between man and the nature. Natural resources were used destructively by the ministries and authorities [Sidorenko, 1967]. An obsession with gigantic projects gained a foothold in the country. Decision-makers in the sphere of natural resources, both in the Russian Federation and the former USSR, in view of inertia of the past and other circumstances are not, in fact, ready to combine efforts to defend social, economic, and environmental human rights as it is the case in the developed countries. This, in particular, is the reason for their sluggish attitudes towards the remnants of the pond construction system in our country and preservation of plans for construction of environmentally hazardous large HPP reservoirs in the basin of the Amur River, on the Angara River, and what is totally unacceptable, of a giant dam and the sea for the Evenkiyskaya HPP on the Nizhnyaya Tunguska River.

Something other is required by time. Slightly less than one-half of the living matter remained on the Earth by the end of the 20th century due to the unbridled development of the terrestrial parts of the world [Watson, et al., 2000]. In the developed countries, and recently also in China and India, forests are being restored, environmental framework is being shaped, and different types of green economy are being introduced. That has a positive impact on the Earth's climate. Keeping to the strategy of man-made seas construction and fragmentation of major rivers with dams in Russia looks unacceptable compared to the contemporary international approach. The impact is hazardous to the human beings and nature not only at the regional level. It causes a multifaceted damage to the environment-shaping mechanism of the biosphere. It also has a negative impact on the natural links between the in-land river basins and the pericontinental ocean zone. Its condition is important primarily for the quality of the world waters and, consequently, for the functioning of the main heating mechanism of the Earth [Lisitsyn, 2004; Gorshkov, 2007]. It is necessary to raise this issue at the international level. Protection measures should be taken to preserve the system of in-land river basins and the pericontinental ocean zone. ■

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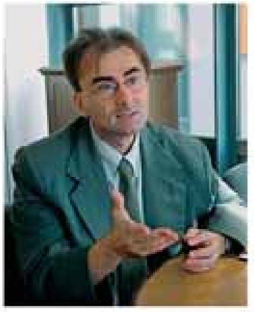

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SUSTAINABLE MANAGEMENT OF RIVER OASES ALONG THE TARIM RIVER (P.R. CHINA) AND THE ECOSYSTEM SERVICES APPROACH

ABSTRACT. In north-western China, the endorheic Tarim River is running along the northern rim of the Taklamakan desert. It is the solely water source for the oases in the region as precipitation is low. The river is mainly fed from water of snow and glacier melt, causing floods in the summer months. Due to global climate change the annual water discharge is increasing. However, not sufficient water flows downstream, as the region is the main production area of cotton in China, and much water is needed for irrigation. A conflict arises between water users of the upper reaches and water users of the lower reaches of the Tarim River as well as with the natural vegetation. The central question of the Sino-German SuMaRiO project (Sustainable Management of River Oases) is how to manage land use, i.e. irrigation agriculture and utilization of the natural ecosystems, and water use in a very water-scarce region, with changing water availability due to climate change, such that ecosystem services and economic benefits are maintained in the best balance for a sustainable development. The overall goal of the project is to support oasis management along the Tarim River under conditions of climatic and societal changes by: i) developing methods for analyzing ecosystem functions/ecosystem services, and integrating them into land and water management of oases and riparian forests; ii) Involving stakeholders in the research process to integrate their knowledge and problem perceptions into the scientific process; iii) Developing tools (Decision support system) with Chinese decision makers that demonstrate the ecological and socio-economic consequences of their decisions in a changing world.

KEY WORDS: China, Tarim Basin, Sustainable Management, Ecosystem Services

INTRODUCTION, STUDY AREA AND PROBLEM DESCRIPTION

The Tarim River is located in the northern rim of the Taklamakan Desert in the Xinjiang Uyghur Autonomous Region in the Northwest of P.R. China (see Fig. 1). The basin is bounded by the Tian Shan in the North (up to 7000 m asl.), by the Kunlun Shan in the South (up to 6000 m asl.), by the Pamir Mountains in the West (up to 7000 m asl.) and is at an altitude of 1000 Meters above sea level in average. The Taklamakan Desert dominates the basin. The Tarim River is the longest endorheic river in China flowing eastward ending in the Taitema Lake. The Tarim River forms at Aksu City through the confluence of the Yarkant River from the West, Hotan River from the South and Aksu River from the North. The latter river contributes about 70% to the Tarim River's discharge.

The climate in the Tarim River Basin is continental and arid [Kottek et al., 2006] with monthly average temperatures of –7°C in January and 26°C in July and

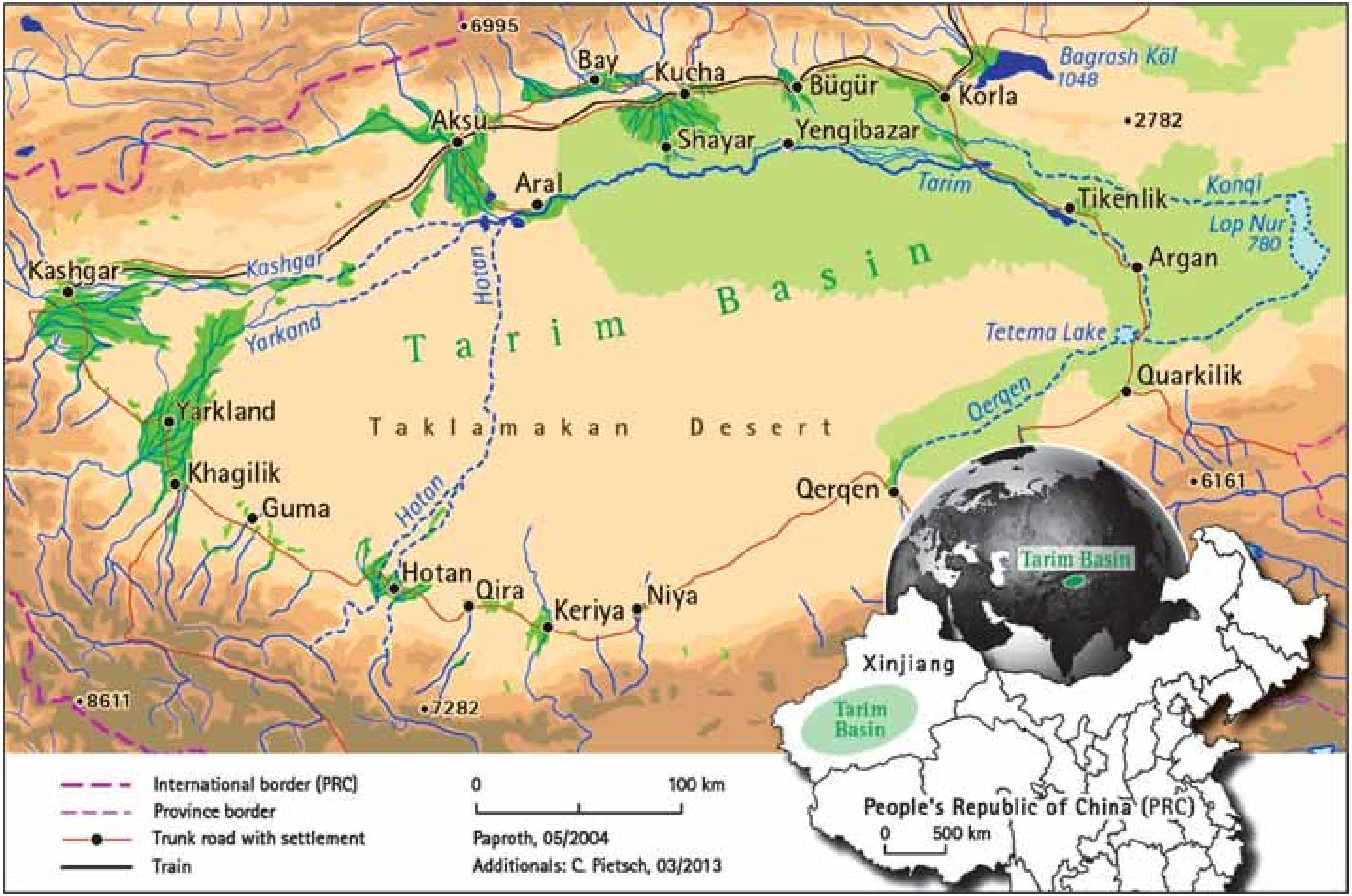

Fig. 1. The study area

50 mm precipitation in average per year. In the surrounding mountains the average precipitation is 400 mm. The average potential evaporation rate for the entire basin is about 1600 mm per year. Additionally, the region has a high duration of sunshine per year (2500 hours).

Southern Xinjiang is rich in various ecosystems. Especially there are desert and semi-desert ecosystems as well as the riparian vegetation along the rivers called 'Tugai'. The Tugai ecosystem consists mainly of Euphrat Poplar (*Populus euphratica*), Tamarix species (e.g. *Tamarix ramosissima*), reed (e.g. *Phragmites australis*) [Halik et al., 2011] and shrubs as well as special adapted plants. In the oases agriculture plays the dominant role with cotton and orchards, but there is also peri-urban and urban vegetation. These ecosystems provide various ecosystem services.

Xinjiang's primary sector (natural resources) has a share of 16%, whereas the secondary sector (industry) has a share of 50% on the provincial's gross domestic product. Farming, besides forestry and fishing, had a share of 67% of the agricultural production in 2008 [China Statistic Press, 2009]. The main agricultural product is cotton. In Xinjiang 40% of the total Chinese cotton is produced [Chadhuri, 2005], that is about 15% of the worldwide produced cotton. In 2011 the cotton production area was 1 129 700 ha. Cotton production is very water intensive. In China 3000 to 5000 cubic meters of water are used per hectare.

Human activities have taken place in the Tarim River Basin since several thousand years, and the region is permanently inhabited since several hundreds of years. The Tarim River provided a corridor for the ancient Silk Road along which settlements were founded in the oases. The Silk Road made it a centre of exchange and commerce in those days.

Starting in the 1950's, a rapid development of the region puts growing pressure to the land and water resources of the Basin. During these times the Chinese government promotes the development of the western provinces of China and encourages people to move to the "West". The on-going settlement in this region is causing conflicts between human needs and nature. The water supply in this region is solely depending on river water. Thus, water management is crucial to keep human and nature needs in balance. Most of the water is used by agriculture, especially the water intensive production of cotton. Additionally, it uses most of the agricultural land. Due to the overuse of fertilizers and pesticides, water and land are prone to salinization. This leads to land grabbing and desertification.

In Fig. 2 the regional problem is sketched. Due to the low precipitation and the high evaporation rates, the region's water supply depends solely on the river water. Fresh water flows mainly in summer into the Tarim River. This glacier and snow melt water causes floods and fills the reservoirs and channels. In the last five decades the annual average temperature rose by 0,4°C. The global climate models predict a continuation of this trend in the next fifty years, probably causing a surplus of water and thus the expansion of cotton fields in the upper reaches in the next years.

In the study region, two major conflicts do exist: First, the conflict of water use between human needs and natural vegetation; second, the conflict of land use between cotton production and unspoiled land. The effects of these conflicts are land degradation and desertification.

In the scope of SuMaRiO project research on climate change, agricultural impacts on the environment, ecosystem services and socio-economics in the region has been carried out. The results of the project will be used to set up a decision support system. This decision support system will support a sustainable water and land use management in the region. On an international level the Convention of Biodiversity and the Convention to Combat Desertification are implemented by the project.

Besides irrigation, the water is used for industrial production, households and is needed by the natural Tugai vegetation. However, the biggest water user is the agriculture. The Chinese

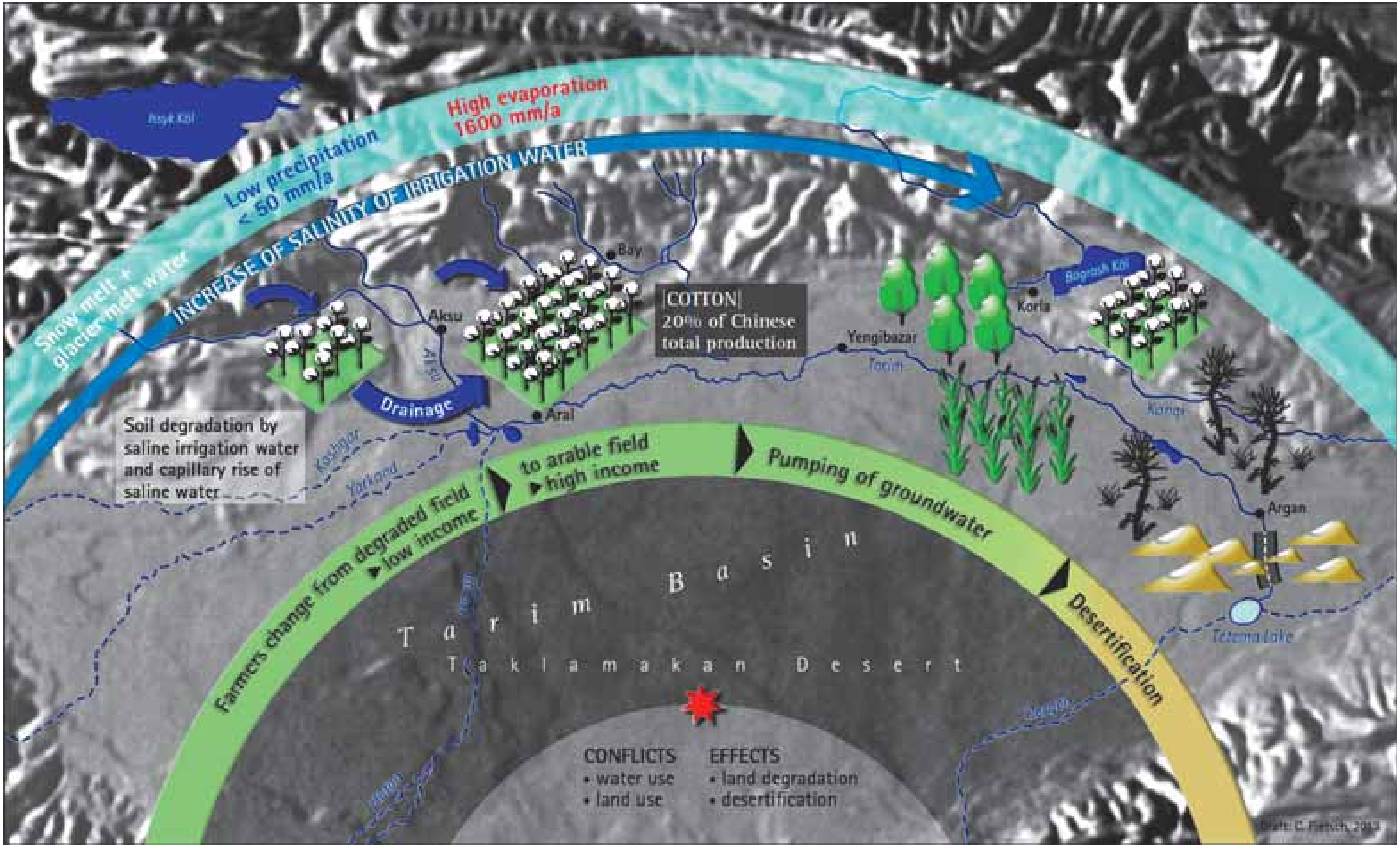

Fig. 2. Sketch of the regional problem on land and water management

government promoted cotton production in Xinjiang starting in the 1980's. The dry climate and the high duration of sunshine hours make the region potentially suitable to produce cotton with high quality. But the cotton in Xinjiang requires an average of 4,000 cubic meters of water per hectare. High yields can only be reached on the poor silty soil with a high input of fertilizers and pesticides. The fertilizer and pesticide residues are washed deeper into the soil by the irrigation water. On a field with an existing drainage system, the polluted water is drained into the drainage channel. This highly saline water is led back into the Tarim River causing an increase of salinity of the river water towards the lower reaches of the Tarim River. The salinization of the Tarim River water is increasing even more, as the already saline water is used along the Tarim River again for irrigation and thus more and more fertilizer residues are added to the water. The biggest area of cotton production along the Tarim River is on the upper reaches, with the freshest water, using and storing most of the water coming from the Aksu River. The lower reaches are falling dry in winter and spring. Farmers in that region are pumping groundwater to produce cotton or to irrigate their orchards. This causes the drop of the groundwater level on which the natural vegetation is depending.

The cotton production helps the farmers to increase their income and their standard of living in the rural areas. Smallholders who do not have installed a drainage system in their fields leave the saline fields behind and utilize new land for their cotton production to secure their livelihood. In fields with no drainage system, the groundwater table is rising due to heavily irrigation. With capillary rise of the shallow groundwater, salt is transported to the soil surface making the field unsuitable for further cotton production. This causes a vicious cycle of land grabbing, and expansion of the desert which is threatening the ecosystems and the livelihoods of the farmers.

THE SUMARIO PROJECT

The SuMaRiO project is funded by the Federal Ministry of Education and Research of Germany in the Sustainable Land management funding measure. The project consortium comprises eleven German and nine Chinese Universities and Research Institutions and various Chinese Stakeholders. The project started in March 2011 and has duration of five years.

The central question is how to manage land use, i.e. irrigation agriculture and utilization of the natural ecosystems, and water use in a very water-scarce region, with changing water availability due to climate change, such that ecosystem services and economic benefits are maintained in the best balance for a sustainable development. The overall goal of SuMaRiO is to support oasis management along the Tarim River under conditions of climatic and societal changes by:

- Developing methods for analyzing ecosystem functions/ecosystem services, and integrating them into land and water management of oases areas and floodplain forests;
- Involving stakeholders in the research process to integrate their knowledge and problem perceptions into the scientific process;
- Developing tools with Chinese decision makers that demonstrate the ecological and socio-economic consequences of their decisions in a changing world;
- Jointly identifying options for optimizing economic, ecological, and societal utilities.

PROJECT STRUCTURE, ECOSYSTEMS AND ECOSYSTEM SERVICES

The project comprises five work blocks (see Fig. 3). Work Block 1 is organizing and coordinating the project. Work Block 2 is dealing with the regional climate change and the discharge of Tarim tributaries. This work block includes the modelling and monitoring of glaciers and snow melt.

Work Block 3 is working on sustainable water and land use management from plot scale

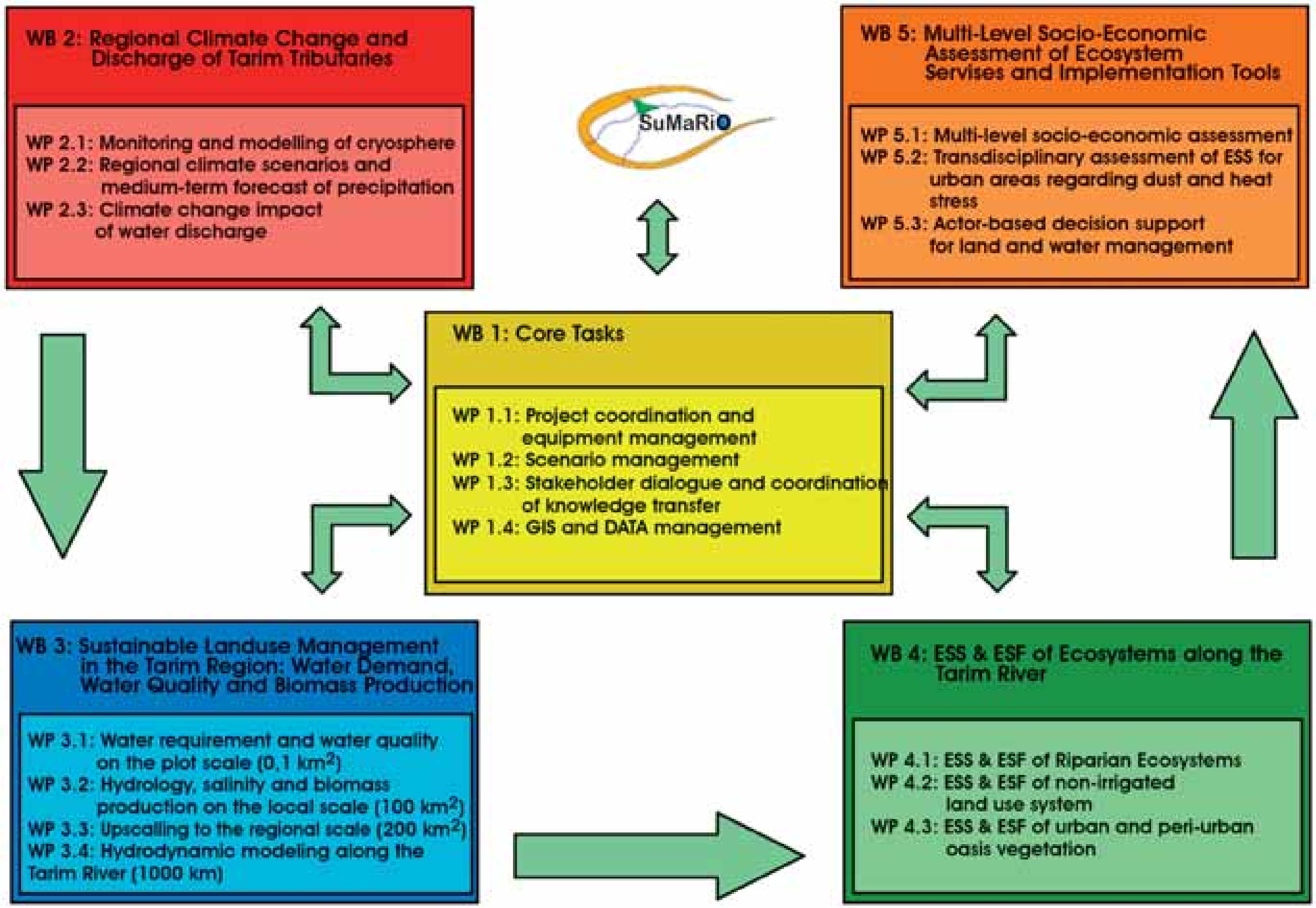

Fig. 3. SuMaRiO project structure

(farmer's field) via farm scale to regional scale (Tarim Basin) on agricultural ecosystems. On plot scale studies on water use and evaporation of cotton plant is carried out. On the regional scale plant parameters like biomass and leaf area index is taken from satellite images. Along the length of the Tarim River a model with water users is set up.

Work Block 4 is studying the ecosystem services and ecosystem functions in the following ecosystems: i) riparian ecosystem (Tugai vegetation), ii) non-irrigated land use systems, iii) urban and peri-urban ecosystems. The mainly investigated ecosystem services in the project are: a) provisioning services with water supply, food and fodder, fibre and raw material and natural medicine; b) regulating services with water purification, soil fertility, air quality and local climate; c) supporting services with genetic resources, biomass production, nutrient cycling and water cycling; d) cultural services with recreation, aesthetic appreciation and scientific discovery.

Work Block 5 assesses on several levels the socio-economic situation of the region. With contingent valuation method the social value of a more sustainable water management program (willingness to pay) and thus water pricing is assessed. Family farms, large scale farms and farms of the Xinjiang Production and Construction Corps (state farms) are analyzed. The utilization potential of native plants, like *Apocynum pictum* and *Phragmites australis* (reed) is estimated. A transdisciplinary assessment is conducted of the ecosystem services for urban areas regarding dust and heat stress.

OUTCOME OF THE PROJECT – A DECISION SUPPORT SYSTEM

The outcome of the project will be a decision support system. This tool will enable the stakeholders to see the consequences of their actions in terms of water and land management.

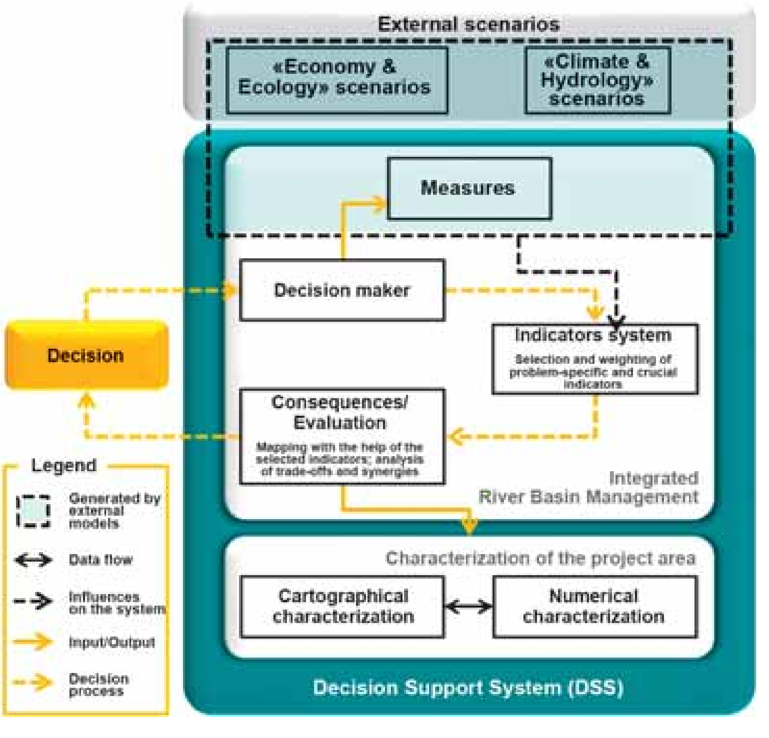

Fig. 4. Outline of the decision support system of the SuMaRiO project. Source: Marie Hinnenthal, Universitaet der Bundeswehr, Muenchen

On the way to develop the decision support system, the multi-level stakeholder dialogue is an important tool for the implementation of the project results. The dialogue involves the local farmers earning their livelihood mainly from agriculture. There are family farmers from the Uyghur minority and from the Han Chinese being interviewed on their livelihoods. Stakeholders on county level, city level and provincial level are being interviewed. The feedback on the scientific work in SuMaRiO and the needs from the different stakeholder levels will provide input to the decision support system.

The decision support system (Fig. 4) will combine the Integrated River Basin Management and ecosystem services. The decision support system is based on two external scenarios. There will be a scenario dealing with the regional economy and ecology. In this scenario "business as usual" and "regional sustainable management" with its consequences on the ecosystems will be implemented. The scenario on climate and hydrology will comprise the trends in climate change in the region and their impact on the hydrology in the region.

The step "Alternatives" will give the user the possibility to implement measures (e.g. policy measures), other options or the combination of several measures. In the Step "Consequences/ Effects" first the status quo is indicated. The changes based on the observations of past and future scenarios (e.g. climate change) according to the prompted measures will be illustrated. According to the results of the decision support system the user can see the consequences of her/his action, for example an implemented policy measure.

IMPLEMENTED GOALS OF THE CONVENTION OF BIOLOGICAL DIVERSITY, THE CHINESE NATIONAL BIODIVERSITY STRATEGY AND ACTION PLAN AND THE CONVENTION TO COMBAT DESERTIFICATION

On an international level the SuMaRiO project implements goals stated in the Convention of Biological Diversity and the Convention to Combat Desertification. Under the Convention on Biological Diversity the international community adopted the Strategic Plan of the Convention on Biological Diversity (CBD) or the so called Aichi Targets in 2010. The Aichi targets are 20 headline targets, organized under five strategic goals that address the underlying causes of biodiversity loss, reduce pressure on biodiversity, safeguard biodiversity at all levels, enhance the benefits provided by biodiversity, and provide for capacity building [Secretary of CBD, 2010].

Under the strategic goal to address the causes of biodiversity loss by mainstreaming biodiversity across government and society, the SuMaRiO-project contributes to the Aichi targets 2, 3 and 4 by reaching out to stakeholders at all levels and taking steps to implement sustainable production and to integrate ecosystem services into planning in the region. The reduction of the direct pressures on biodiversity and promotion of sustainable use is the second strategic goal of the Convention of Biological Diversity and is implemented by the SuMaRiO-project under the Aichi targets 5, 7 and 8. The project is assessing the status quo of natural habitats, especially forests, agriculture and studies the impact of land use on degradation (soil salinization) and vice versa. The third goal of the CBD is to improve the status of biodiversity by safeguarding ecosystems, species and genetic diversity. Under the Aichi Target 11, the study along the Tarim River assesses the extinction risk of the Tugai vegetation and evaluates the ecosystem services and benefits from protected areas. The benefits from biodiversity and ecosystem services to all should be enhanced, as stated in the fourth strategic goal of the CBD. SuMaRiO evaluates ecosystem services which are related to water, health (dust transport), well-being and the function of the urban vegetation. It also analyzes ecosystems supporting livelihoods and the well-being of local communities and will provide a tool to manage natural resources conflicts. These tasks are under the Aichi Targets 14 and 15. In the project the implementation through participatory planning, knowledge management and capacity building, the fifth strategic goal of the CBD, is a major part. With the stakeholder dialogue, representatives from all levels are involved in the creation of the decision support system. The projects' decision support system will meet the postulation of Aichi Target 19.

To implement the Convention on Biological Diversity, each country has its own National Biodiversity Strategy and Action Plan (NBSAP). The Chinese NBSAP promotes large-scale projects on biodiversity with international capital and to strengthen the international exchanges and cooperation with the focus on capacity building in biodiversity. The project, furthermore, promotes the harmony between man and nature and has the strategy to strengthen the ecosystems. The SuMaRiO project, having a focus on land use, is carried out in the national priority area 2 (the northwestern ecologically fragile territories) a typical desert ecosystem. The impact of climate change on biodiversity is assessed and the conservation of biodiversity and wetlands is integrated into sectoral and regional planning. The project investigates, assesses and monitors biodiversity in different ecosystems in the region (action field 3) and aims to improve sustainable use policies (action field 1). In the stakeholder dialogue the project encourages stakeholders to actively participate in biodiversity conservation and sustainable use to improve the implementation capacity.

Objectives of the Convention to Combat Desertification (CCD) are also implemented by SuMaRiO. The project aims to improve the living conditions of the local populations by assessing the socio-economic and environmental vulnerability to climate change. The focus of SuMaRiO is sustainable land management and the sustainable use of biodiversity which generates a global benefit via the production of sustainable produced cotton. Awareness raising on land degradation and education is promoted in the stakeholder dialogues and the exchange with students. In the process of developing a decision support system, policy, institutional and socio-economic drivers of land degradation and barriers to sustainable land management are assessed. With the help of the decision support system recommendations to remove these barriers are developed. The results of the project will improve knowledge of interactions between climate change adaption and restoration of degraded land in an ecological fragile area.

In the SuMaRiO project the Convention of Biological Diversity and the Convention to Combat Desertification are considered in one large region. The project's results will contribute to the Convention of Biological Diversity and the Convention to Combat Desertification and the Chinese national biodiversity strategy and action plan. The recommendations are found in a rational discussion between various stakeholders. The decision support system is a crucial tool for finding quantifiable results of the planned measures and supports the stakeholder's discussion. The implemented policies are described in point 3 of this extended abstract.

ECOSYSTEM SERVICES

The concept of EcoSystem Services (ESS) was first used in the 1960's and has been formalized and brought to a general public by the United Nations Millenium Ecosystem Assessment program, launched in 2001. In the Millenium Ecosystem Assessment Report (MA) Ecosystem Services are defined as "*the benefits people obtain from ecosystems*" [MA, 2003]. This definition refers to the definitions given by Costanza et al. [1997] and Daily et al. [1997]. It takes natural as well as man-made or man-modified ecosystems into account and refers to material as well as intangible benefits [MA, 2003].

Usually Ecoystem Services are classified to four categories [according to MA, 2003, Mace et al., 2011] (see also Fig. 5):

- **Provisioning Services**: Products obtained from ecosystems. E.g.: Food, Fresh Water, Fiber, Genetic resources

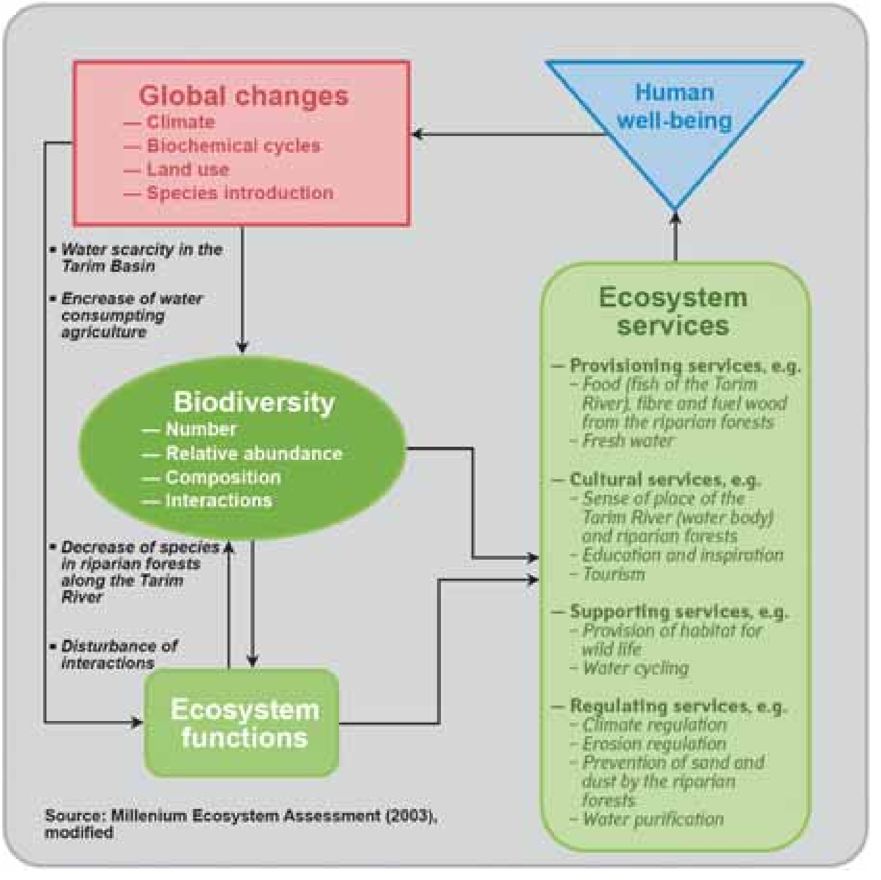

Fig. 5. Ecosystem Functions and Ecosystem Services as discussed in the SuMaRiO framework

- **Regulating Services**: Benefits obtained from ecosystem processes. E.g.: Climate regulation, Water purification, Disease Regulation

- **Cultural services**: Intangible benefits obtained from ecosystems. E.g.: Recreation, Tourism, Aesthetic, Educational

- **Supporting Services**: Necessary for production of all other services. E.g.: Soil formation, Nutrient cycling, Primary Production.

The concept of ecosystem services, as introduced, is a very holistic approach aiming to maintain or improve human well-being. Human well-being is strongly dependent on functioning ecosystems that satisfy fundamental human needs like fresh air, drinking water and food to name only some. Ecosystems and their ability to deliver ecosystem services are affected by human impacts as well as natural environmental change. The aim of the Ecosysem Service concept is *"to enhance the contribution of ecosystems to human well-being without affecting their long-term capacity to provide services"* [MA, 2003]. It propagates a sustainable use of natural resources. Ecosystem services are underpinned by biodiversity. In most cases a stable delivery of ecosystem services increases with biodiversity [Norris et al., 2011].

Ecosystem services can be seen as a tool for integrating ecosystems into decisions of all kind (especially landuse decisions) and conduct them towards a sustainable direction. Daily et al. [2009] give a framework on how ecosystems and their services are

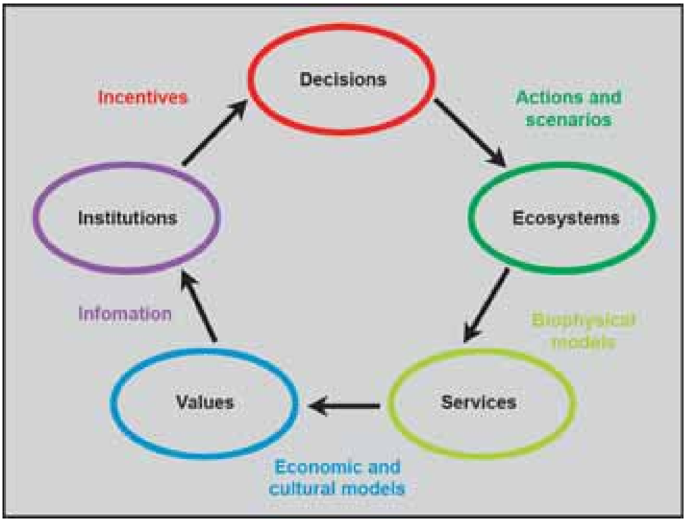

Fig. 6. Linkage between ecosystems and decisions. Source: Daily et al., 2009 (altered)

linked to decision making and figures out the transdisciplinarity of the concept, which is introduced in the Fig. 6.

An ecosystem consists of certain structures and functions, which are interacting. The United Nations Convention on Biological Diversity defines an ecosystem as '*a dynamic complex of plant, animal and micro-organism communities and their nonliving environment interacting as a functional unit*' [United Nations, 1992]. These functions and structures have to be assessed and modeled using natural science methods. In cooperation with local stakeholders (e.g. administration, local population) the services delivered by an ecosystem are identified. The importance of each service is dependent and differing on the stakeholders' point of view and the particular scale that a project is dealing with. Using economic and cultural models the provided services are valued. A valuation can be achieved using several methods. For example the travel-cost method, where people are asked, how much they would be willing to pay to visit the reviewed ecosystem [European Environment Agency, 2010].

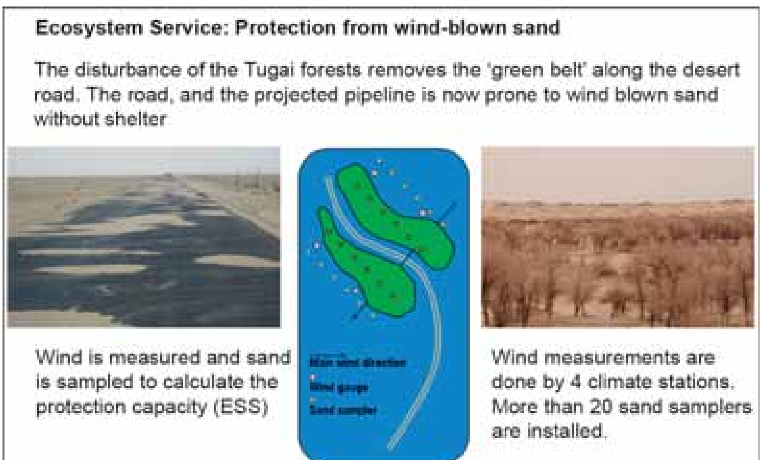

Fig. 7. Research scheme for the potential of Tugai forests regarding "sand fixation"

Amongst others within SuMaRiO a cost-benefit analysis used to valuate the ecosystem service 'sand fixation', provided by the Tugai vegetation at the lower reaches of Tarim River. Since there is a national highway accompanied by the vegetation belt this protective function can be valuated by comparing the costs of road maintenance at sections with and sections without natural vegetation, respectively the costs for artificial lining. Figure 7 shows the research scheme which is applied in the SuMaRiO project to make research on the ESS 'sand fixation' of Tugai forests.

The depicted values are to be embedded in institutions. This can happen in form of pilot projects, demonstrating the usefulness of sustainable decisions. It is important to try to strengthen representative existing institutions and provide information on the merits of certain decisions.

The step from institutions to decisions mainly is about financial incentives. The question is how decision makers can be motivated to decisions taking the ecosystem values into account. Especially within the SuMaRiO research area a merge of modern techniques and knowledge and traditional management approaches has a high potential to create a conservation approach.

The circle is fulfilled with the step from decisions to ecosystems. Here is examined how made-decisions are feed backed by the ecosystem. This deals with the retrospective as well as a projection to the future, using different scenarios. The scientific task lays in the developing of these scenarios and monitoring the effects of decisions on ecosystem structures and functions.

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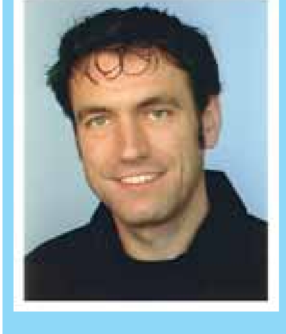

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LANDSCAPE PLANNING IN UKRAINE: THE FIRST LANDSCAPE-PLANNING PROGRAM

ABSTRACT. The paper presents the results of the first, in Ukraine; project on landscape planning widely accepted in European countries. Under the project implemented in 2010–2013, a landscape-planning program has been developed for the Cherkassy oblast. This is the first document of this kind in Ukraine. The program is mainly based on the experience of the German and Russian schools of landscape planning and on research and assessment conducted by the authors, which allowed identifying approaches to landscape planning, principles of the national policy, and characteristics and potential of environmentally friendly planning in Ukraine. The paper discusses the main phases of the work on the development of the landscape program for the oblast. It also identifies the main stages and key concepts and principles of landscape planning. The paper presents the results of integrated research on the identification and classification of conflicts in land use and the integral concept of the developmental goals for the oblast. The results can be the foundation for adopting management decisions and development of action plans for the lower hierarchal branches.

KEY WORDS: landscape, planning, environmental management, conflict, development.

INTRODUCTION

The interests of society to manage spatial development can be met through different planning approaches and instruments. Planning is "a complex process leading to a consensus based on the recognition of all problems and assessment and identification of the goals. The ultimate goal is to develop a 'template/model for future development'" [Landscape Planning and Conservation, 2006, p. 46]. An important tool for the European planning, which is developing in Ukraine and ensures the implementation of the principles of sustainable development, is LANDSCAPE PLANNING (LP) [Landscape Planning: Implementation, 2012; Rudenko et all, 2011; Rudenko, Marunyak, 2012]. LP is accepted as a key planning tool aimed at the conservation of nature and landscape management. One of the most important LP tasks is research on the impact of natural resource use in a particular region, on finding ways to deal with and prevent the existing conflicts between users, and on preventing the loss of natural landscape properties as a result of the destructive impact of human activities. Environmental objectives in LP are achieved through transparent and democratic decision-making by fostering communication and engaging in dialogue all stakeholders – everyone who lives and works in a particular region, makes management decisions, or invests ideas or funds in its development.

BACKGROUND INFORMATION

Ukraine, with its changed landscapes and complexity caused by the transformed environmental properties of the natural components, indeed, needs the development of the new approaches to the environmentally friendly spatial development. Among the most important approaches, is the development of the concept of sustainable development and creation of projects on its implementation, and design of methodological and practical steps for the LP implementation.

In 2010–2013, the authors of this paper examined the experience of landscape programs (LaPro) in Germany [Landschaftsprogramm Brandenburg, 2009; Landschaftsprogramm Saarland, 2009; Landschaftsprogramm Schleswig-Holstein, 1999; etc.], refined and modified the principles and methods of LP developed in Germany [Auhagen, Ermer, Mohrmann, 2002; Heiland, May, 2009; Landschaftsplanung, 2004; Riedel, Lange, 2002] and Russia [Alekseyenko, Drozdov, 2011; Drozdov, 2006, Guidelines for landscape planning, 2001; Landscape Planning: Tools..., 2005], and applied them in a specific spatial planning project. Thus, they have designed a LaPro for the Cherkassy oblast. According to the works of German and Russian colleagues [Landscape Planning and Conservation, 2006, p. 50], a LP program is a planning document that is "developed at the level of the federal land (districts, cantons, regions, etc.), which states the general purpose, requirements, and activities for the preservation of the nature and landscape management. It establishes a framework for the lower branches of planning".

The concept of "landscape" in LP is treated in a broad sense and takes into account the different views on the definition. In our study, in accordance with the LP approaches [ILN, 1998] and the definition of the European Landscape Convention, landscape is treated as a "an area [Golubtsov et all, 2011], whose original character is recognized by people and is the result of the action and interaction of natural factors and/or human activity" [The European Landscape Convention, 2004; section 1a]. Depending on the type of assessment, the landscape can be interpreted in different ways: the point of view in relation to the soil or plant species is different from the understanding of the landscape, for example, considering its attractiveness and aesthetic perception [Landschaftsplanung, 2004, p. 22].

Obviously, the different interpretations of landscape do not contradict, but complement each other; it is important to identify which one is the most suitable for a particular task [Grodzinsky, 2005]. Therefore, in LP, the selection and interpretation of landscape from different points of view is inevitable. For example, the assessment of the most attractive areas for tourism and recreation activities (one of the main objectives of LaPro) includes different approaches to the systematic analysis of the landscape structure:

- classical genetic and morphological approach to determine the natural preconditions for such activities;
- analysis of man-made landscapes based on the types of land use –arable land, hayfields and pastures, industrial sites;

- subject approach –the perception of holidaymakers of certain spaces –a large forest stand, a large forested area, combination of woods and fields, settlements, river valleys;
- cultural studies approach –the identification of the "mental" landscape of historical and cultural artifacts, such as Kholodnyi Yar and Kanevsky Hills.

THE PROBLEM STATEMENT

The purpose of this paper is the discussion of the methodological aspects of LP and the main results obtained in Ukraine during its implementation. The paper presents, in detail, the inventory and assessment stages of this type of planning, the features of the analysis of existing and potential conflicts associated with the use of natural resources, and approaches to the development of the concept of the goals of land use. While working on the LaPro, we have identified the sectoral goals of using the territory of the Cherkassy oblast, focused on a specific component of the environment (climate, air, flora and fauna species and habitats, surface- and groundwater, soil, and landscape shape) for a specific type of human activities. The integral concept of the goals is a final document that, in a map format, reflects the agreed upon differentiation of the territory by the protection goals and the enhancement and development of the landscapes.

The framework conditions for planning in the Cherkassy oblast are an integral part of the preparation of landscape plans and have been discussed in the previous publications [Rudenko et all, 2011]. We want to emphasize that this phase is usually associated with a general spatial analysis and identification of the conditions for a particular area (institutional, social, economic, natural, and environmental) and objectives and tasks of planning.

THE INVENTORY-ASSESSMENT PHASE OF WORK

The main purpose for the inventory-assessment phase of the LaPro development was to systematize data on the natural and socio-economic conditions of the study area. We conducted a targeted analysis of this information to determine the sensitivity of natural resources to the negative impacts of economic development and their significance to various human activities.

In the course of development of the LaPro for the Cherkassy oblast, the *inventory* of all available information on the socio-economic development conditions, characteristics of the natural resource use, and all the components of the natural resources was conducted [Golubtsov et all, 2011; Landscape Planning: Implementation, 2012]:

– **socio-economic conditions**: parameters that characterize the structure of industry, agriculture, transport infrastructure, foreign trade, demographics, labor market, social security infrastructure, etc. This information is important for setting the planning goals and identifying general directions and opportunities for development of the territory; it is necessary, therefore, for the selection of appropriate types of territorial assessment. For example, based on the structure of production (the dominance of agriculture) and the data on employment (high unemployment), one of the goals of the framework LP project was to define the recreational potential of the area as an alternative to the traditional industries; therefore, it was necessary to assess the attractiveness of the landscape for tourism and recreation;

- **natural resource use**: features and structure of the natural resources, the structure of land use, emissions, waste disposal, hazardous objects, etc. These data is the basis for defining the anthropogenic load on the landscape, identifying conflicts between the natural environment and human activities, finding the ways to optimize the structure of agricultural land and expand protected areas, and other activities;

- **climate and air**: solar radiation, atmospheric circulation, atmospheric pressure, wind direction, temperature of air and soil, precipitation, and atmospheric phenomena; the local climate (mesoclimate) and mesoclimatic regionalization; air emissions of individual pollutants from stationary sources;

- **surface water and groundwater**: reserves of groundwater and surface water, surface water quality, water consumption, the depth of groundwater, groundwater aquifers (interstratal water) and their characteristics (distribution, thickness, chemical composition, etc.);

- **species of flora and fauna, biotopes**: the distribution of species of flora and fauna, the main biotope types, ranges of concentration of rare species of plants and animals listed in the Red Book;

- **soil**: the distribution of soils, soil-forming rocks, physical and chemical soil characteristics (size distribution, cation exchange capacity, humus content, pH, water permeability), areas with manifestation of adverse economic activity processes (salinization, waterlogging, eroded soils). Radioactive contamination from the Chernobyl nuclear power plant;

- **landscapes**: natural territorial complexes, modern landscapes, landscape image, geographical localization and characterization of the cultural and historical heritage, visual observation and photography;

The systematized and processed information is incorporated in the LaPro in a text format supplemented with the descriptions of the nature and society and the cartographic material developed and organized using GIS techniques (ArcGIS software). The geographic information system for the Cherkassy oblast in the LaPro consists of the raster (topographic and thematic) and vector maps (basic scale –1:200 000) positioned in the same coordinate system and linked with the databases on the territorial characteristics. The data on the current land use and territorial planning of the area became the basis for the determination of conflicts between the existing and planned human activities and landscape functioning.

The important principles of the inventory phase of the study is the maximal level of the integral scope of work, which is consistent with a reasonable selectivity of data screening (evaluation of the data utility at the inventory stage) and flexibility of decision-making (the interchangeability of data and possible use of expert assessment). These principles are particularly relevant considering the situation in Ukraine, namely, obsolete data, their deficit and inconsistencies, and the immature system of environmental monitoring.

According to the modern LP concept [Auhagen, Ermer, Mohrmann, 2002; 6/Guidelines for landscape planning, 2001; Landschaftsplanung, 2004; 16/Riedel, Lange, 2002], ASSESSMENT in LP is used, first, for spatial differentiation of landscape features significance and, secondly, for identification of areas most vulnerable to the negative impacts of human activities. The evaluation criteria, according to the experience acquired to date, must meet the following requirements. They should focus on the goals of the territorial use stated in the framework project, correspond to the modern conditions of the natural environment, forecast possible changes of conditions of the natural components in the course of the implementation of the main directions of the territorial use, and identify the allowable level of such use [Guidelines for landscape planning, 2001, Vol. II, pp. 14–15]. Two categories of assessment are used in LP, namely, significance and sensitivity, each represented, as a rule, by 3–5-point ranking scales [Auhagen, Ermer, Mohrmann, 2002; Heiland, May, 2009; Landschaftsplanung, 2004]. A 3-point scale is used in the LP program in the Cherkassy oblast: for sensitivity/significance, it is high, medium, and low.

Significance means the level of correspondence of the conditions of the natural components to their reference state and is used to identify the optimal level of targeted use-functions, individual for each natural component (for example, significance of soil to cereal or other crops production corresponds to the natural soil fertility) [Guidelines for landscape planning, 2001, Vol. II, p. 15]. The important criteria for defining the significance are such characteristics of the components as productivity, diversity, rarity, uniqueness, historical significance, and aesthetical attractiveness. Obviously, the same range has different significance for different landscape functions [Heiland, May, 2009]. "High" significance of landscape means that the target use within its boundaries is realized to the most optimal level; "low" significance means that there are few or no preconditions for such use. For example, the elevated and strongly dissected by gullies landscape of Kanevsky dislocation is highly important for the natural protection and tourism, but has low significance for agriculture.

Sensitivity is generally regarded as the intensity and speed of reaction of natural components to certain impacts (chemical pollution, soil plowing, recreational activities, etc.), the elasticity with respect to its return to the original state (a state of the components prior to or at the beginning of the intensification of anthropogenic impact) [Landschaftsplanung, 2004, p. 84]. "High" ("low") sensitivity means the higher (lower) probability of a component to degradation due to the impact.

In the development of the LaPro for the Cherkassy oblast, the focus was on the types of assessment of sensitivity and significance of the natural resources (Table 1) that correspond to the framework goals of planning [Rudenko et all, 2011]: development of agriculture, recreation activities, and tourism; optimization of water supply and consumption; and protection of bio- and landscape diversity (Fig. 1).

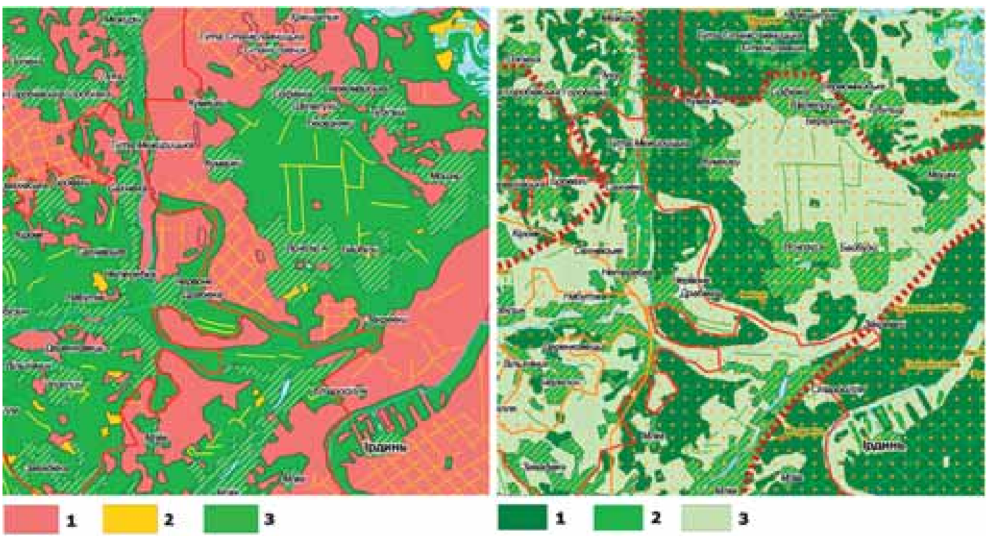

Fig. 1. Ukraine. The landscape program of the Cherkassy oblast. The sensitivity of biotopes to anthropogenic impact (a) and biotope significance (b) (fragments)

a) Sensitivity of biotopes to anthropogenic and natural impacts

Legend: 1. High –Biotopes with the highest sensitivity (low stability) to the anthropogenic impact (forest stands, wetlands); 2. Medium –Biotopes with the medium level of sensitivity (stability) to the anthropogenic impact (perennial stands, hay-fields, forest protective belts)
3. Low –Biotopes with a relatively low sensitivity (high stability) to the anthropogenic impact (arable land territories of settlements)

b) Significance of the "Species and biotopes" component

Legend: 1. High –Biotopes with insignificant anthropogenic change that provide for the environmental conditions close to natural; 2. Medium – Biotopes with notable anthropogenic change that provide conditions for habitat for some species; 3. Low – Biotopes with significant anthropogenic impact and poor biodiversity

**Table 1. Ukraine. The landscape program for the Cherkassy oblast.
Assessment of sensitivity and significance of the components**

SENSITIVITY	SIGNIFICANCE
Climate and air	
Sensitivity of air to chemical substances pollution	Significance of climatic conditions to human livability
	Significance of climatic conditions to recreation
	Significance of climatic conditions to agriculture
	Significance of climatic conditions to solar and wind energy generation
Ground and surface water	
Sensitivity of groundwater to chemical pollution	Significance of groundwater (interstratal) to water supply
	Availability of water resources
	Quality of surface water
Species of flora and fauna; biotopes	
Sensitivity of biotopes to anthropogenic and natural impacts	Significance of the component "Species and biotopes"
Soils	
Sensitivity of soils to chemical pollution	Natural productivity of soils (significance to crop production)
Sensitivity of soils to water erosion	
Sensitivity of soils to wind erosion	
Landscapes and landscape image	
	Significance of landscapes to tourism and recreation

IDENTIFICATION AND ASSESSMENT OF NATURAL RESOURCE USE CONFLICTS

It is well known that most of the environmental problems that arise in the course of natural resource use exist not because of their fundamental unresolved uncertainty, but due to the collision of interests of users of natural resources in the absence of effective practices of conflict management and population unawareness of their possible negative effects. Thus, the analysis of the methodology for territorial assessment through the prism of the geographical environment and production indicates that "the elimination of territorial conflicts is the most important task of optimizing natural resources. There are "intensive," "spatial," and "environmental" ways of solving the problem" [Socio-economic geography, 2011]. At the same time, conflict resolution techniques using LP methods assume accounting for all these approaches depending on the situation, potential, and intentions of the process participants.

The Cherkassy oblast is a region of Ukraine with a relatively favorable environmental state. At the same time, as shown by a detailed analysis, there are a number of problems and conflicts in natural resource use, whose solution is required to ensure the continued sustainable development. Some of them are historically caused by the features of the productive forces in the USSR, while others formed in a significant economic downturn after Ukraine gained its independence.

A conflict associated with the inefficient use of agricultural land and crop-rotation structure is a wide spread and growing phenomenon. The region has problems of the national level and scale: radiation pollution from the Chernobyl nuclear power plant, environmental conditions of water resources, primarily, of the Dnieper river valley and adjacent territories, and aging of capital assets and infrastructure facilities. The processes have different type of dynamics and regime. There are potential difficulties associated with functioning and protection of practically all natural components.

The following groups of conflicts were considered in the study region:

– the time of occurrence (those that have arisen in the past, today, or may arise in the future);

– scale (national, regional, or local level);

– the duration and frequency of manifestation (permanent, seasonal, or episodic).

The social sector was considered in a special block (unemployment, morbidity, poor quality of public services, and the aging of the population). Processing of information on conflicts and assessment of their impact at the final phase of work (including representation in a specially compiled map) indicate that there are two groups of conflicts (existing and potential). This has allowed taking into account existing natural resource use conflicts and problems in the region by identifying the territories with maximal intensity of their manifestation in the present and future.

The final phase of the LaPro creation was the development of the INTEGRAL CONCEPT OF THE GOALS. The main goal of the LP program, i.e., the highest hierarchal level of LP, is the identification of the main functional zones of the territorial use, general goals of the use development, and requirements to the protection of the nature and landscape management. According to LP approaches, there are three types of the goals, namely, preservation, development, and enhancement (Table 2).

The goals were derived based on the assessment of landscape conditions with all available data on the evaluation of the landscape components significance and sensitivity (Table 2; Development principles). This was achieved by the superimposition of the evaluation maps on each component [Guidelines for landscape planning, 2001]. Thus, the assessment and analysis of each evaluated component result in the maps on the sectoral goals. Mapping the sectoral goals allowed delineating the main directions of the balanced use of the natural resources: surface and groundwater, climate and air, soil, flora and fauna species, and landscapes.

At the final stage of the LaPro development, the sectoral goals were integrated in the

Table 2. Ukraine. The landscape program of the Cherkassy oblast. Types of goals and principles of their development [based on 6/Guidelines for landscape planning, 2001, Vo. II, p. 29; 12/ Landschaftsplanung, 2004]

Types of goals	Types of actions and activities	Principles of development
PRESERVATION	Preservation of the existing environmental conditions, which is only possible when the territory either is not used or is not intensively used.	Is adopted in the cases when landscapes have the highest significance and the highest sensitivity to impacts. For the especially significant landscapes, the use is restricted and a regime similar to the nature-reserve (the regime of special protection) is established.
DEVELOPMENT	Territorial development is allowed at either low- or high intensity level. The implementation of the "Development" goal results in the preservation or decrease of its protection status (environmental protection) by one level.	Is adopted for the rest of the territory with special attention given to the level of assessment of sensitivity to the negative impacts. For the development of the existing and planned land use, landscapes with the high level of stability are suitable. The natural resource use is achieved in compliance with the existing legal requirements.
ENHANCEMENT	Only a complex of activities for territorial enhancement is allowed. This relates to the territories that have been or are affected by the intensive use and have a high level of sensitivity of different destructive impacts.	Is adopted for the territories characterized by low significance. All natural complexes affected in the course of use are combined into one zone for enhancement and rehabilitation. For the territories under the danger of irreversible changes or for the landscapes with a low ability to regeneration, special additional activities should be undertaken.

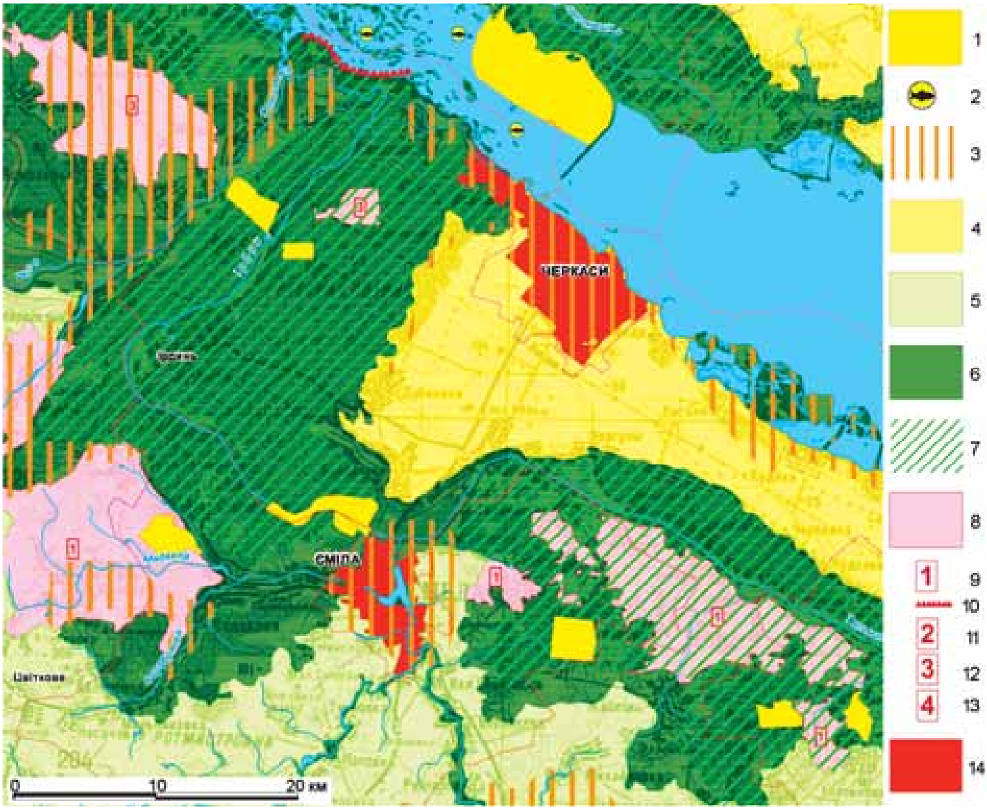

Fig. 2. Ukraine. The landscape program for the.
Cherkassy oblast. The integral concept of the goals (a fragment).

Legend: 1 –**Environmental protection. Maintenance and control of the existing territories for environmental protection.** *Possible use: ban on agricultural use; scientific research; regulated tourism related to studies of the nature. Territorial characteristics: landscapes with high sensitivity and presence of rare and typical types of plants and animals, specifically,* 2 *–spawning grounds.* 3 –**Preservation of natural and cultural heritage.** *Possible use: controlled development for landscape preservation; tourism development; preservation of the traditional types of agriculture. Territorial characteristics: historical cultural landscapes with a significant number of cultural heritage objects.* 4 –**Balanced environmentally friendly agriculture.** *Possible use: crop rotations; controlled use of machinery and proper use of fertilizers; promotion of biodiversity; biotope maintenance in settlements; maintenance and development of the regional green corridors. Territorial characteristics: agricultural landscapes with high natural soil fertility and low sensitivity to pollution and erosion.* 5 **–Balanced land use with emphasis on resources that require protection.** *Possible use: development of different types and forms of land use; promotion of environmentally friendly agriculture and horticulture; promotion of tree planting; controlled use of soils subjected to erosion. Territorial characteristics: agricultural landscapes with higher sensitivity to water erosion; forest management areas; river valleys; orchards and tree belts.* 6 –**Balanced land use with emphasis on the development of the tourism and environmental network.** *Possible use: forest management to maintain natural conditions and increase of forest planting; controlled hunting; production of goods typical for the region; development of recreation opportunities in attractive landscapes and historical sites; development of the environmental network. Territorial characteristics: Landscapes attractive for tourism and recreation; with high bio- and landscape diversity and special importance as habitats for rare species, e.g., large forested areas. Special attention –*7 *–distribution ranges and concentration of rate species of plants and animals, potentially, the cores of the network; special natural resources use regime and controlled tourism.* 8 –**Mitigation of negative impacts on landscape for environmental improvement.** *Possible use: non-intensive, special land use for rehabilitation of resources that require protections; enhanced monitoring of negative impacts and phenomena. Territorial characteristics: landscapes subjected to such negative impacts –*9 *–water erosion;* 10 *–abrasion of river banks;* 11 *–wind erosion;* 12 *–consequences of radioactive pollution of soils highly sensitive to chemical pollution;* 13 *–continual flooding. 14 –***Mitigation of negative impacts on landscape for the population livability enhancement.** *Possible use: decrease or cessation of negative impacts, e.g., noise or chemical pollution. Territorial characteristics: sites of large communities near industrial areas and automobile highways* final map “The integral concept of the goals”, which highlights the functional areas and the priority objectives of further action in relation to the landscape and outlines the future of natural resource management in the region (Fig. 2). The map also takes into account the existing and potential conflicts related to environmental management.

The consolidation of the sectoral goals invariably raises the question of selecting the priority targets. The highest priority, as a rule, is given to the goals associated with rehabilitation or enhancement: mitigation of impact (e.g., pollution or erosion) or prevention of landscape degradation due to negative impacts. Given the choice between alternative uses at the same site, the preference should be given to the *preservation* objectives of the current high-value landscapes, not to the *development* goals with an uncertain outcome: thus, the preservation of highly significant productive agricultural soils are of higher priority than the development of the recreational potential there. However, the main goal is to preserve and maintain the high level of biodiversity, rather than to develop any other economic sectors.

It should be emphasized that any of the types of the goals for the relatively large territory under the LaPro framework at a scale 1:200 000 should be regarded as a recommendation for the priority for this territory, but without excluding other uses (goal types) within smaller areas. The practice of LP [e.g., Landschaftsprogramm Brandenburg, 2009; Landschaftsprogramm Saarland, 2009; Landschaftsprogramm Schleswig-Holstein, 1999;] suggests that the types of goals at the level of LP programs are not always clearly separated from each other. However, the fundamental differences between them must be understood, since these differences play an important role in determining the priorities for related purposes at the subsequent levels of planning.

CONCLUSIONS

The LaPro for the Cherkassy oblast is the modern planning document developed for the first time ever in Ukraine. This is the first official document of this kind, in line with the traditions and practices of the European LP. The program for the Cherkassy oblast contains an explanatory note and maps, 10 in total, at a basic scale of 1:200 000, and more than 40 maps on a smaller scale.

At the core of the LaPro are the digital maps compiled using the integral assessment of the regional territory and applying modern software products (ArcGIS). The GIS-based LaPro contains information on the components of the nature (climate and atmosphere, surface and groundwater, soil, and flora and fauna), anthropogenic load on the landscapes, and existing and potential conflicts associated with this load. Thus, besides the planning goals, the LaPro promotes compilation of the regional database that can be used for other purposes also.

The main resulting document of the LaPro is the map “The integral concept of the goals” that presents the main directions of the natural resource use in the Cherkassy oblast complying with the principles of sustainable development. The map utilized the results of the assessment of landscape sensitivity to the existing and potential negative impacts and their significance to the priority types of natural resource use. The LaPro identifies general goals for the preservation, development, and enhancement of the landscapes. These goals have to be further refined and developed in detail at the subsequent stages of LP.

The LaPro has been coordinated with the materials of the territorial planning of the Cherkassy oblast and is a comprehensive framework for the management and investment decisions and the development strategy that provides territorially “bound” sollutions to issues related to the placement of certain objects and types of economic activity. ■

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IGU REGIONAL CONFERENCE IN KYOTO (AUGUST 4–9, 2013)

In the period between International Geographical Congresses in Cologne (2012) and Beijing (2016) Regional Conferences are held each year. They are destined, firstly, to integrate geographical communities of different macro-regions of the world and, second, to strengthen the contacts between IGU sub-disciplinary and problem commissions. The Regional Conference in Kyoto was the first of this series. It was the major and rather successful event in IGU activity this year. The Conference gathered 1431 participants from 61 countries – more than the organizers originally expected. About 600 participants represented Japan – the country which hosted the conference, and the others came from different parts of the world. A great number of them were from the Asian-Pacific region, which justifies the very idea of regional conferences. The days spent by the participants in the ancient Japanese capital were filled with an intense and rich dialogue – between geographical sub-disciplines, human and physical geography, geography and other sciences, between researchers and practitioners, between different generations of geographers, East and West, North and South.

The Conference's motto was "*Traditional Wisdom and Modern Knowledge*". The scientific program included the sessions organized by 39 of the 40 IGU Commissions as well as meetings held on the initiative of separate groups, key lectures and special sessions devoted to the perspectives of our Union and to the main IGU interdisciplinary projects (*International Year of Global Understanding* and *Our Sustainable Cities*). In particular, the audience enjoyed the key lectures by Professors Sarah Radcliffe from the University of Cambridge (UK) entitled "Plural Knowledges and Modernity: Social Difference and Geographical Explanations", Paul Robbins from the University of Wisconsin-Madison (USA) on the political ethics in environmental issues and Jean-Robert Pitte from the University of Paris-IY (France) on the role of human geography in global forecasts. Professors Kenji Satake, Itsuki Nakabayashi and Mikiko Ishikawa (Japan) offered three key lectures at the special plenary session devoted to the reasons, the consequences and the lessons of the 2011 East Japan earthquake disaster. They stopped also on spatial planning issue and the restoration of the regions which suffered from this disaster.

The Conference proved again how important it is to build joint projects and to develop cooperation within and between IGU Commissions. As Claude Bernard once said, "Art means "I", Science means "We". So, in coming together at such large conferences, the global geographical community becomes stronger, and realizes how important and influential it can and should be.

The Conference showed that IGU, facing new challenges, was able to find new directions and forms of activity. I refer to new ideas approved at the meeting of Commissions' Chairs and the IGU Executive, the initiatives concerning a broader involvement of young scholars, particularly through the contacts with the association of Young Earth Scientists (YES), the preparation of the extraordinary International Geographical Congress on the occasion of the IGU centennial in 2022, the relations with ICSU, ISSC and other global scientific organizations. New national geographical communities which have recently applied for membership in IGU or updated it were welcome.

The Conference marked a step in the promotion of geographical education in both secondary schools and universities. In many countries we observe an attempt to replace geography by "synthetic" courses of natural or social disciplines or simply to remove it from school curricula altogether. The declaration signed by IGU, Eugeo and Eurogeo in early September in Rome is a direct result of our meetings in Kyoto.

I particularly appreciated the special session on the status of geographical journals, the issues of their ranking and open access. There is a pressing need to improve the ways in which the output of scientific research is evaluated by funding agencies, academic institutions, and other parties. The presentation by Professors Christian Vandermotten, Mike Meadows and Ton Dietz at this session demonstrated that the abuse of citation indices and of journals impact factor those who evaluate our activity is a serious threat to the future of geographical departments and can undermine the personal careers of many scholars. Using calculation based on the geographical journals' data bases compiled by IGU and by the journal *Belgŭo*, the authors showed that this index strongly discriminated publications in national languages (non-English), in the field of geography as a whole and particularly in human geography, and on regional issues. It was agreed that IGU should endorse the *San Francisco Declaration on Research Assessment* (www.homeofgeography.org/news2013/June) and that IGU should develop recommendations on the matter to national research and education governmental institutions.

IGU and the Local Organizing Committee paid special attention to supporting young researchers: they set for them a low registration fee and distributed a number of travel grants. The authors of the best poster presentations by young researchers were awarded during the closing ceremony. The special exhibition "Traditional Wisdom and Modern Knowledge presented in Maps" was held in honor of the IGU Kyoto Regional Conference at the Kyoto University famous for its excellent collection of old maps. Tea masters from *Urasenke*, the largest traditional tea ceremony school, presided over authentic tea ceremonies.

Finally, the Conference in Kyoto was so successful due to the exemplary work of its Local Organizing Committee. We all noticed the rapid and efficient registration facilities, the tireless work of volunteers, always active and helpful, a user friendly program handbook, a memorable opening ceremony and many more highlights.

Vladimir A. Kolossov

INSTRUCTIONS FOR AUTHORS CONTRIBUTING TO "GEOGRAPHY, ENVIRONMENT, SUSTAINABILITY"

AIMS AND SCOPE OF THE JOURNAL

The scientific English language journal "GEOGRAPHY, ENVIRONMENT, SUSTAINABILITY" aims at informing and covering the results of research and global achievements in the sphere of geography, environmental conservation and sustainable development in the changing world. Publications of the journal are aimed at foreign and Russian scientists – geographers, ecologists, specialists in environmental conservation, natural resource use, education for sustainable development, GIS technology, cartography, social and political geography etc. Publications that are interdisciplinary, theoretical and methodological are particularly welcome, as well as those dealing with field studies in the sphere of environmental science.

Among the main thematic sections of the journal there are basics of geography and environmental science; fundamentals of sustainable development; environmental management; environment and natural resources; human (economic and social) geography; global and regional environmental and climate change; environmental regional planning; sustainable regional development; applied geographical and environmental studies; geo-informatics and environmental mapping; oil and gas exploration and environmental problems; nature conservation and biodiversity; environment and health; education for sustainable development.

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2. Papers are accepted in English. Either British or American English spelling and punctuation may be used. Papers in French are accepted under the decision of the Editorial Board.

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7. We encourage authors to list three potential expert reviewers in their field. The Editorial Board will view these names as suggestions only. All papers are reviewed by at least two reviewers selected from names suggested by authors, a list of reviewers maintained by GES, and other experts identified by the associate editors. Names of the selected reviewers are not disclosed to authors. The reviewers' comments are sent to authors for consideration.

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2. The **title** should be concise but informative to the general reader. The **abstract** should briefly summarize, in one paragraph (up to 1,500 characters), the general problem and objectives, the results obtained, and the implications. Up to six **keywords**, of which at least three do not appear in the title, should be provided.

3. The **main body** of the paper should be divided into: (a) **introduction**; (b) **materials and methods**; (c) **results**; (d) **discussion**; (e) **conclusion**; (f) **acknowledgements**; (g) **numbered references**. It is often an advantage to combine (c) and (d) with gains of conciseness and clarity. The next-level subdivisions are possible for (c) and (d) sections or their combination.

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Journal references should include: author(s) surname(s) and initials; year of publication (in brackets); article title; journal title; volume number and page numbers.

References to books should include: author(s) surname(s) and initials; year of publication (in brackets); book title; name of the publisher and place of publication.

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