RUSSIAN GEOGRAPHICAL SOCIETY

FACULTY OF GEOGRAPHY,
M.V. LOMONOSOV MOSCOW STATE UNIVERSITY

INSTITUTE OF GEOGRAPHY,
RUSSIAN ACADEMY OF SCIENCES

No. 02 [v. 05]
2012

GEOGRAPHY ENVIRONMENT SUSTAINABILITY

EDITORIAL BOARD

CONTENTS

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REGIONALIZATION IN EASTERN AND CENTRAL EUROPE: OBSTACLES AND PERSPECTIVES

ABSTRACT. Regional policy depends on efficient administrative systems for designing and implementing strategies, and places considerable demands on Member States' public administrations in terms of e.g. financial management and monitoring; project selection procedures; ex ante environmental impact assessments and cost-benefit analyses; and the monitoring and evaluation of outputs, results and impacts. EU member states have taken a range of different approaches to the administration of regional policy.

The construction of regions in the countries of Eastern and Central Europe became one of the important debate topics for preparation for EU membership. Despite the numerous similarities in the changes that have taken place in the territorial structures of the Eastern and Central European countries, the differences in the responses individual countries gave to the challenges of regional development and the varied results of their development efforts demonstrate that the "Eastern European Bloc" is at least as heterogeneous as the former member states of the European Union. EU accession opened up a Pandora's Box in the countries of Eastern and Central Europe. The fundamental issue of how unitarily structured states can be set on a decentralised path became the centre of debate. The paper introduces the Central and Eastern European achievements of region building processes and searches for an explanation of the reasons for the difficulties of Eastern and Central Europe in regional construction; it summarises the administrative and political development pre-requisites of the transition to a regional outline of the possible advantages of a regional institutional system in the creation of the Cohesion Policy ensuring a decrease in regional differences.

KEY WORDS: regionalism, regional development, structural and cohesion policy, Eastern and Central Europe, European Union

INTRODUCTION

Regionalism, the regional decentralisation of power and the distribution of labour among the different forms of local government have found themselves in the crossfire of debate in the unitary states of Eastern and Central Europe [Enyedi, Tózsa, 2004; Horváth, 2010; Keating, Hughes, 2003; Lütgenau, 2011]. The change of the political system, the process of connecting to the globalising European economy, the construction of a local governmental structure using the concepts of civic democracy, all shed new light on the mutual connections of central and regional local power, the harmonisation of settlement independence and meso-level public administration functions. In almost all of the former socialist countries the central issue became that of the economic, political and functional transformation of the basic levels of local government. The earlier sub-national levels disappeared (as in the successor states of the old Czechoslovakia), their functions to a large extent decreased (as in Hungary), changed (as in Poland), or, alternatively, new regional meso-levels were created (as in Croatia) or are being created (as in Slovenia).

The construction of regions in the countries of Eastern and Central Europe became one of the important debate topics for preparation for EU membership [Bachtler, Downes, Gorzelak, 2000; Michalski, Saraceno, 2000]. However, the application of EU structural policy relates to appropriate size in terms of the population potential of sub-national development units and their economic capacities, in view of the concepts of economies of scale, and so, during the preparation of the EU pre-accession programmes, planning-statistical regions had to be created in all countries. From a formal point of view, solving this task did not create any particular problem. The government of each country listed the regional public administration units as meso-level development regions, and, on the basis of EU recommendations, the formal organisational structures (regional development councils, development directorates and agencies) were also created.

In parallel with the creation of the organisational framework of an EU-compatible development policy, there started, in most countries, an intensive debate on issues of content. In these debates, numerous issues (which had earlier received less attention among the topics relating to the change of regime) were raised: What functions should the development regions have? How can they become public administration units serving the decentralisation of the centralised state system? What resources should they have to fulfil the development programmes? Which city in the region should become the regional centre?

EU accession opened up a Pandora's Box in the countries of Eastern and Central Europe. The fundamental issue of how unitarily structured states can be set on a decentralised path became the centre of debate. This present study searches for an explanation of the reasons for the difficulties of Eastern and Central Europe in regional construction; it summarises the administrative and political development pre-requisites of the transition to a regional outline of the possible advantages of a regional institutional system in the creation of the Cohesion Policy ensuring a decrease in regional differences.

THE FORMAL CHANGE IN REGIONAL ADMINISTRATION

The new nation-states in Eastern and Central Europe established in the aftermath of World War I had to face – from the point of view of their future regional development – two difficulties. One of the issues to be addressed was how to create a unified structure for those (new) parts of the country which earlier had been developed in different economic areas, in order to link their infrastructural systems. The other was to create a new system of regional organisation of central government power. The heavily centralised state powers created their own regional bodies partly on their former administration basis, but completing those tasks needed to create the new, unified state territory was most effectively assisted by the low number of administrative units involved. Following World War II, the Soviet-style regional administration was organised differently – now based upon different power considerations. The Communist states, in accordance with their political interests, heavily changed the countries' regional administration on several occasions, sometimes organising smaller regional units and sometimes larger. Hungary can be considered as an exception to this, in that, in the 20th century (apart from some under-populated counties being combined) the number of sub-national units in the country has not changed (Table 1).

In Eastern and Central Europe a hierarchical planning organisational system – with a fairly powerful central planning office at the top in each country – had previously been the decisive organisational form of regional development. Regional development based

Table 1. Changes in the number of regional administrative units in Eastern and Central European countries

Country	Pre-WW II	1950s	1960s	1970s	1980s	2009
Bulgaria	9	13	28	28	9	28 (1999)
Czech Republic	2	13	8	8	8	14 (2001)
Hungary	25	20	20	20	20	20
Poland	14	22	22	49	49	16 (1999)
Romania	9	18	18	40	41	42
Slovakia	2	6	4	4	4	8 (1996)

Source: The author's own design.

on central large-scale investment and state social policy did not require a multi-participant institutional system operating in horizontal co-operation, and the state's interest in re-distribution, together with the central will, were carried out most effectively by vertically subordinated organisations. This philosophy of state organisation also defined the regional administration system.

Following the change of regime, the organisational framework of Eastern and Central European states underwent important conceptual changes [Blažek, Boeckhout, 2000; Boev, 2002; Gorzelak, 1998; Horváth, 1996; Illner, 2000; Stasiak, 1999]. A local government structure has replaced the hierarchical, executive council system, and the related legislation has created the constitutional basis for a decentralised exercise of power. By now, in fact, local authorities have been equipped with constitutional guarantees of their organisational and decision-making independence, and very significant changes have been introduced into local government financing. In formal terms, public administration in Romania and Hungary has remained unchanged, although in Bulgaria the previous multi-county system was restored. At the same time, both the Czech Republic and Slovakia (as in the period between 1949 and 1960) created counties relatively small in size. Only Poland established large-size "voivod-ships" and here the reform of the country's public administration has been an important milestone in the process of preparing for EU accession.

It is, therefore, quite evident that the question of the public administration units (meso-level) positioned between central government and the settlements will continue to be an open issue – and extremely important from the point of view of regional policy. It is, in fact, a general phenomenon in Eastern and Central Europe that these levels – as a reaction to the negative role which they mainly played under the previous system and their extremely strong political and redistributive functions – have very few local administration rights.

THE DEVELOPMENT AND STATISTICAL REGIONS

A pre-requisite for Eastern and Central European countries to join the EU or to benefit from support from the Structural Funds was the creation of large regions (NUTS 2 units): on this basis the most effective development concepts, and the programmes serving their realisation, could best be drawn up. The 206 NUTS 2 regions established in the 15 member states of the EU are very different from the point of view of their public law and administration situation – and their physical size and population numbers. Basically, we are looking at units nationally determined, in which, at the same time as the NUTS 2 system of each country should meet common requirements, they operate as statistical (calculating, analysing, planning, programming, coordinating) and developing (support policy, decentralising) units. In the 10 Eastern and Central European member states the number of meso-level administration units at the end of 1999 was 357, and it was clear that the EU's support policy could not supervise such a high number of regional units. In consequence, it became essential to create larger regional development and statistical units.

Defining boundaries within the NUTS system is, from the EU's point of view, an internal affair – which means that, apart from size, there are no absolute EU requirements in terms of the creation of the regions: the decision lies within the scope of national governments. However, on the basis of experience with creating regions, the various concepts and likely impacts can be expressed in a way which makes the definition of the region relatively straightforward:

- a prehistory of regional cooperation and, hence, the chances of regional cohesion,
- relative size status from the point of view of the national regional structure,
- relative spatial homogeneity in terms of the basic aims of regional policy,
- an effective internal structure (centre, sub-centres, skills and the ability to cooperate etc) of a region and the observance of public administration borders,
- the existing (or demanded) "geo-political" similarity of the units united in a region and the degree of identity of the definitive, long-term, international orientations,
- the costs of creating and operating the regions (decision-preparing, decision-making and professional administrative background institutions, organising the information, planning, managing and monitoring activities, the institutional system of decentralised financing etc), the economies of scale from a functional point of view,
- the existence of a multi-functional, major urban regional centre.

The NUTS 2 regions are listed in the Regional Development Acts or Government Decrees of each country. However, the Regional Development Act adopted in Hungary in 1996 was quite cautious, indicating merely that the counties could create regions in order to carry out common tasks. It did not, however, define the development regions of the country; and this imprecise regulation had, as a consequence, the fact that counties joined together widely differing regions purely for fund-raising purposes – and there were counties which participated in three or four regional alliances However, the Amendment to the Act in 1999 defined seven development statistical regions and separated the counties into regions. In fact, a Government Decree listing, in an itemised form, the theoretical concepts defining development regions was created only in Bulgaria [Geshev, 2001]. The Bulgarian Government defined the aspects of the creation of the regions in 1999 as follows:

- The number of regions should be relatively low and they should be defined on the basis of their size and natural resource potential; their economic and social capacities should be able to undertake large-scale programmes;
- The regions should not be too large to be manageable, and the number of counties comprising a region should be optimal in order to be able to organise their cooperation;
- There should be a common development problem in the region which could be felt in any point of the region and which motivates the regional development actors to cooperate;

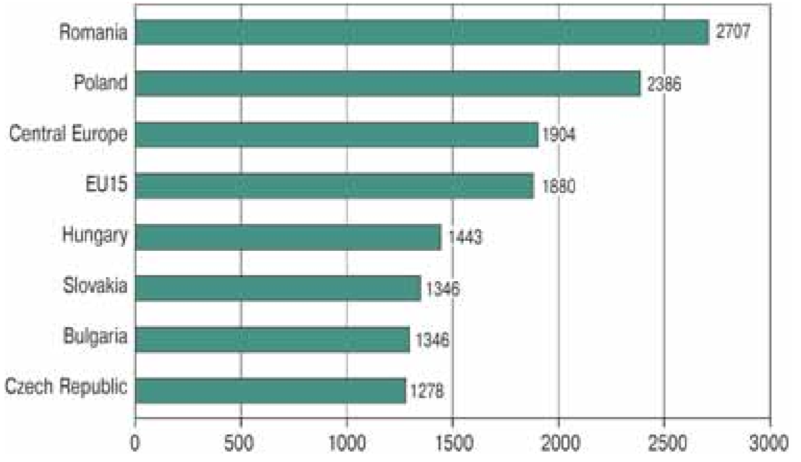

Fig. 1. Average population of NUTS 2 regions in Central Europe (2009, '000)

Source: *The author's own calculations on the basis of Regions. Statistical Yearbook, 2006*

– Natural geographical units and historical traditions should be taken into consideration;

– The region should have a relatively developed urban network and several growth-poles;

– The planning region should comprise complete public administration units.

In the other countries, and after long debate, a compromise decision was reached in terms of the creation of NUTS 2 regions, and these (more or less) matched the above basic concepts. As regards size, they parallel very closely the average of the earlier EU member states (Table 2, Fig. 1). Individual countries, however, did not come to define their central regions in the same way. In Bulgaria, Poland, Hungary and Romania, for example, the capitals, together with their surrounding "Metropolitan" regions, made up one NUTS 2 unit, whilst, in the Czech Republic and Slovakia, the capitals alone constitute one single region. Since there is also visible in Eastern and Central Europe that general pattern of spatial economy in which the larger region surrounding a country's most developed growth pole can

Table 2. The most significant data of NUTS 2 units in Eastern and Central Europe, 2009

Country	NUTS 2 regions		
	Number	Average area ('000 km^2)	Average population ('000s)
Bulgaria	6	18.5	1,294
Czech Republic	8	9.9	1,278
Hungary	7	13.3	1,463
Poland	16	19.5	2,386
Romania	8	29.8	2,707
Slovakia	4	12.2	1,346
ECE	49	14.7	1,904
EU15	206	15.3	1,880

Source: The author's own calculations on the basis of Regions. Statistical Yearbook, 2006.

show weaker performance (a consequence of the "filtering-down" effect), this solution generated strong debate in Hungary. The overall performance of the Central Hungary region (due to Budapest's high GDP per capita) is as much as 105% of the average of the EU-27 and could not, therefore, be included in the Objective for convergence. Support, therefore, is more modest. (Budapest itself produces 144% of the EU average, whilst the region's remaining unit, Pest county, produced just 55% in 2009). Similar problems can be noted in the other countries also.

THE DILEMMA OF THE REGIONAL CENTRES

Those larger towns or cities can be called regional centres which, on the basis of their size and geographical location, fulfil the role of administrative, industrial and transport centre of a large area which is home to between one and three million inhabitants. These stand out from their surroundings and enjoy a higher proportion of the resources of their region than would be justified by their population.

Due to the influence of urban development processes, the regional centres of Western Europe built up their position over centuries, and their functional accumulation of wealth and growth of resources are closely connected with their region. In their development, the restructuring of the economy and the quality change in their transport and service sectors also played a major role. The settling and gradual expansion of the leading positions of central and local government administration, naturally, played their part also, in that more favourable conditions were created in these cities to enable them to accept the new economic growth-driving forces – although, in the development of their performance capacity, administrative factors can only be seen as secondary resources. Their dynamism was basically generated by the role of industry and services affecting both their regional and their wider markets. It is, therefore, no accident that, when the institutionalisation of regionalism – in particular countries in different development phases – led to changes in public administration, the choice of headquarters for a region seemed quite obvious in each West European country: the largest city, the richest in functional terms, the most outstanding in economic potential became the centre of public administration for the region.

In many countries the decentralising trends of national regional policies, and especially the growth-pole concepts, played an important role in the development of the regional centres [Cities in the new EU countries, 2004; Potentials for polycentric development in Europe, 2004; Schindegger, Tatzberger, 2002; Waterhout, 2002]. The essence of the use of the growth-pole strategy was that those innovations given regional development support were directed only to a limited number of locations (mainly as a part of the planned concept targeting the modification of the regional spatial structure), attempting to support economic activity to raise the level of welfare within the region. The creation of the growth-pole was, first of all, motivated by complex industrial development, by the dominant new (or modernised) economic sectors and developed services. Using the principles of the French spatial economics school in economic policy resulted in an essential strengthening of connections in the economic space among companies and sectors.

Paralleling the clear results achieved in the development of those major urban centres which are treated as poles, the consequences in terms of the effect as experienced on regional transformation are less favourable. It is not in every country that growth-poles have been developed as the driving forces of regional development, and especially in those countries where the spatial-political, politico-economic and the political strategies involved in public administration could not be framed within a unified system, the results of the use of this paradigm are spoken of with some scepticism., The elaboration and fulfilment of their (incomplete) policies were not embedded in a unified decentralised concept, but appeared as separate, disjointed steps or attempts to reform, and they were ineffective – especially since the under-performance of the synergies produced some undesired results.

As a consequence of the multi-coloured administrative structure of European countries, we can speak of regional centres in a variety of ways. In countries with a federalised and regionalised system, the public administration centres work at the meso-level as real regional centres, whereas, in centralised, unitary countries the centres of the NUTS 2 units have more limited (planning and organising) functions.

In the development of regional centres in each country many identical and numerous specific factors played a role. However, the general trend seems clear, in that, in the great majority of European regions, the largest town or city is the centre of the region. However, as a result of European urbanisation development processes, the density of the large cities in the countries across the continent differs, and the proportion of the population living in towns or cities with more than 100,000 inhabitants varies from country to country. From 8–34% of the population of the EU-15 member states live in cities with populations above 100,000. (In defining the population proportions we did not take the population of capital cities into account)

In terms of the number of towns or cities, Germany heads the ranking list. Germany, in fact, has 83 towns exceeding this 100,000 figure; then comes the UK with 65, Spain (55), Italy (49) and France (35). Regarding the proportion of the national population which this represents, the order is: Spain, Germany, Italy, Sweden and the Netherlands (Fig. 2).

The large city network in Eastern and Central Europe – except for Romania and Poland – is thin (Fig. 3). In the whole area, 97 towns or cities are above 100,000 in population terms, and two-thirds of these are found in Poland and Romania. Slovakia has, apart from the capital, a total of one major city. In these two countries the number of regions is much lower than the number of cities but the largest of the latter are evenly distributed over the whole area and can be become potential regional centres. For this reason,

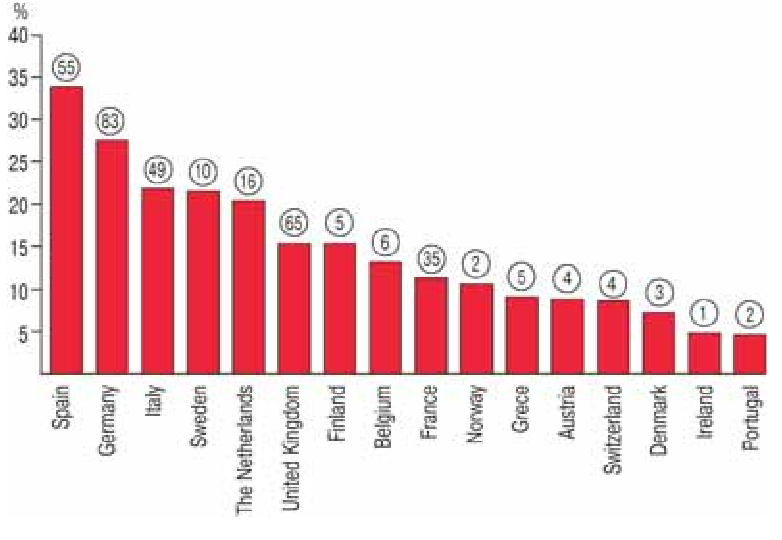

Fig. 2. Number of towns or cities with over 100,000 inhabitants in selected European countries, (excluding the capital) and their proportion of the national population, 2009.

Source: *Author's own construction based on data from national statistical yearbooks*

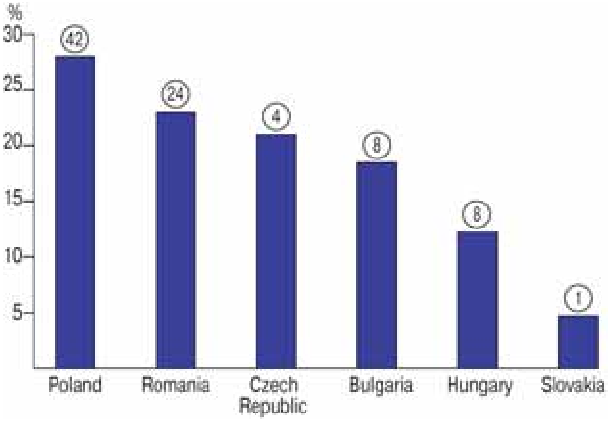

Fig. 3. Number of towns or cities with over 100,000 inhabitants in Eastern and Central European countries (excluding the capital) and their proportion of national population, 2009.

Source: *Author's own construction based on data from national statistical yearbooks*

therefore, designating a regional centre could be much more convenient.

In most of the Eastern and Central European countries the debates over the designation of regional centres became more intensive as the EU accession process progressed. In Poland, after the introduction of the new voivodship public administration, the leading major cities became the centres of the new regions. The only exception is the Kujawsko-Pomorske voivodship where the regional centre is not Bydgoszcz, the industrial centre with 368,000 inhabitants, but Torun, with its historical traditions and a population of 208,000. In the other countries the competition among towns or cities goes on almost exclusively in respect of the setting-up of the labour organisations of the development agencies and of changing the number of the NUTS 2 regions. The latter is especially at the centre of debate in Romania. Several cities with traditionally strong regional organising functions in the country, such as Arad, Oradea, Sibiu, and Târgu-Mures lost their potential regional centre role. These demand a change of the national regional system. The dissatisfaction in the counties belonging to the planning-statistical regions is shown by the fact that the headquarters of the regional development councils in several cases in Romania were set up in smaller county centres. There were also examples of neglect of the role of the leading cities in Bulgaria. As a result of the public administration reform undertaken in the '70s, in which, instead of small spatial units, six large "oblasts" were created, the leading major city was replaced, and a smaller-sized town in the geographical centre of the region became the regional centre.

IS EASTERN AND CENTRAL EUROPE UNITARY OR DECENTRALISED?

Should it be thought desirable to give an important future role to the meso-level units in regional policy in Eastern and Central Europe, this would clearly bring the current meso-level system into sharp focus. Both the size and economic potential of the counties in their current form are too small for them to become the basic units of decentralised regional policy, and it is to be expected that, in the future, regionalism will become stronger in more and more countries, and that this will lend weight to the re-defining of the distribution of labour between centre and provinces. There will be a serious opportunity to establish inter-regional cooperation operating on the basis of economic conformity and to increase cohesion in Eastern and Central Europe – but, even then, only if the tasks

Table 3. The weight of capital cities in Eastern and Central Europe (2009, as percentage of national total)

Areas	Sofia 2007	Prague	Budapest	Warsaw	Bratislava	Bucharest 2007
GDP	24,6	24,5	37,4	n.a.	24,2	16,5
Industrial output	15,9	13,0	17,6	11,8	37,3	17,0
Foreign capital investment	49,9	25,7	56,5	33,0	71,2	46,7
University student numbers	43,3	31.4	49,2	16,7	83,0	32,4
R&D employees	72,7	48,0	55,8	30,0	40,2	39,0

Source: Author's own construction based on national statistical yearbooks.

now accumulating (a genuine regional decentralisation of power and the creation of a regional development strategy conforming to the market economy) could be carried out, would it be possible that regionalism in its West European meaning could take root in this area. Today the driving forces of growth are concentrated in the core areas of individual countries, something which indicates, over the long term, the maintenance of the differences between the national regional units – or even their increase (Table 3).

The changes occurring during the last decade indicate that the political scope of activity within regional policy at the beginning of the new century – over and above the self-determination of economic development – are defined by two major factors: the first of these is the EU's organisational, operational and financial reform together with Eastern enlargement, whilst the second (to no small extent influenced by the first) is the establishment of a new distribution of labour within government in the nation states – in other words, decentralisation.

Decentralisation – as proved most clearly by the processes of previous decades – is now regarded in Europe as a perfectly normal phenomenon. In 1950 a quarter of the population of the continent lived in federalised or regionalised states, a figure which, by the mid-90s had risen to 60%. By the end of the first decade of the following century – without taking into account the successor states of the former Soviet Union – more than three-quarters of the population of Europe will live in countries where influencing the factors of economic growth, it will not be the state but rather, the sub-national level which will play the defining role. This quantitative change – according to our current knowledge – will be the result of the creation of new regional administration in two countries with a high population – the United Kingdom and Poland.

The basic interest of the nation-state in the future will be to try to use its power to determine economic policy within its borders to counter-balance the effects of external pressure from globalisation and integration – by increasing the ability of the regions to defend their interests in a regulated fashion. It is already the case that the traditional regional development practice of Keynesian economic policy cannot be used successfully in the new paradigm, and the state's regional policy will be substituted by the region's own policy. This paradigm change, however, cannot occur automatically, the interests of the regions being developed to different levels. In the institutionalisation of regionalism important differences are to be seen. The poorest regions can hope for improvement through outside (national and international) help, as in the past, their motivations depending more on traditional support systems than on what might be gained through the autonomy (in its wider sense) of a "Europe of the Regions". The devoted fans of regional decentralisation come from the group of developed regions which will clearly be the beneficiaries of the Single Market and of the Economic and Monetary Union. It is not by chance that, today, Europe's most efficient regional cooperation network (not even connected territorially) comprises: Baden-Württemberg, Lombardy, Rhône-Alpes, and Catalonia, who created a co-operation under the name "Europe's Four Engines" [Amin, Tomaney, 1995].

The general spread of regionalism, however, still faces large barriers, and national governments will continue in the future to play an important role in the connections between the regions and the EU Commission. The poorest regions of Europe can realise their interests least of all in the integration decisions, as the poor countries anyway have fewer representatives in the EU bodies. The competition policy of the EU also reinforces the effects of centralisation, and community regional policy is less capable of counterbalancing the differences emanating from varying competitive abilities. Federal Germany is the best example of this; the regional regionalism and the decrease of spatial differences can also be matched at central government level.

In parallel with the irreversible deepening of European integration, the key positions of the national government are still retained, at least in three areas. One of the most important tasks of the state is to regulate capitalism in public companies, and industrial development, even in the future, cannot be imagined without effective national financial systems, as the safest starting point for corporate strategies will be the domestic market and the regulation environment also. The other important central government task remains the coordination of national innovation and technical development programmes. Finally, as the third national level priority can be considered to be the labour market and industry-political tasks, success in fulfilling these two latter national functions, however, depends on how effective a part can sub-national public administration play in fulfilling numerous partial tasks. Consequently, regionalisation is at the same time a prerequisite for the successful operation of the nation-state, since macro-political aims cannot be fulfilled without thoughtful human resources, educational training and enterprise development; nor can well-balanced market competition be imagined without the cooperation of the social partners. The solution of these, however, is the most optimal at the level of the regions [Keating, Loughlin, 1997].

In Eastern and Central Europe today the future of the division of power between state and region still seems uncertain. The prospects for decentralisation depend on the success of economic efficiency and the results of the "top-to-bottom" managed change of regime, but the pre-conditions at regional level for setting up power are unfavourable. In the former planned economies, the organisational framework deriving from strong centralisation has remained, even if the substance of central power has changed a great deal. Even in the most favourable cases, the process of decentralisation can be expected to be a long one.

Three possible ways of decentralisation can be envisaged in Eastern and Central Europe, and each of these differs from the others in terms of the extent and quality of the division of power. The choice of way, naturally not an arbitrary one, the historical traditions of an individual country, the nature of the economic transformation, the establishment of institutions of the market economy, political power relations and the degree of sophistication of the spatial structure all influence the decline of power concentration. The pressure to decentralise which falls on the central state administration is obviously stronger in those countries where the dynamic, regional major urban centres (for example, in Poland) wish to initiate their autonomous development, their structuring into the European regional division of labour, with the help of the (possibly, most liberalised) utilisation of their internal resources and post-industrial development factors. On the other hand, the legitimisation of bottom-up initiatives meets greater resistance in those countries (for example, in Hungary) where the central regions have a dominant, even a strengthening, position in the factors of production increasing competitiveness. Although the example of these two countries is a good one in demonstrating that the existence of regional centres capable of being made effective is no more than a potential advantage, the "suction effect" towards decentralisation originating from the political legitimacy of Hungarian regional local authorities and the legal regulation of regional development can somehow counterbalance the lack of strong regional centres of appropriate European size.

In the first possible decentralisation model, the division of labour between central and regional bodies is organised under clear, precise rules, and the development tasks for which the two types of body are responsible differ simply in respect of which regional unit these tasks affect. To solve these problems, regional authorities even have their own income resources and have wide-ranging rights in respect of planning, and the developments of local authorities which are part of their own circle can be subsidised from these (regional) funds. Depending on the economic development level of the region, "own" and "shared" income can be supplemented by transfers from central government funds. This strategy provides the most comprehensive form of decentralisation, and, in the long-term, this is the most effective solution. However, to create this, numerous – political, constitutional, public administrational and economic – pre-conditions are necessary, and, even today, the progress of regional self-government in Eastern and Central Europe does not seem a realistic prospect. Further differentiation in the region will also derive from the fact that Poland and, hopefully, Hungary will take steps along the road to regionalism.

The gist of the second decentralisation strategy model is that only certain functions (planning, development, executive, authorisation and financing) are transferred from the centre to the regions, with the remaining regional, political tasks continuing within the competency of the central government. The expansion of the redistribution of power depends on the tasks which are to be decentralized, the institutional system which is to take them over and the tools which will be at the disposal of the regions. This version is the best in the short-term for those countries with a unitary system, since the preparations for transferring power need less effort, since there is no need for a complete transformation of the public administration system, since the actual influence of the central bodies does not change (which is the most important consideration), and, as the management of regional development through de-concentrated state organisation will be more complex, perhaps their efficiency will increase.

In the third option, the new division of responsibility between central and regional organs is based upon their handling of specific, occasional tasks. They create a common managing body for developing the peripheral, lagging regions, and the state provides part of its financial resources to this decision-making forum, whilst the execution of the development programmes is delegated to the spatial units. This version represents the weakest version of decentralisation, but, since there is no need to change the established power structure, it is not surprising that most Eastern and Central European countries have started to elaborate their spatial development programmes on this basis. Central governments consider this solution as the easiest way to solve the problem: they do not need to put their hands into a hornet's nest and the vertical and horizontal power relations remain untouched.

CONCLUSIONS

The region is considered to be a spatial unit serving the sustainable growth of the economy and the modernisation of the spatial structure, with independent financial resources, fulfilling autonomous development policy and equipped with local government rights. On the basis of this term – whose factors naturally developed differently in the different periods of European development – regions have not so far existed in Eastern and Central Europe, despite the fact that some geographers (on the basis of the indisputable results obtained by geographic science in regional research) assert that we do possess some well-defined, natural regions. Such "form without content"15 – as in previous decades 15 – cannot, in itself, steer the spatial structure of the country in a favourable direction, decentralise the new space-forming forces and create the pre-requisites for multi-polar development. The region, if defined as a framework for regional research, is not capable of organising the space-forming powers of the 21st century without the competencies, institutions and tools.

Regions in the new member-states are necessary, since European regional development clearly proves that a sub-national level comprising approximately 1–2 million inhabitants regulated on the basis of self-government concepts (as a result of the region's economic capacity and structural abilities) is considered to be:

– the optimal spatial framework for the realisation of regional development policy, oriented towards economic development,

– the appropriate field for the operation of post-industrial spatial organisation forces, and the development of their interrelationships,

– the important area in which to enforce regional and social interests,

– the most appropriate size of spatial unit to build a modern infra-structure and the professional organising-planning-executing institution of regional policy,

– the main factor in the decision-making system of the European Union's Regional and Cohesion policy. ■

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"NEW" GEOGRAPHY IN UKRAINIAN REALITY: MISSION AND DEVELOPMENT TRENDS

ABSTRACT. It is a well-known fact that science is international in nature and has no national boundaries. The authors of the paper presented herein used the combination of the words "new geography" and "Ukrainian reality" in attempt to focus attention on the complexities of geography in a fundamental change of social development objectives and methods of management. The authors are concerned about the decrease in the degree of influence of geography on various spheres of human life and consider the distinctive characteristics of geographical science through the presentation of the features of its construction methods (object-oriented, subject-oriented, and problem-solving methods). The weakness of geography is manifested in the lack of knowledge refined to natural laws. But it is precisely a geographer who forms a specific individual model matrix of relations using geographic logic his/her perceptions.

Given the current transformation processes taking place in Ukraine, there is now a new international challenge in complex conditions of development: limited resources; environmental, demographic, and financial problems; and much more – "re-discovering of the world". It is natural that each country meets challenges in its own ways. Therefore, by using the combination of the words "new geography" and "Ukrainian realities", the authors attempt, on the one hand, to focus attention on the complexities of the modern formation and development of geography and, on the other hand, to emphasize the advantages of geographical studies of various spheres of human activity. They demonstrate that in Ukraine, own vectors and the development trends of geography were formed and brought real results that were positively valued not only by the scientific community, but also by society as a whole. There is a large gap between scientific and educational geography. Two possible options to reduce this gap are suggested. Examples of the implementation in Ukraine of some projects based on achieving "new geography" are provided.

KEY WORDS: informational geography, geoinformatics, National Atlas, sustainable development, geographical space, regional geopolitics.

INTRODUCTION

The history of any science is a path of self-cognition in a changing world and of understanding the driving forces behind its development and marketing advantages of its capabilities in the development of human civilization. Geography, for two and a half thousand years, has gone through several stages in its development.

The first stage was associated with the ancient natural philosophy; it determined the main directions of the geographical understanding of the Universe and of the Earth's surface as the elements of the environment. The name of the second stage, defined as the epoch of the Great Geographical Discoveries, reflects, in general, the vanguard role of the most active part of humanity rather than that of geography. Due to the activity of many "pioneers" – the researchers of "blank spots", the map of the Planet Earth was created, which became the object of the spatio-temporal organizational study of the world in many sciences, including geography.

Geography has reached its maturity in the third stage, when it became the family of diverse sciences visibly useful and necessary to solve many challenging problems. Scientific geography, as part of natural sciences, sought to bring together, in relation to geographical features, analytical laws of natural science, based on the proposed by A.A. Grigoriev notion of a single physical-geographical process, while relying on the duality of the science of human habitation, that has become, starting from K. Ritter, the most convincing embodiment of knowledge about the environment (geoecology, environmental ecology) [Bagrov, Rudenko, Chervanyov, 2010, Rudenko, 1999]).

At present, we believe a new stage – the geography of information (according to A.D. Armand [Armand, 2002], N.V. Bagrov [2005], and L.G. Rudenko [1999]), is emerging. These authors recognize that geography of the future is based on knowledge of the object through the information about it, available for the study of modern systems via information gathering, ordering, processing, and interpretation, and applying modern GIS technology. In significant part, this geography examines the pragmatic function and is increasingly linked with geoinformatics addressing together real problems of development of humanity. Thus, we believe, that the stage of "new geography" has commenced.

Information geography encourages immersion into the traditional object of knowledge with a greater understanding of geospace and of its inherent properties, with a deeper knowledge of different types of structures, including real and virtual networks; it is a new approach to resource assessment that measures not only material, but also intangible resources.

Modern geography should consider the fact that although the world has changed significantly, its economic growth remains uneven: three dimensions – density, distance, and disconnection that are manifested in such market mechanisms as agglomeration, migration, and specialization, define its spatial economic landscape. These trends pose a new task to the geography – to define the role and importance of market factors at different geographical levels in the development process.

All this, naturally, should affect the change in the style of thinking of geographers, the style of the development of new methodological concepts, requiring rather complicated methods and technologies for its realization. The latter is impossible without a radical update of the research framework of geography through distance learning methods in conjunction with information technology.

New economic development conditions and the activity of related sciences have exacerbated the dilemma of "to be or not to be" that have periodically challenged the geographical science. This has led to increased activity and even to the enhancement of the practical relevance of research.

The most active response to these challenges have already come from the cartographers who received a new object of cartography – an independent state with its new external and internal features of a transformed economy, infrastructure, and new problems not inherent in the previous Ukraine. Cartographers, using modern computer and GIS technology, have created on-line maps of emergencies in response to the request of the Ministry of Emergencies of Ukraine and of other agencies and organizations; they have been already compiling topographical maps of cities and regions for wide use, tourist maps, and digital maps. The most significant examples of such activities include the National Atlas of Ukraine (paper and electronic versions) based on the concept of the Institute of Geography (National Academy of Sciences of Ukraine), which has been used in the managerial, educational, and scientific activities and convincingly represents the State at the international level. In the process of its creation, its own sophisticated database on the nature, population, economy, and resources of the State has been generated and applied [National Atlas..., 2007]. This Atlas was preceded by its pilot electronic edition in Ukrainian and English (2000).

The project on the compilation of an atlas in the GIS format that evaluates the risks of emergencies in Ukraine is currently under way; the project unified the efforts of the geographers and experts of the Ministry of Emergencies of Ukraine [Rudenko et al., 2010]. These, as well as other not mentioned herein works, integrate information about new Ukrainian reality and all its positive and negative implications in the development of society.

Speaking about the most successful national projects in the field of new economic and social geography, we should limit ourselves to the discussion of the most representative of them. First, this includes a series of reviews of the status of the Ukrainian economy in the developing world, written by economic geographers and resource experts of the Institute of Geography (National Academy of Sciences of Ukraine). The most notable among them is the collective monograph "Ukraine: main trends of interaction between society and nature in the XXth century (geographical aspect)" [Topchiev, 2010]. The project was conducted on the postulate that the world is built on a balance of natural forces and that the wedging of human activity into natural processes, despite its different directions, has, unfortunately, many negative consequences. Thus, the monograph analyzed the major trends in the components of nature, population, and economy in Ukraine over the past 100 years; it showed the effects of interaction between society and the nature and was the first to present the conceptual strategy of balanced development of Ukraine and its regions.

We should also note the emergence of new fundamental results on the completions of Doctor of Sciences theses. Among them are: V.I. Zakharchenko [2006] – on the processes of transformation of the industrial market of the Ukrainian territorial systems; S.P. Son'ko [2002] – on the socio-natural systems in their current and future perspective; S.A. Lisovsky [2004] – on economic-geographical factors of balanced development of Ukraine; I.M. Yakovenko [2004] – on the theoretical and methodological foundations of the recreational resource use; G.P. Pidgrushny [2007] – on the role of industry in regional development; I.V. Gukalov [2008] – on the assessment of quality of life of the population; A.V. Gladkyi [2010] – on the modern vision of the essence of the development of the agglomeration forms of territorial organization of production; Yu.N. Palekha [2009] – on new approaches in the economic evaluation of land. There was also a certain "penetration" of geography into public administration through a Doctor of Sciences dissertation by T.N. Bezverhnyuk [2009] devoted to regional resource management. There should be also mentioned a phenomenological study of "new geography" based on the concept of the founder of the philosophical phenomenology E. Husserl (intentional paradigm of A.G. Topchiev) incorporating, in a very timely fashion, awareness of humanity's place in the nature-society system [Topchiev, 2010].

In the geomorphology field, a series of new works has been published too. For example, S. Kostrikov defended his Doctor of Sciences dissertation and, together with I.G. Chervanyov, published a monograph on the synergy of fluvial topography, which is based on strict principles of natural sciences [Kostrikov, Chervanyov, 2010].

Scientists of the Geomorphology Department of the Institute of Geography (National Academy of Sciences of Ukraine) have published monographs on the environmental aspects of the geomorphological studies, on neogeodynamics of the Baltic Sea depression and adjacent areas, on the common problems of paleogeomorphology, on development of the Earth in the Phanerozoic, on the dynamics of the modern topography of Ukraine [The current dynamics..., 2005, etc.], on the geomorphological-mapping approach and on structural-geomorphological and neotectonic studies in the active fault zone platform part of the territory of Ukraine.

The publication of a unique three-volume Encyclopedia of the Environment of Ukraine [The Ecological Encyclopedia..., Vol. 1-2006, V.2-2007, V.3-2008] became the impetus for the further development of the integral work in the field of wildlife management and conservation; this, for the first time ever, was carried by a public organization – the All-Ukrainian Ecological League, with the active participation of the national geographers. There was a flow of publications, including ones by geographers, on sustainable (balanced) development of Ukraine and its regions [Assessment of the outcomes..., 2004]. There began trends in the areas of research and development, which may be considered unique in the sense that some projects were customer-tailored and served the customer to achieve profit. At the Xth Congress of the Ukrainian Geographic Society (2008), a discussion of business-geography, initiated by scientists from Kharkiv, was specifically discussed. They understand business-geography as a body of different trends and methods of the use of geographical knowledge and approaches to investigate territories for business purposes and sound investments [Chervanyov, Ignatyev, 2008]. In contrast to the traditional application of geography, business-geography has all the features of a scientific enterprise (including the image and financial dependence of the fate of a participant undertaking such activity on its outcomes). This direction of geography requires a careful weighing of personal capabilities, strengths, and risks and avoidance of "bottlenecks".

In this review, we restrict ourselves to just a few examples of works of Ukrainian geographers. In general, in our opinion, in order to improve the innovative potential of geography and to expand its effective use, the priorities, at this stage, are as follows:

– determination of the overall strategy of the territory to achieve the optimal organization and harmonization of relations in the "society–nature" as the basis for relevant business sectors in the utilization of natural conditions, resources, and assets of the territory;

– creation of multi-purpose databases and knowledge bases for assessing existing natural and economic resources, the effectiveness of their use, and the rationale for optimization of the economic trends of land use;

– solution of environmental problems on the basis of assessment of risk, appropriateness, effectiveness, and efficiency of the use of the natural resource potential and environmental protection;

– assessment of the significance of geographic innovative industry developments to ensure the balanced development of objects of different hierarchical levels (national, regional, local) as well as improvement of the efficiency of the individual business areas in which we operate together with our Russian counterparts in the IAAS [Geographic aspects..., 1999];

– increase in accuracy and precision of geographical research using the established infrastructure of spatial data, information obtained at experimental sites, and monitoring the functioning of terrestrial systems (including, of course, economic and social information as well) [Bagrov, 2010].

We would also like to emphasize that now the specialization of research is not only objects-based, as in classical geography, but is oriented more toward problems and methods for their solution. This is due to the fact that geography became involved in the development of certain socially significant human and large regional problems receiving, along with it, the status of problem-oriented knowledge.

Geospatial approach is the leading mission of geography in such research and development [Rudenko, Gorlenko, 2010; Son'ko, 2002]. Geography is unique because only it accepts responsibility for the analysis and description of complex phenomena in their territorial combinations and interactions, introducing them to the public as an integral resource [Nahirna, Pidhrushny et al., 2011]. In recent history, methodologies, results of geographical research, and different visions of its essence have intertwined. It is normal to the science located at the crossroads. It is very important to preserve the pluralism of approaches, methods, and the mission. In this sense, we consider it necessary to draw attention to a number of fundamental provisions relating to the new challenges of our science.

Geography is the science about the resources of society (social development) defined by a certain territory (or water area). The novelty of the modern approach here is that the territory is now not only a cognitive object, as a carrier of properties, not only the placement of certain objects and interactions between them, but it also acts as an integral resource that represents its characteristic attributes; geography considers the territory as a unique formation of geosystems capable of self-organization.

The "geographic highlight" of this vision is that the territory as an integral resource creates a new property due to diverse combinations (spatial, functional, and spatial-functional) because the space of development is the most important, indispensable, and scarce resource [Rudenko, 2003; Rudenko, Gorlenko, 2010]. At the same time, in this interpretation of the territory (land, in the common sense), the land is finally recognized not so much as capital in terms of a productive resource of society (which is also important), but as capital valued even more than other forms of human capital. Moreover, it is capital of special properties. Mastering it makes geography some new "political economy of space," and the "key" for the disclosure of, as previously mentioned, the intangible features of the territory, interpreted, taken together, as the intangible natural asset [Bagrov, Rudenko, Chervanyov, 2010]. It should be noted that those countries and regions that have recognized this earlier than others are already receiving rent from the exploitation of this asset. From these considerations, the key scientific challenge follows, i.e., to develop a methodology that would be based on such requirements and would allow finding appropriate methods for evaluating and optimizing resources in their territorial integrity and the ways of their description, inventory, reporting, analysis, and synthesis – all that is covered by the vision of the territory as an integral resource.

In the natural science sense, the new quality should be reflected in the identification of properties caused by precisely such (and not by some other) combination of properties (the positional principle according to V.A. Bokov, G.E. Grishankov, and E.A. Pozachenyuk). But there are also economic, social, legal, and informational relationships [Bagrov, 2002], which are now left out the discussion, but should be borne in mind.

The subject of science is a conceptual point, which consists in choosing the answer to the question, what is the geography of today: the object-oriented science, which has the ontological evaluation of the form existing outside our mind material world and the section of the fundamental knowledge needed by science itself for the construction of its skeleton; or the subject-oriented and epistemological science and the combination of visions of the world – hypotheses, theories, laws, ideas about the subject; or, finally, continuously changing relational knowledge, i.e., object-object and subject-object, and also spatio-historical and relative?

The situation in this third vision of geography is exacerbated by the fact that the carriers and users of knowledge about the environment ("environment" in the common usage in the former Soviet Union, or, according to the world's scientific concept of "environmentology") are other professionals and especially – public figures. It should alert geographers: we are missing something if, contrary to the established status of the ancient classical geography, humanity has been forced to seek new, still growing, but extremely active areas of knowledge.

The purpose of this paper is to discuss the model of building the "new geography". This problem has been discussed many times in Ukraine. In staging and methodological approaches (not always under this specific term), it adequately reflects the "collective wisdom" of the authors of the publications [Bagrov, Rudenko, Chervanyov, 2010; Bagrov, 2010, Geographic aspects..., 1999; Petlin, 2010; The spatial analysis..., 2009; Rudenko, 1999; Ukraine: main trends..., 2005; Shabliy, 2001; etc.]. Addressing the problems of this "new geography" allows implementation of the principles of strict science and their incorporation into the fabric of geographical knowledge; it serves as a model that organizes it.

Thus, the specific question is what are the distinct differences of geography in respect to other and primarily to related fields of knowledge and what are its indispensability and uniqueness? With this in mind, let us focus attention on the *ways of formation of geographical science*.

THE OBJECT-ORIENTED APPROACH

More often in the national science of the last century (and implicitly now), the main attribute of fundamental science was considered to be a material object of knowledge, which would exist independently of a certain dialectically defined form of matter motion. In this respect, geography was not able to achieve success, even though the problem of finding a place in the chain of material forms was addressed by such outstanding scientist as A.A. Grigoryev; V.S. Lyamin attempted to incorporate a kind of logical "loop" into the system of forms of matter in motion, which covered several well-known forms – however, unsuccessfully.

We believe that the reason for this failure is that the object of knowledge was identified with the object of science. The areas that, in our opinion, are lacking sufficient attention are as follows:

1. Understanding differences between the ontological essence of what is the target of cognition (*the natural object*), cognitive epistemological object (*the object of scientific geography*), which is isolated from the object of science through its paradigm, method, and aim, and the subject "constructed" by a researcher (by science directly) and then studied: simulated, refined, improved, etc., in a certain logical loop of the learning process [Chervanev, Bokov, Timchenko, 2004].

2. A clear awareness that the scientific object and the subject (the latter in particular) ***are not*** the segments of the material world (in the common usage of the word). They must be the internal (for science) images of the external material reality, but existing as the ideal constructs. In the information world, they may not have realistic analogues (to be the purely epistemological positively oriented constructs).

3. Observance of scientifically defined rules (the theory of similarity) where scientific knowledge about the object (subject) is transferred to the natural object or exists by itself as knowledge about the perfect

model constructs, becoming the foundation for obtaining the next level of theoretical knowledge, etc. [Dyakonov, Kasimov, Tikunov, 1996].

4. The fact that geography is able to study not only the material environment, but also the virtual environment. It most of all relates, apparently, to socio-economic geography and geographical mapping, covered by information geography. After all, in this and in other aspects of geography, a scientific object is constructed from the secondary, tertiary, and other information that does not have, so to speak, a material primary natural object (e.g., identification and mapping of electoral preferences). Cyber-maps that have appeared recently (maps of cyberspace), mental maps, and other are in the same category of the virtual objects of research [Bagrov, Rudenko, Chervanyov, 2010].

THE SUBJECT-ORIENTED APPROACH

It is commonly known that the same object may represent a number of research subjects. We should add that, for true science, it is essential to learn to abstract away from a natural object for the sake of creation of its scientific objects, i.e., of the perfect representation (ideal model). This requires a priori determination of the essential aspects of the ideal model – the subject of research (conceptual, structural, functional, simulation, synergetic, and any other model of a research object). If, in the middle of the XXth century, philosophers and geographers were able to evaluate, for example, the teachings of A.A. Grigoriev about the single geographical process, it would have allowed avoiding a known conflict, which has put the outstanding scientist to his knees – he has designed his own object of study in the form of the geographical environment and its dynamics – a single physical-geographical process [Academician..., 2011].

Note also that spatiality and complexity are considered the attributes of knowledge and a measure of the geographical content since N.N. Baransky.

Spatiality. The treatment of spatial relationships varies from a fairly simple, according to A. Hettner, interpretation of chorology to a very complex investigation of the metrics, topology, and organization of space [Lastochkin, 2002] and the territory [Rudenko, Gorlenko, 2010; Son'ko, 2002]. These (and other) works show that there is not only and not so much a renaissance of science propagated by Hettner, as a significant deepening of science, methodology, and instructional equipment of spatial analysis as specific means of knowledge about organization of geosystems. At different spatial scales, the chorological approach is expressed differently; it has also a hierarchical structure of "embedded spaces". In no other science, except for a family of geographical sciences (if geology is also included), the chorological approach and its inherent methods of spatial identification, function, location, and neighborhood are not, perhaps, as important as in geography. It becomes clear that in no science there is space as comprehensive as in geographical sense – a certain order of objects co-existing at the same time. There are no properties of inhomogeneous space, such as anisotropy, anisomorphism, and respectively, properties derived from them: originality, noncommutativity, and irreversibility. No complicated forms of symmetry are sufficient to determine terrestrial objects. All of them are isolated as subjects if the "new geography" is aware of the relevant cognitive structures – the research object (unlike a natural object) and the scientific subject.

From the viewpoint of the authors, three aspects of understanding of the spatial aspects of geography are important and timely:

– the introduction and development of the concept of "geographical topology of space" with the fundamental concepts of "type of space" (Euclidean, spherical, conical, bilateral) and its derivatives – "symmetry", "position" and "neighborhood";

- the introduction of geographical realm as continuity of research of simultaneously co-existing objects;

- the introduction of abstract space of properties and characteristics – usually multidimensional, being isolated from the continuum of properties.

Complexity. By the definition of N.N. Baransky, this is the second attribute of the geographical content of the object-oriented approach. During the last 30 years, complexity has been also sometimes identified with systematicity as a certain criterion of geographical typology. This conflict has been adequately presented by V.N. Petlin [Petlin, 2006, Petlin, 2010]. But not even once have the researchers determined the necessary and sufficient list of delineating attributes that should always be followed in determining the cognitive status of the subject matter of geographical research, battling each other in nuisance: in fact, as noted above, it is possible to construct a set of subjects on the same object of research. Because of this, analyticity (for components and geospheres), complexity, and systematicity are different subject constructs reflecting, in varying degrees, various aspects of the research object.

At the same time, more and more the "up-to-dateness" of a geographer is determined by how he/she looks like an expert in a very narrow particular subject area, e.g., analysis of remote sensing information, computer processing of geodata, GIS technology, etc. [Kostrikov, Chervanyov, 2010; Lastochkin, 2002]. Consequently, there is a specialization of research not only in terms of the objects, as in classical geography, but more through the subject and method of research. A presentation of the landscape synergetic principles by V. Petlin is a fair example of the newest approach in landscape research. He believes that the synergetic approach based on the principle of system integrity rejects the classical approach in landscape research, which is based on the postulate of homogeneity. This is an extremely important and necessary process for geography in general.

THE PROBLEM SOLVING APPROACH

The third methodological approach in geography that exists in reality has been discussed rather apart from other issues and, at this point, vaguely; this is the problem-oriented approach. We would like to recall unconditional success of such geography, for example, of the development of regional environmental management in Ukraine. This extensive research program was overseen by the National Academy of Sciences of Ukraine and was implemented by the efforts of geographers unified through the regional centers of the Ukrainian Geographic Society for more than ten years. The results have been recognized through the awarding of the State Prize of Ukraine to a cycle of monographs on the regional resources management. Since then in Ukraine, constructive geography, which had been conceived by I.P. Gerasimov specifically as the problem-oriented branch of geography, exists as a scientific field and as a specialty at universities and the State Commission for Academic Degrees and Titles.

The prospect of the participation of geography in the development of different urgent issues is also promising. Medical geography has existed as such branch for quite a long time; more or less known various other branches of geography – military, reclamative, and environmental. Another convincing example in favor of the high potential of the problem-oriented concepts of geography are solid modern editions of the Institutes of Geography of the National Academies of Sciences of Russia and of Ukraine, devoted to the geographical aspects of sustainable development and the interaction between society and nature [Geographic aspects..., 1999, Assessment of the outcomes..., 2004, Ukraine: main trends..., 2005]. The discussion of the problem-oriented approach as a methodological problem opens a fundamental "Social Geography", by

A.I. Shably [2001]. We should also note a useful attempt to teach environmental management at the geosystem level [Romanov, Yaromenko, Martyniuk et al., 2010].

Having presented the aforementioned information, we should try to define the relationships that exist between the object-, subject-, and problem-oriented approaches in geography and how these approaches should be treated. The attitude of geographers to these three approaches, which assume significance of "three geographical dimensions", is ambiguous. Some scientists believe that it is impossible to be just a geographer without having determined which subject domain a geographer have mastered and may be trusted, so to speak, as a guru. On these grounds, there is the separation of physical, economic, and social geography, where each of them, in turn, is divided into branches based on the principle of dichotomy, regardless of how this "tree" is called as a whole. Others, with a different degree of flatness, deny this, insisting that a geographer is only a "synth" of knowledge about the territory. The followers of this vision of geography contract experts from particular fields (geophysics, landscape geochemistry, regional economics, demographics, etc.) for the analytical work. These methodologists position the synthetic approach (often regional analysis), as a positive one, against the subject-methodological differentiation of geographical science, as a definitely negative concept.

Evidence that synthetic geographical thinking, which previously was the subject primarily in educational fields, has acquired the scientific and constructive significance is associated with progress in addressing economic, social, and environmental problems of social life, with improvement of research of phenomena in the geosphere, which translates epistemologically into the polysystem methodology [Son'ko, 2002] and even into an entirely new paradigm of science (analysis by A.G. Topchiev of the aforementioned intentional paradigm [Topchiev, 2010]).

THE "NEW GEOGRAPHY"

Geography teaches a person to compile the image of the World from a variety of scenarios and, largely, through reflection. People have been puzzled for centuries trying to explain ***geographic phenomena***, limiting themselves to observation and logical explanation (approximately at the level of formalism of black or gray boxes in cybernetics). A deeper knowledge was frequently not pursued, because the explanation of phenomena that have already occurred is already controlled by the past and is socially irrelevant.

With the space age began the phase of the ***informatization of geography***. The emergence of technical instruments provided opportunities to obtain an enormous flow of information. Then, there was the emergence of GIS technology, which allowed better integration of geodata. These two factors combined have led to the loss of the very need in obtaining primary information related directly to the geography of the Earth, which has always been the preference of geographers. Studies of human environment – the original object of geography – are becoming the subject at the junction with technical sciences (technical geography according to V.S. Preobrazhensky). Under this influence, the primary scientific geographical knowledge goes by the wayside, drops to the second-rate importance, and the study focuses on specific ways of visual perception and the increasingly sophisticated visual analysis of certain territorial integrity (in both physical and economic geography, and therefore, they should no be separated).

As a vivid example of such a transformation of relationships, we should mention the drift of the concept of "landscape" – the fundamental concept in the empirical branch of physical (and now in economic) geography, and derived notions of "landscape organization", "landscape planning", "image of the landscape", "landscape architecture", etc. In the past 20 years, this concept has transitioned from a fairly unique concept of a specific (landscape) level of geographic shell (it had only three aspects of consideration – regional, typological, and individual) to a variety of interpretations, mainly aesthetic categories important culturally, however retreating from geography [Grodzinsky, 2005].

Somewhat generalizing the situation, we should also note that there appeared a "dualism" of the landscape science:

– First of all, landscape science continues the traditional study of natural territorial complexes as a reality, that is, of ontological objects; hence, landscape science in this respect remains the branch of natural science, as it has been treated beginning from A. Humboldt and Z. Passarge, the classical landscape scientist V.V. Dokuchaev (through the soil landscape), F. Ratzel (through "soil" geopolitics), the most consistent proponent of the classical materialistic view of the landscape L.S. Berg; then it was continued by N.A. Solntsev, K.I. Gerenchuk, A.G. Isachenko; and now, in this sense, it is examined by V.A. Bokov, A.V. Melnik, V. Petlin, etc. The latter introduced this subject fully in the aforementioned constructive landscape study [Petlin, 2006] having created a sort of the "multi-vector" antithesis to M.D. Grodzinsky's landscape approach [Grodzinsky, 2005].

– At the same time, landscape studies have returned to the roots of the original non-geographic concept – as the subject of cultural studies for consideration of a much broader, but the diffused scope (as is characteristic of humanities). This is an image of space, significantly different (up to the opposite extreme) in the different visions of different ethnicities, different cultures, and even different strata of society; the different standards and assessments, as we can read with interest in L.N. Gumilev's and D.N. Zamyatin's works. A good deal of interesting and diverse discussions about this subject is presented by M.D. Grodzinsky (and not only in the two volumes cited above, but also in other works, such as on landscape aesthetics). Obviously, this dualism divides the cognitive process: to some extent undermining the basis of the classical landscape studies while simultaneously giving more weight to the general cultural vision of space ("meta-geographic" according to D.M. Zamyatin). Everything has a meaning, but also takes its toll.

We think (contrary to the alternative assessments) that the landscape should be viewed as a complex territorial resource, together with properties of space and a set of individual resources that are not normally associated with the landscape. In this sense, we remove the conflict between the two alternative visions – physical and cultural geography.

NATURAL CAPITAL AND GEOGRAPHY

A set of two possibilities – a clear expression or delineation, on the one hand, and the expansion of the "field" of values for the humans, on the other hand, allows one to take another important step – to give the landscape a pragmatic status of natural capital in a very broad interpretation of the rather important concept of post-nonclassical environmentology.

In our perception of the post-nonclassical economic vision of the problem [Bagrov, Rudenko, Chervanyov, 2010], this is a set of three components:

– share capital of the common use resources: air, water, and vegetation, in the situations where they can not be isolated, alienated, or become the objects of civil law. As necessary conditions for life and its comfort, these properties now serve as the values that are in the structure of business, facilitating (or hindering) profit;

– critical capital of some properties and relationships inherent or missing in the environment (geosystems): water in arid areas, groundwater position, the manifestations of adverse exodynamic (maybe endodynamic, but we do not know exactly) processes, etc.; in each case, the presence / absence of this, that, or other properties, or their combination changes the view of other components of the natural capital;

– the anthropogenic component of natural capital (we should note now, to not dwell on this later, that the south coast of Crimea is now almost entirely man-made).

WEAKNESSES AND STRENGTHS OF GEOGRAPHY

Geography has little knowledge refined to the natural science law; it does not have its certainty, a manifestation of an irresistible force (such as the physical, chemical, and, in part, biological laws). Geographical knowledge is probabilistic since it correlates with stochastic systems. It is nonlinear, because a geographer will never say with confidence that A inevitably follows from B. However, quite often a geographer can name many potential impacts, several chains of interactions, and much more, following a kind of special geographical logic: geographical analogies, indirect observations, specific experience, etc. How does a person thinking geographically, with virtually no possibility of a rigorous proof, accomplishes it? N.V. Bagrov states that it is done through a certain individual sample matrix of relations that humans create, develop, and maintain continuously in their minds, both individually and as members of society, that is, through culture. A geographer calls it *the world reflection matrix*, referring to the multi-faceted human world. Due to the presence in the mind of such a matrix, humans more or less successfully cope with cognition of the difficult undifferentiated (not refined) systems generated by the various states, fluctuations, etc., and forced or spontaneous inhomogeneities. With this, geography more clearly and adequately, although less precisely and often little less formally, characterizes the existing world order. N.V. Bagrov calls this order (spatial, spatio-temporal, and functional), by analogy with the previous matrix, *the matrix of world comprehension*. The way in which geography is forming the image of the World is important. Try to drop geographical knowledge of high school (at times, there were attempts to do so, and still, not in each country, geography is taught in school) and make an image of the World from the refined physical (chemical, biological, and social) laws. Indeed, in each case, one has to solve such, for example, tasks:

A) what are the laws manifested at the moment and specifically here?

B) how do they interact (repeated each time), depending on specific terms of engagement and the environment?

C) why other physical (chemical, etc.) laws do not manifest themselves? And so on.

We are confident that this will not work. Physics, chemistry, and biology, in some sections, strive toward the purity of knowledge, go to the depths, but they lose the broad scope in the process. For the sake of the purity of an experiment, they remove all side effects that complicate the matter, or just random factors, which force them to go to laboratories, to instruments, to an unbelievably sophisticated experiment in an incredibly refined conditions, etc. Geography walks along a radically opposite way, seeking to know phenomena in their entirety, without dismembering, "in-situ", as close as possible to their natural conditions. This makes the task incredibly difficult to solve, however, no other science does it.

GEOGRAPHY, SOCIETY AND PUBLIC CONSCIENCE

How are these motions manifested in educational geography and real geographic research? Primarily as a kind of eclecticism: in the fundamental part, from the standpoints of natural philosophy and, to a certain degree, of the exact (instrumental) natural science, but in a much more simplified and, regretfully, an arbitrary form, i.e., outside the strict system of knowledge – from the point of view of country studies that were formed in the epoch of the Great Geographical Discoveries. In the sectional disciplines, the presentation is very often associated with translation into the common knowledge of specific concrete achievements (visions, concepts, points, of view, well-known names – therefore, again, in the natural philosophical way. Regarding the dualistic approach, it is being "washed out" of geography via its artificial separation into groups of disciplines among the physical-geographical and the socio-geographical fields, through which the aforementioned duality nourishes the "great" ecology representing the extremely beneficial source of knowledge about the environment to it. This situation's outcomes and tolls for the geography are well known.

The relationship of geography and society are manifested in the highest degree through problem-oriented solutions, or participation in programs and projects. Previously, these were planned activities, as a rule, large-scale economic projects. Nowadays, there is none, and problem orientation is limited to aspects of geoecology, territorial organization, recreation, population distribution, and the creation of protected areas.

But there are exceptions in the current difficult conditions: the consolidation of all geographers (and not only) in the problem-oriented projects that target the integral representation of the product (the general scheme of planning of the territory of Ukraine, the National Atlas of Ukraine, the pilot edition of the Environmental Atlas of Ukraine, landscape planning, etc.).

In different countries or sectors of society, different geography or, rather, different mentality prevails and manifests itself in the understanding and design solutions. Everyday consciousness is focused subjectively. It is largely self-centered or, at best, anthropocentric: only pragmatically significant issues are under attention. Why have ecological studies prevailed so quickly over geography, biology, and even physics? Because ecology includes problem stating and knowledge that is constructed based on the object-subject principle oriented, however, subjectively. People in general care about what relates to their own (personal, group, corporate) interests: what is helping or, conversely, preventing satisfaction of basic needs.

GEOGRAPHICAL SCIENCE AND EDUCATION

How are these processes manifested in educational geography and the actual geographical research? What is the solution? We believe there are two ways to improve these relationships.

The first way is palliative: keep the content of geographical education in schools and recompose it as follows: in primary school, whatever is possible through observation, contemplation, or a school experiment (geographical test plot, weather monitoring, monitoring of the school territory); in middle school, through whatever connects geography with physics, chemistry, and biology, i.e., through ecology; in high school, through such aspects as geosciences, geography of the world economy, political geography, that require a completion of the formation of *the matrix of world comprehension*.

The second option is radical. It requires the separation of school geography from geographical science. It involves the formation, in school, of *the world reflection matrix* (initially, using local history and, then, country studies and national geography); *the matrix of world comprehension* should be addressed through interpretive geography (geographical method, its application in everyday life, in analysis of environment, even in modern global problems assessment). Then, all this should be done based on a plan, a map, or an atlas, with the mandatory active use of modern audio-visual mapping, GIS technology, and educational web programs for achieving knowledge. In this second approach, school geography is much different – it may be more socially perceived and more focused. The time would demonstrate the effectiveness of this approach.

THE ACHIEVEMENTS OF THE "NEW GEOGRAPHY"

It is unlikely that we will be able to cover, in one paper, all the achievements of the "new geography." The choice will be driven primarily by several examples in those areas in which the authors are involved.

The geographical dimension of regional geopolitics. Increasingly, geopolitics is considered as political science, with which we have difficulty agreeing in principle. This is because traditional geopolitics as a form of gaining power by influencing spatial relationships of countries has been known for a long time, and its "power" doctrine as often admired, as condemned. There are issues to discuss from a political-geographical point of view. Geopolitics as a branch of knowledge, which has reached a certain degree of institutionalization (the large number of textbooks, curricula, university departments, the emergence of such institutions as the Academy of Geopolitical Problems), is actively "professing" and transmitting to neophytes (and to general masses of the population) a series of its own ideas and conclusions, not being able, however, to become a fully *scientific discipline*. In other words, a certain professional community has formed around geopolitics, but there are still no disciplinary rules and restrictions that actually transform this or that branch of knowledge from the similarity of "art" and "craft" into a *"scientific discipline"*.

In Ukraine, primarily due to the efforts of the emerging regional geopolitical school of V.I. Vernadsky Tauric National University, geopolitics has remained in the realm of geography, but much has changed in the direction and status. The most powerful and productive school of geopolitics of the Crimean region has actively introduced itself into the concept of the development of the Autonomous Republic of Crimea (ARC) as part of its paradigm. This paradigm, in particular the following fundamental points: the awareness and adoption, including – through the Constitution of the ARC – of the special status of Crimea as the *central element of the Eurasian geopolitical space* (which, incidentally, almost 10 years later, was accepted even by such a world-known geopoliticican as Z. Brzezinski) is the proof of the fact that the development vector of Crimea should be different than the one that exited during the long preceding period. Crimea should become the paragon, model, and proving-ground of *the post-industrial noospheric sustainable development* [Bagrov, 2010]. We will not review the problems and substance of "neogeography", a concept introduced into science by E. Turner (2006), because the representatives of "neogeography" have confused geography with cartography (we are referring to geographical data in raster formats in a single coordinate system using the open hypertext format).

Geographical study of alternative energy. The regional energy crisis, with Ukraine turned out to be in its center, showed the necessity of transformation of energy policy. The concept of Energy Program adopted recently presents the "30 + 30" model – with the target to achieve, by 2030, 30% of energy production from alternative sources.

Any geographer understands that alternative energy sources are a new natural resource. It is either natural objects, or processes, or products with a certain attitude toward them, and therefore requiring an appropriate geographical support. Two Ukrainian Universities – Tauric and Kharkiv – are jointly working on the problems of alternative energy as the potential for its development. Tauric National University created one of a kind UNESCO Chair "Energy Ecology and Sustainable Development" (2005). There is every reason to believe that this line of research that combines geography and very promising business (in Ukraine, there are nearly 10 major non-governmental wind and solar power plants), will also raise interest in the "new geography", filling it with a non-traditional content.

Territorial planning. The territory as the object of complex geographical research is the eternal field of activities of geographers. In the current conditions in Ukraine, there have been fundamental changes in this area. The Land Code of Ukraine has been adopted (2002); under this Code, there are three forms of land ownership possible: state, collective (municipal), and private; governmental property has lost its traditional priority. Ukraine ratified the Convention on the establishment of the Pan-European Ecological Network (2002). The interest in land management among the new landowners has intensified, while environmental conflicts related to the proximity of various forms of land use and other traditions of land management have become more frequent.

In such circumstances, the spatial mission of geography is reappearing at a new level. The new vision of the integrated potential of the territory in the context of economic activities at the regional level, as an independent resource for development, appears highly promising in terms of the overload of the most part of the territory with commercial facilities, what we see by analyzing active geopolitical, geoeconomic, and other relationships, conflicts, and alliances. We see in practice the correctness of the theoretical concept of geoversum whereby geospace reflects, explains, and allows one to organize co-existing terrestrial space objects of different quality (territorial management) [Bagrov, 2010]. Geospace is becoming an attractive environment resource, particularly for land business. Naturally, the concept of land capital (the main part of natural capital) has become apparent. Land rent is the basis of monetary and fiscal valuation of a land owner's relationships with the State. It can potentially fill the treasury of some main regions such as Crimea [Bagrov, Rudenko, Chervanyov, 2010]. These opportunities remain still just a potential and they require a profound professional definition, cataloging, and studying for their transformation into economically relevant resources, and deployment of sustainable resource use technologies attractive to both the government and business. Unfortunately, these solutions are still rare, but they already exist (for example, the aforementioned the integrated territorial planning schemes of Ukraine, approved in the form of the Law of Ukraine in 2002).

It is known that in the Soviet Union there existed a certain dualism in the organization of the territory: theoretical issues have successfully been developed by geographers (often in collaboration with foreign counterparts), but the practical side of things were implemented by agricultural science and urban planning. This led to different interpretations of the problem, of course, of geoengineering.

Currently, the scientific-practical direction of territorial analysis based on theoretical principles of B. Rodoman and A.Yu. Reteyum, on methodological works of K.N. Dyakonov, N.S. Kasimov, and V.S. Tikunov, generalized for Ukrainian conditions by V.A. Bokov, Ye.A. Pozachenyuk, and A.G. Topchiev, is developing. There are several geographical centers for territorial planning, including the one most practically advanced – the Tauric. Here, over 10 years ago, the Scientific Center for Sustainable Development Technologies has been established at V.I. Vernadsky Tauric National University. This Center is focused on planning of territorial facilities [Bagrov, 2010]. Similar studies are conducted at the Institute of Geography of the National Academy of Sciences of Ukraine and other regional centers.

CONCLUSION

The discussion presented above allows us to conclude the following:

– geographical science has its own field of research, which is not covered by any other science;

- geographical studies integrate new knowledge and information about space due to the high significance of the concepts of location, purpose, and development resources;

- geography in Ukraine, preserving and developing the traditions of the Russian geographical school, is looking for its own scientific concepts and methods of implementation, seeking to be the "growth pole" of environmental economy, in order to become, in alliance with it, a "new geography" at the science forefront ensuring the sustainable-noospheric development. ■

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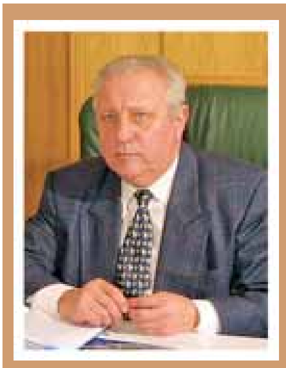

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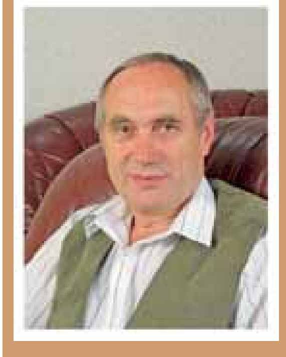

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DIVERGING DISCOURSES ON THE SYR DARYA

ABSTRACT. The hydraulic mission of the Soviet Union has transformed Central Asia's Syr Darya River into a governable entity. After the dissolution of the Soviet Union the river system disintegrated and conflict arose over the operation of the main dam and reservoir of the river: the Toktogul. Uzbekistan and Kyrgyzstan have widely different and diverging sanctioned discourses on how the dam should be operated and on the nature of the water itself. These discourses have had a significant impact on the hydro-politics of the river basin and the operation of the dam. The central argument of this paper is that both the decline of the Aral Sea, and the potential conflict between the states are driven by the same modernist governmentality of the river.

KEY WORDS: hydro-politics, governmentality, critical geopolitics, Aral Sea basin, Syr Darya

INTRODUCTION

In February 2011, the United States Congress discussed its foreign policy strategy for Asia, an important component of which turned out to be water security in Central Asia. The report for the meeting suggested that: *"the United States cannot expect this region to continue to avoid 'water wars' in perpetuity"* [Kerry et al., 2011: 12]. This statement echoes the oft-cited prophecy of the vice-president of the World Bank, Ismail Serageldin, that the wars of the future will be about water, not oil. Given its particular geopolitical history, the countries of Central Asia have frequently been singled out as a hotspot for this type of conflict.

However, no large violent conflicts have materialised so far and there seems to be consensus in academic circles that wars over water alone are highly unlikely [e.g. Allan, 2002; Wolf, 1998; Zeitoun & Warner, 2006]. Nonetheless, the study of the geopolitics of freshwater resources – "hydro-politics" – remains important for other reasons. Conflicts over water can take many forms that impact daily lives, national economies, and international politics [Yoffe et al., 2004]. Central Asia in particular, is an interesting case study because of its unique geopolitical setting, with domestic river basins becoming international rivers with the dissolution of the Soviet Union. This has provided sets of challenges that have not been addressed, and that are frequently misunderstood. It is the goal of this paper to contribute to the understanding of hydro-politics in Central Asia by looking at the particular modernist mentalities that have made the Syr Darya a "governable" river.

With the Syr Darya and Amu Darya Rivers, Central Asia is relatively water abundant, although the distribution is highly unequal. Fig. 1 shows a map of the area with the two main rivers that terminate in the Aral Sea indicated, as well as the distribution of flow generation and flow abstraction among the five republics. Both rivers are fed by glaciers and snow melt from the Pamir and Tien Shan mountains, whose influxes of water are highly variable. The agriculture-driven economies require much water, also in places where it is not naturally available, but the Soviet authorities have constructed extensive networks of canals, dams, and irrigation works to ensure continued

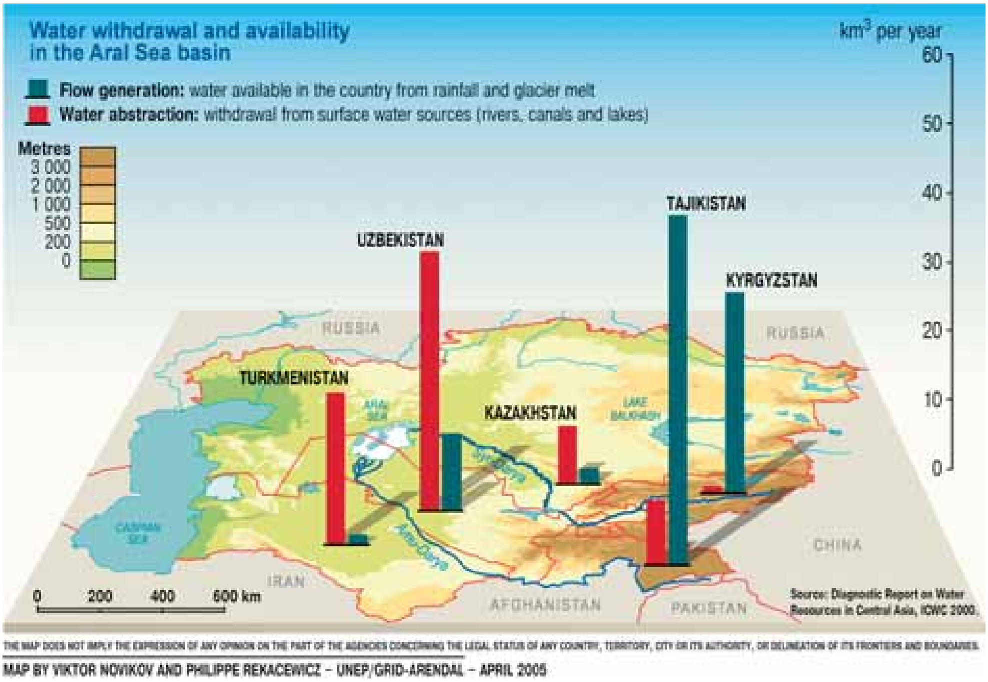

Fig. 1. Water withdrawal and availability in the Aral Sea basin. The two main rivers, the Amu Darya and the Syr Darya are indicated.

Source: *UNEP 2005*

productivity. Unfortunately, this modification of the natural flow of the rivers has had dramatic consequences for its terminal lake. The Aral Sea virtually disappeared, after most of its inflow had been diverted for irrigation [Micklin, 1988].

To understand how the river was managed during Soviet times and how the tension between the riparian states has developed, I draw from Michel Foucault's work on governmentality and its application to the rule of nature and rivers in particular [Agrawal, 2005; Foucault, 1991; Rutherford, 2007]. There has been considerable debate around the meaning of governmentality theory, but I follow a close reading of Foucault original texts. Governing, according to Foucault, is the construction of regimes of truth and the dissemination of these truths through discourses, practices, and disciplining techniques. Spreading these truths takes places beyond the state itself and across social networks and societies.

Rivers can be made "governable" through the material construction of facilities like dams and canals, but also through the discursive construction of goals of government and normalising practices. The way dams are perceived by a society as modernising forces and "use it or lose" it mentalities are part of the regime of truth constructed by the leaders and play as important a role in governing the river as the dams themselves do. The combination of the material and the discursive composes, what I term, the *governmentality of a river***.** Governmentality theory distinguishes itself from alternative theories of rule, like Putnam's governance theory or Gramscian hegemony theory by looking at *how* power and rule work [Dean, 1999].

In this paper I argue that there are parallels between the decline or the Aral and the water disputes in the region. The Central Asian rivers have been made governable by certain practices that are expressions of particular nature-society relations, distributions of power, and development strategies, yet these do not reflect the demands of local populations. In Soviet times, a governmentality that over-emphasised cotton productivity for a political centre far away (Moscow) led to the decline of the sea. After independence, multiple ways of governing the river emerged, favoured by different national elites that clash in form and content. The parallels suggest some important questions: who governs the rivers for whom, in what interests, and how?

MAKING A RIVER GOVERNABLE, SOVIET-STYLE

Irrigation has taken place in Central Asia for centuries, but it was the hydraulic mission of the Soviet Union that truly transformed the geography of Central Asia[1]. Making the river a manageable entity included the construction of dams, canals, the foundation of scientific institutions and a hydraulic bureaucracy, but also the discursive justification of large-scale irrigation and other interventions [Molle, Mollinga, & Wester, 2009]. Indeed, the transformation of the Syr Darya and Amu Darya Rivers was guided by a particular *governmentality of the river* that included both material and discursive "technologies of government".

It was water that brought the Russians to Central Asia in the first place. There is archaeological evidence that the areas around the Amu Darya and Syr Darya Rivers have been under intensive irrigation since at least 8000 years ago [Lewis, 1966]. When the Russians conquered Central Asia in the 1880s, about 2.5 million hectares were irrigated, but the Tsarist colonisers realised that this area could be increased easily and rapidly [Petrov 1894 in O'Hara 2000]. The region was seen as a *"reservoir of raw material [...] and a haven for land-hungry peasants"* [MacKenzie, 1974: 168]. Financing projects was difficult during Tsarist rule, but this changed when, after the Civil War, large state resources and energy could be directed to water development [Micklin 1991].

Nonetheless, managing Central Asia's water for irrigation proved quite a challenge. Scarcity itself was not the problem: on average there is sufficient water in the basin for the population to feed itself and grow cash crops for exports, [Wegerich 2002]. Instead there is spatial and temporal variability that makes irrigation complex [Nezlin et al. 2004]. Virtual all water comes from mountainous Kyrgyzstan, whereas the irrigation takes place in the plains of Kazakhstan and Uzbekistan. The vast majority of precipitation is in winter, but the growing season in summer. Moreover, there is huge inter-annual variability that is difficult to predict, see Fig. 2. This variation in river run-off has been a daily reality for the farmer and an inconvenience for the irrigation engineer. However, it also provided the Soviet planner with a highly complex problem. While the variability causes uncertainty in agricultural yields, achieving the goals of the 5-year plans became a huge challenge.

But river variability can be managed by building water storage facilities in the river and this was a solution close to the Soviet planners' hearts because it also offered a chance to demonstrate society's dominance over nature. Although the construction of dams and canals was nothing new in Central Asia, the size and pace at which modifications to the river's natural flow were introduced were unprecedented. Under Soviet rule hundreds of dams were constructed, canals were dug and artificial lakes were created, but the period is best characterised by a number of enormous state-led projects like the Kara Kum Canal, the reclamation of the Hunger Steppe, and Khrushchev's Virgin Lands Campaign [Hannan & O'Hara 1998; Rumer 1989]. Figure 3 demonstrates the enormous increase in dams and water storage facilities since the 1960s. Effectively,

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[1] The hydraulic mission is the pervasive modernist idea that all freshwater resources in a basin should be used to benefit mankind. Its practices include the damming of rivers, construction of irrigation canals and, often large-scale, diversion schemes. Allan defines it as *"a feature of modernity, a term used to describe the processes of change in the industrialising North of the late nineteenth and the twentieth century"* (Allan, 2002: 28).

Fig. 2. Water flow measurements at the Toktogul site over the last century. Horizontal line is the average. There is a significant variability in water inflow over the years, making the irrigation systems complex to run without inter-annual storage facility. Graph constructed by author based on data from cawater-info.net, n.d.

the dams, canals and other large schemes produced a river that was governable by bureaucrats rather than by farmers.

The epitome of control over the Syr Darya was the Toktogul dam and reservoir. Where other dams were unable to deal with the inter-annual variability, the Toktogul was the only reservoir in the river that had the capacity to store water for multiple years. Its maximum capacity of 19.5 km^3 was of a different order of magnitude than the others. When the reservoir was commissioned in 1973 the supply of firm water resources downstream increased by more than 30% [Antipova et al. 2002]. With this dam completed, the natural cycles of the Syr Darya seemed *tamed* at last and nothing would stand in the way of development (and cotton production).

The construction of dams and canals was the physical manifestation of the governmentality of the river, which was guided by the modernist discourse of society's relation to nature following certain aspects of Marxist-Leninist ideology. Rivers are perceived to be part of a nature that needs to be controlled by mankind. This is because

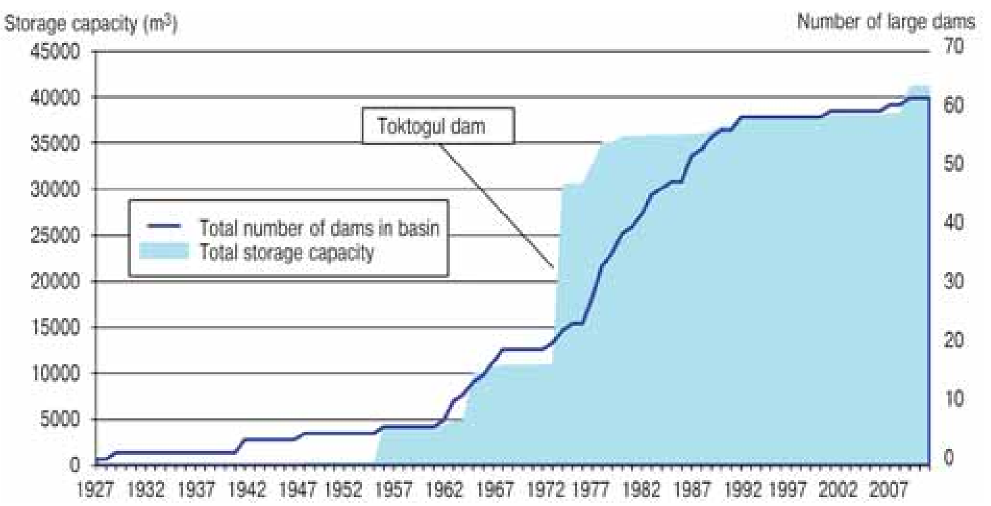

Fig. 3. Increase of number of dams and water storage capacity over time. The largest increase in storage capacity is the inauguration of the Toktogul reservoir. Graph constructed by author based on data from cawater-info.net, n.d.

an uncontrollable nature was equated with uncontrollable social norms, which was a real fear of the Soviet authorities [Oushakine 2004]. Zonn [1999] acknowledges the role of ideology in the water management and irrigation strategies of Soviet Central Asia. He argues that the concept of cotton self-sufficiency and the idea that development is directly related to land reclamation have contributed to the decision to divert water away from the rivers.

Indeed, the construction of the Toktogul was not only significant for its economic benefits, but also because it reaffirmed the power of the Soviet Union that placed society in a position to control nature. Slogans that celebrated its construction stated: *Naryn, serve the people!* According to Feaux De La Croix [2011: 495], *"Like other giant modernist projects, [...] the dam was an emblem of science altering geography to serve humanity".* The Toktogul and other reservoirs have made water seem like a free, common, and unlimited good and the Amu Darya and Syr Darya were stripped from their environmental, social, and cultural contexts. This had its implications on the volume of water that is being used in Central Asia's highly inefficient irrigation systems.

Through certain practices the river is made governable by bureaucrats and taken outside of its natural context. Although the concept of governmentality was conceived of by Michel Foucault to discuss the rule of societies [Foucault, 1991], it has frequently been used to describe the rule nature, and people in relation to nature too [Agrawal, 2005; Rutherford, 2007]. Governmentality theory suggests that the hydraulic mission is not innocent economic development, but the product of deliberate political strategies to serve the interests of certain elites.

The increased cotton output that followed the construction of the dams greatly benefited the ruling elites in Moscow and Tashkent, but certainly not everyone. The most well-known victim has been the Aral Sea and the people living around the sea. During the dam construction boom in the Syr Darya and Amu Darya River, the Aral Sea, as terminal lake in the basin, lost 90% of its volume [Micklin, 2007]. Desalination, heavy pollution, and dire economic and social decline were the consequences of this. The once large fishing industry collapsed completely [Glantz, 1998]. This ecological disaster is a direct consequence of Soviet strategy for managing the rivers, although these consequences were probably not intended.

The authorities had the illusion of a river that was perfectly manageable through the dams, irrigation canals, and central authority: an image of high-modernity. In fact, the Central Asians rivers were over-utilised, undermanaged and misappropriated causing, one of the worst man-made catastrophes [Spoor & Krutov, 2003]. The Aral Sea itself is seen as lost by most local and international observers. The international donor community supported the Central Asian states by founding, in 1992, the International Fund for Saving the Aral Sea. But in contrast to what its name may suggest *"its activities are no longer intended to save the Aral Sea, [because] it is too late to save the Aral Sea"*[2]. However, the underlying governmentality that caused the decline of the sea is, albeit in different forms, still there and potentially causing more worrying problems.

One singular vision on how to manage the water resources in the basin has split into multiple competing versions, after the dissolution of the Soviet Union in 1991. The five successor states all wanted to capture as much of the resources as possible, but their interests diverged. Kyrgyzstan, Uzbekistan, Tajikistan, Kazakhstan, and Turkmenistan now each have their own governmentality, their own ideas on how to govern their part of the river. Unfortunately, these governmentalities are at times opposed, potentially leading to violent conflict. In this conflict of interest, some observers

[2] Interview Tashkent June 2009, country director International Fund for Saving the Aral Sea.

have identified a risk for *water wars* [Cooley, 1984; Starr, 1991], including more recently a influential 2011 report by the US Senate Committee of Foreign Relations [Kerry et al., 2011]. Although I do not concur with the risk of *water wars* in Central Asia, the study of *why* and *how* these governmentalities have diverged remains important.

THE DISINTEGRATION OF THE SYR DARYA RIVER

It took decades to transform the Syr Darya into a governable river, but only a couple of years for the system to disintegrate and fragment. When in 1991 the Soviet Union collapsed, the five Central Asian Republics found themselves independent but facing massive challenges. The river system that was *made governable* on a basin scale became fragmented and prone to conflicts. This section address the apparent paradox of a water management status quo inherited from a unitary polity but different and diverging politics and economic systems. The Toktogul dam, for all its importance in the earlier development of the Syr Darya River, produced a water-energy nexus that is difficult to manage because of the disintegration and fragmentation of the river system.

A year after the dissolution of the Soviet Union, the water ministers of the Central Asian states declared in Almaty that the region's water resources would be governed based on the principles of equality and mutual benefit [Wegerich 2004]. In practice, this meant that the Soviet status quo of water governance would remain in place. Some new organisations were introduced, such as the Interstate Commission for Water Coordination (ICWC) and its executive Basin Management Organisations (BVOs), but the allocation of water was in line with Soviet standards: Uzbekistan receives nearly 52% of all the water in the Aral Sea basin and Kyrgyzstan only 4% [McKinney 2003]. There have been ample attempts at formulating a regional agreement that acknowledges the post-1991 geopolitical setting, but most have failed. In the words of a spokesperson of Kyrgyzstan's Ministry of Foreign Affairs: *"more than 20 regional agreements on water have been signed, but most are not working"*[3]. Indeed, it appears that it is all paperwork and little action.

At the same time, the five Central Asian states have diverged widely economically and politically. The economies are no longer part of a unitary economic space, trade barriers have arisen, and protectionism and ideas of self-sufficiency are guiding policy-makers [Spechler 2002]. Politically, Kyrgyzstan embraced more liberal reforms, whereas Uzbekistan and Kazakhstan remained wedded to authoritarian state forms. Moreover, the different states all used notions of nationalism to cultivate legitimacy at home. A component of this modern nationalism was the construction of a discourse of danger vis-à-vis the neighbouring states [Megoran 2002].

The combination of economic decline, authoritarian regimes, and strong nationalist tendencies has prevented economic or political cooperation in the last two decades. This is particularly ironic given the integrated economic system of the area during Soviet times. Borders that were previously purely administrative delineations became enforced and militarised realities [Megoran 2004]. The regional electricity transmission network, one of the major achievements of the Soviet times, was partly abandoned. Leaders liked to produce the perception of regional cooperation through a set of high-level summits, but none led to badly-needed reforms of the water governance system [Gleason 2001]. Obviously, this had negative repercussions for the Aral Sea, but the relation between the states suffered too.

This is the central paradox in the governance of the Syr Darya River: the riparian states have pledged to uphold the Soviet status quo or river management, yet they have diverged dramatically at other levels. The new states

[3] Interview Bishkek September 2011, director Ministry of Foreign Affairs.

have all different and widely divergent views on how to manage the river and what to do with the water. And the controversy ultimately comes down to the single largest reservoir in the river, the facility that virtually controls the flow of the river: the Toktogul.

Because the Toktogul holds the largest reservoir and because it is the most upstream in the river system, the volume and timing of water discharges affect the entire flow of the Syr Darya River. It was of vital importance to the cotton industry downstream and to this end the authorities agreed in 1984 that in a normal year, 75% of the water should be discharged in summer [Sharma et al. 2004]. That the discharge of water could be used to generate electricity was recognised, but was initially seen as a pleasant side benefit rather than a goal *an sich* [Easter et al. 1998].

Yet the hydropower potential proved to be enormous and four more hydroelectric power plants were constructed between 1973 and 1990 right downstream of the reservoir. Today, this cascade accounts for 95% of total electricity generation in Kyrgyzstan with an installed capacity of 2870 MW and is considered to be the country's most valuable asset [Murphy et al. 2011]. Controlling the river flow and generating electricity are intricately linked. Discharging 1 m^3 from the reservoir generates 1 kWh[4]. Water in the reservoir is multiple: both an input for cotton irrigation and electricity. The Toktogul has produced a water-energy nexus and the seeds for political conflict.

Before independence, the majority of water was discharged from the reservoir in summer and the electricity generated in the process distributed among the integrated Central Asian transmission grid. In turn, Kyrgyzstan received ample supply of coal, gas and other fuels. When this barter trade system broke down, the Kyrgyz consumers realised that electric heating was much cheaper because of the massive supply from the Toktogul hydroelectric cascade. As a result, water is increasingly discharged in the winter months, when electricity demands in Kyrgyzstan are highest, and less and less water reaches the agricultural fields in Uzbekistan and Kazakhstan during the vegetation season [Sievers 2001].

The gradual shift in Toktogul's operating regime has heightened tension between Kyrgyzstan and Uzbekistan (and to a lesser extent Kazakhstan). The downstream states have consistently complained about the diminishing supply of water. Uzbekistan has responded to low summer water discharges by cutting down gas supplies or closing off the border with Kyrgyzstan [Torjesen, 2007]. The violent rhetoric expressed by the neighbours suggests a risk for geopolitical conflict, although nothing of the sort has happened yet [Sievers 2001]. Nonetheless, the International Crisis Group has reported that Uzbek army units have prepared to take the Toktogul by force, if deemed necessary [ICG 2002]

The inconvenient reality is that the geopolitical changes of 1991 have bared the multiple nature of the Toktogul. The dam, reservoir and cascade that were once hailed as progress that *tamed* the river [Azrilyan, 1983], produced a river that could be managed according to *multiple* governmentalities. The multiplicity raises numerous questions on its purpose, who is authorised to govern the river, and on the nature of the river itself. In fact, both the decline of the Aral Sea and the present tension between the riparian states is caused by the governmentality of the hydraulic mission. In this modernist experience society may have won the battles with nature, but through its efforts it may have created a battle of society versus society in turn.

Water-energy nexuses are not unique, but when the multiplicity of the Toktogul became reality Central Asia experienced a broader, almost deliberate fragmentation of water management, by sector, in knowledge, and spatially, that has had serious implications for the politics of the river. Firstly, the efforts towards cooperation have failed to account

[4] Interview Bishkek September 2011, consultant Ministry of Energy.

for the energy side of the equation [Sievers 2001]. Economic analyses from the World Bank have demonstrated the value of both water for irrigation and water for electricity generation and have proposed a payments regime that acknowledges this value [Sharma et al., 2004]. However, Uzbekistan's President Islam Karimov has insistently stated that the regional forums are for water only, not for energy. The World Bank's senior water expert stated that the repeated failure of Uzbek government officials to engage in the water-energy dialogue has prevented further action and blocked the finance for large projects[5].

Secondly, observers have noted that the data and knowledge on climate, water flow and agriculture is increasingly fragmented. It has been suggested that even the BVO has multiple data sets [Wegerich, 2004]. This is according to the Institute for Water Problems, a organisation that falls within the umbrella of the Kyrgyz Academy of Sciences, one of the reasons why Kyrgyz officials do not trust the Uzbeks when it comes to water: *"I am shocked by how water professionals know everything but play with facts and figures for political reasons. It is these [Uzbek] people that make a political issue out of water management"*[6]. The sentiment is similar on the other side of the border.

Thirdly, as a consequence of the fragmentation of the water and energy sectors and of the knowledge base the main storage facilities in the river have formally stopped coordinating their water discharge patterns. Specialists from the Kyrgyz State Committee for Water Resources acknowledge that was the purpose of the river-wide governance structure to connect the operation of the Toktogul (Kyrgyzstan), Kairakkum (Tajikistan), and Chardarya (Kazakhstan) dams in order to optimise production, *"but the political climate for this has been lacking"*[7]. The dams in the different countries seem to be governed by different motives. According to one influential donor: *"nothing is decided formally but all governance happens at an ad hoc basis. Although the states have been able to manage past crises, it is not a stable situation and the governance regime is always at the brink of disaster"*[8].

If there are multiple *governmentalities* managing the water, is the Syr Darya still governed as a river? The occasional floods, the low-levels of the Toktogul in certain years, and the water shortages during the vegetation seasons suggest otherwise.

WHAT IS WATER? DIVERGING DISCOURSES ON THE SYR DARYA

The water management structures in the river are still more or less the same as those of Soviet times, but the discourses guiding their operations are not. Both Uzbekistan and Kyrgyzstan have *sanctioned discourses* produced by small elites that guide policy-making. More often than not, these discourses benefit the elites rather than the country as a whole, but they are the main drivers of international relations.

The sanctioned discourse of Uzbekistan is driven by the ideology designed by Islam Karimov, the country's president (March, 2003). Given the highly authoritarian and repressive nature of the Uzbek state, there is little open competition to the ideology of the sanctioned discourse [Melvin 2000]. The production of Kyrgyzstan's official discourse is characterised by a higher level of political competition than those of the other Syr Darya riparian states, but the production of knowledge is still top-down with a small political elite having a virtual monopoly on agenda-setting. In this section I look at how the sanctioned discourses of Uzbekistan and Kyrgyzstan have diverged since independence. The central point of tension is the nature of the water itself.

[5] Interview Bishkek September 2011, water expert World Bank.
[6] Interview Bishkek June 2009, officer Institute for Water Problems.
[7] Interview Bishkek September 2011, director State Committee for Water Resources.
[8] Interview Bishkek September 2011, country officer GIZ.

The view from Bishkek

The clearest exponent of the official Kyrgyz water discourse is the adoption of the 2001 Water Code that aimed to reform the country's water sector[9]. The code includes a provisional law that allows Kyrgyzstan to charge downstream countries for the storage of water in its territories, the maintenance of structures and reservoirs, and the loss of income by foregone energy production [Heltzer 2003]. The reforms confirm a departure from the Soviet status quo that was already initiated under President Askar Akayev in the 1990s.

The controversial move from an integrated Soviet system with water as a common good towards the recognition of its economic value and the implicit commodification of water followed, according to a director at the Ministry of Water and Agriculture, from the breakdown of the Soviet economic system and the failure of cooperation. He argues that when Kyrgyzstan was charged market prices for oil, gas, and other commodities that used to be free, its leaders realised that water was its only resource and rather valuable for the agriculture downstream[10].

There appears to be a clear distinction between what Kyrgyz official policy proposes and what is pursued in practice. The ratification of the Water Code was rather an expression of the official discourse than an actual policy goal. The Kyrgyz leaders attempted to redefine the underlying conditions of regional water management in their favour, by challenging the Soviet and post-Soviet water management paradigm. In terms of the debate this has fuelled, this has been a successful yet dangerous strategy, because of the vehement polemic it has generated in policy circles throughout the region. The departure from Soviet ways of thinking towards neoliberal reforms allowed the legislation to pass. On the other hand, the legislation itself fuels the further development of a mentality of water management that favours liberal economic thinking on water governance. Although this discursive strategy has little direct impact on the water itself, it moves the Kyrgyz governmentality even further away from the Soviet – or Uzbek – governmentality of the river, and therefore exacerbates the tension.

In broader terms, the 2001 reforms are evidence of the globalisation of the Kyrgyz water policy. Many of the concepts in in the legislation, such as Water User Associations, Integrated Water Resources Management, and water pricing, are part of a global discourse on water management that is pushed by international financial institutions and the donor community [Kemelova & Zhalkubaev 2003]. The wide presence of western donors since 1991 accelerated economic and political liberalisation more rapidly than in the neighbouring states and this partly accounts for the divergence for alternative governmentalities [Abazov 1999].

In part, the Kyrgyz governmentality that emphasises the economic value and commodification of water is a response to the failure of the countries to cooperate post-1991. Simultaneously, this position is an obstacle for further cooperation, as Uzbekistan refuses to agree on this nature of water. This conflict on *what water is* has led to large distrust towards the regional institutions governing the water resources. According to the Kyrgyz Institute for Water Problems: *"Kyrgyzstan cannot cooperate with the ICWC and the BVO-Syr Darya [the regional institutions] because the organisations are dominated by Uzbek"* [11]. Partly because of this, there is an uneasy tension between the post-Soviet realities of water governance and the official water discourse in Kyrgyzstan.

[9] The total extent of the reform is less relevant for this discussion, but the code included a domestic and international component. Domestically, it also introduced the idea of water pricing, as well as Water User Associations and Integrated Water Resources Management. See Herrfahrdt-Paehle (2008) for a further discussion of the 2001 Water Code.

[10] Interview Bishkek August 2009, director Ministry of Water and Agriculture.

[11] Interview Bishkek August 2009, officer Institute for Water Problems.

The view from Tashkent

Uzbekistan's sanctioned discourse is rather different from Kyrgyzstan's. In Uzbekistan there are strong vertical links between the state ideology, the water discourse and practice; the discourse is therefore less contested. Central to the official water discourse is the idea that water is supposed to be free and readily available. The Deputy Minister of Agriculture and Water stated that *"we [the Uzbeks], cannot be punished for being born downstream"* [12]. The concept of water as a free good has its origin in the Soviet Union where to the farmers and local planners water supply never seemed to be a problem, partly because of the hydraulic mission described above. Moreover free water has a pseudo-religious significance and it is claim that water pricing is impossible because *"water comes from the gods"* [13].

The idea of free water is important in the Uzbek state-planned economy as well as for the legitimacy of the Karimov regime. Agriculture, notably cotton and rice, accounts for one third of its GDP, 60% of foreign exchange earnings, and 45% of employment. This system is not only based on the actual provision of free water, but also on the discursive idea that water should be a free good. At the same time, the authoritarian regime derives part of its legitimacy from the praxis of this system: as long as the population believes that Karimov ***cum suis*** can take care of free water and cheap food, they may be willing to accept his authoritarian rule [March 2003a; Adams 2010].

Therefore, any change in the status quo is perceived as a threat by Uzbek elites. Uzbekistan's agriculture-driven economy is still planned from above [Spechler 2008] but it now depends on Kyrgyzstan for its water supply. The trend of increased Toktogul discharges in winter, visible in figure 3, has been explained by the senior Uzbek water official as ***'greedy commercial interests in Kyrgyzstan'***[14], even though this argument misses out on the large power shortages in large parts of Kyrgyzstan. Moreover, the concept of water pricing is rejected by two Uzbek water officials in a 2003 publication, where Dukhovny and Sokolov argue that the commodification of water causes the excesses of capitalism with people aspiring to be the nouveau riche speculating in water markets. Instead, ***"society needs to make such economic activity unviable"*** [Dukhovny & Sokolov 2003: 32].

Given language like this it is not surprising that Uzbekistan's opinion-makers have misinterpreted and/or rejected the reforms proposed by the 2001 Kyrgyz Water Code. The proposal for sharing the maintenance and storage costs has been seen as an attempt to commodify and privatise the water itself. Some went as far to state that Kyrgyzstan is asking money for resources that are coming from god[15]. Similarly, the current operating regime of the Toktogul is described by the Deputy Minister for Agriculture and Water as *"Kyrgyzstan trying to make a desert out of Uzbekistan"*. Ontological disagreement on the nature of water is not helpful for finding a practical solution to govern the region's water, and the governmentalities are diverging further because of the polemic language used on both sides.

What is water?

If discourses are such a fundamental part of the governmentality of a river, how can we understand the divergence between the different governmentalities? When Central Asia was part of the Soviet Union, there was a single and relatively coherent governmentality driven by a discourse based on Marxist-Leninist ideas of development and society's relation with nature. However, as the Central Asian water governance systems disintegrated after independence, different ideas on *how* the Syr Darya should

[12] Interview Tashkent July 2009, Deputy Minister of Water and Agriculture.

[13] Interview Almaty September 2009, Uzbek representative International Fund for Saving the Aral Sea.

[14] Interview Tashkent July 2009, Director Scientific Information Centre Interstate Committee for Water Coordination.

[15] Interview Tashkent July 2009, Deputy Minister of Water and Agriculture.

be ruled diverged along with the political and economic systems of the riparian states. This introduced the central paradox: the post-Soviet water status quo was based on the Soviet governmentality, following the 1992 Almaty agreement, but it turned out that multiple governmentalities existed among the river basin states.

The tension between these governmentalities has become clear in the last decade and takes place at two distinct levels. On the one hand there is a dispute between Uzbekistan and Kyrgyzstan, and to a lesser extent Kazakhstan, on how the Toktogul *should* be operated. Is river made governable for irrigation or for electricity production? On the other hand there is the fundamental disagreement on what the water is. The Kyrgyz governmentality acknowledges the economic value of water but the Uzbeks cling to Soviet ideas of water as a free and common good. Perhaps this difference can be explained by diverging geopolitical interests. However, as discussed above, the production of the official discourses is intimately linked to the legitimacy of the respective regimes, which suggested that it they have reasons beyond a motivation for resource capture. The interaction of the dispute over the Toktogul's operation and the fundamental disagreement on the nature of water make water management a highly complex problem.

This interaction demonstrates that the politics of water in Central Asia goes beyond plain resources capture. It shows how the geopolitical changes after the fall of the Soviet Union have revealed the inherent multiplicity of water and of the large dams. Water in the Toktogul reservoir is transformed by discharging it at a certain time and under certain conditions. The politics in the basin is then about what the water ***is*** and what it *should be*; this type of politics is termed ontological politics by Mol [1999]. There are different ideas on the nature of water and ultimately not even an agreement on what the conflict is about.

CONCLUSIONS: WHAT ABOUT THE GEOPOLITICS?

Both the decline of the Aral Sea, and the potential conflict between the states are driven by the same modernist governmentality of the river. The hydraulic mission has been a regime of truth that introduced large-scale engineering solutions to avert the variability of the river and to make it more productive. Although the productivity has certainly increased, the practices and discourses associated with this transformation of nature have had negative externalities too. The Soviet governmentality was presented as the single, and uncontested way to manage water resources. After independence however, the ways to manage water resources proved to be "multiple": there are alternatives for operating the Toktogul, for instance. The divergence of governmentalities can have negative implications for the relations between the riparian states.

Discussions of knowledge production and discourse formation are frequently neglected in analyses of the water problems in Central Asia. By looking at the hydro-politics of Central Asia through governmentality theory, I aimed to contribute to the understanding of the region's geopolitics, by pointing at why the states cannot come to agreement. In the absence of any legal frameworks, the politics is about power. Uzbekistan is considered to be the ***hydro-hegemon*** in the basin [Wegerich, 2008], but Kyrgyzstan has an edge simply because it controls the operations of the Toktogul reservoir. Discourses are crucial for understanding these relations of power.

In fact, the concept of ***discourse*** has been at the heart of the body of literature of critical geopolitics [O'Tuathail & Agnew, 1992]. This is because *"strategies of power always require the use of space and, thus, the use of discourses to create particular spatial images, primarily of territory and boundaries inseparable from the formation and use of power"* [Sharp 1993:492]. The production of different spatial images of what the water in the Toktogul reservoir is, of whether it could have a direct economic value, and of how the river should be governed is one of the key spaces where the hydro-politics takes place. Looking at discourses also avoids the simplified conclusion of imminent water wars, but it does highlight the other ways in which the conflicts can express themselves and this deserves due attention.

ACKNOWLEDGEMENTS

This work is part of the PhD project "Dams of Damocles: between rivers, states and geopolitics" at the University of Oxford. Financial assistance from the Hay Memorial Fund, Prins Bernhard Cultuurfonds, and Hendrik Muller Vaderlandsch Fonds is gratefully acknowledged. The author would like to thank Prof. Judith Pallot and two anonymous referees for constructive feedback. ■

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MOUNTAIN NATURAL BIODIVERSITY CONSERVATION IN RUSSIA

ABSTRACT. High biodiversity and degree of endemism of mountain biota strengthen the mountain regions' status for the territorial nature conservation. Analysis of the protected areas' representativeness in various mountain regions of Russia shows some discrepancy between their quantity, square and regional biodiversity originality. The biggest divergences are marked for the Northern Caucasus. The main problems: small area of the protected territories and also cluster character of their spatial distribution, mostly in the high mountains are not supposed to conform with the highest values of the regional flora's and fauna's uniqueness, to compensate representativeness of the protected biota and, in anyway, to correspond with the purpose of nature protection frame - the protected territories ecologic network's forming. The situation in the Urals, Siberia and the Far East seems to be better. The large areas of the protected territories are in general agreement with the high originality of the nature ecosystems. Nevertheless each concrete case needs analysis of the regional biota's and ecosystems' biodiversity distribution within the protected areas, including character and (or) unique elements of the regional biodiversity to be held. The development of the effectual territorial conservation of mountain regions needs differential approach. The creation of the large representative parcels of nature landscapes in the key-areas has the considerable meaning in the low-developed regions, difficult to access. And well-developed regions have the necessity of nature protected territories' network development and the planning of the ecological frame's forming. The territorial biodiversity conservation, including the system of federal, regional and local levels with protective conservation of the rare species has to be combined with ecosystem's restoration, especially in the zones disturbed by erosion, recreation and military actions. Also it is necessary to develop the new types of the protected areas – ethnic-cultural territories of traditional mountain land-use. The biological resources', ecosystems' and ecological detriments' evaluation is appropriate for the mountain biodiversity conservation. The last, is aimed to raise the effectiveness of the nature conservation activities and to prove the introduction of new mechanisms of their financing.

KEY WORDS: biodiversity conservation, ecosystems, nature protected areas, high mountain, altitudinal zonality, subalpine and alpine belts, endemics

INTRODUCTION

The mountains occupy nearly 50% of the territory of Russia. The nature of mountain regions is characterized by features, distinguishing them from surrounding plains. From the point of view of biogeography, mountains territories may be considered as "isles", which differ completely from the adjacent plains. On the one hand, mountains could serve as refuges of the plain's biota during the glacier and sea transgression periods. Mountains are considered to be the nature boundaries of states, parts of world (for example, the Urals) and the serious biogeographical obstacles on the ways of the biotic exchange.

On the other hand, mountains supposed to be the ways for penetration of the northern biotic forms to the South and the southern biotic forms to the North. As a result, taking into account the above mentioned factors, mountains are characterized with a high biodiversity at all levels: intraspecies, species, ecosystem, landscape. The biological diversity degree depends on the palaeogeographical factors, geographical situation, dominating heights, massiveness of the mountain region. The high degree of mountain vascular plants' endemism, reaching 13,5% in the mountains of Central and Southern Siberia and up to 25,2% in the Caucasus, strengthens the value of mountain regions for territorial biodiversity conservation and increases their nature-conservative status. Therefore, at this moment, the analysis of biodiversity representativeness of the mountain protected areas network is of great interest.

SPECIES DIVERSITY

The majority of the vascular plant species of Russia grow in mountains. For example, the Caucasian flora in total consists of 6350 species and only 433 of them are spread on the abutting plains and don't rise above the level of low mountain belt (500 m above the see level).

It is necessary to mention that the detection of the mountain flora taxonomic composition has not been finished yet. In some cases species diversity is in the direct relation with the level of the floristic studying of the region. Moreover it needs to appraise the species diversity of the mountain region only with regard to its not representative part: administrative area (oblast or region) or its protected area (reserve or national park).

As for diversity of lichens, there are nearly or more than 200 species of lichens in the Khibiny, in the Northern Caucasus, and in the Siberian mountains. In the Urals there are nearly 150 of them. Unfortunately, the number of lichens in the regional data also depends on the study level and cannot be considered as exhaustive. Furthermore, to a greater extent, these data show low belts of mountains. Data about the lichens flora in the upper belts are very poor. That's why the regional lists don't reflect the real diversity of lichens.

Concerning animals, it should be mentioned, that the vertebrates have been studied better than other groups. More than three fourth of terrestrial animals inhabits the mountain ecosystems. This fact indicates high species diversity of the mountains comparing with the lowlands. For example, more than 90% of all amounts of animals in the Urals and surrounding territories are met in the mountains, which square is lesser than that of the abutting plains [Bolshakov, Berdyugin, 2001]. There are nearly 50% of the former USSR fauna of birds in the Greater Caucasus. Data of the plants and animal species diversity of Russian mountain regions are resulted in the table 1.

The degree of endemics – important aspect of biodiversity – is higher in the mountains than on the plains. Most of endemics are concentrated just in the mountain regions. Mountains of the middle latitude with moderately warm climate are characterized with high level of species richness and endemism. In the Greater Caucasus 1600 plant species, which introduce 25.2% of the total amount of species, are usually identified as endemics [Belonovskaya et al., 1984]. 13.5% of endemics are revealed in the mountains of the Southern and Central Siberia [Klimesh, 1999]. In the Khakassia mountains the total number of plant species counts 1526, and 7.4% of them (113 species) are endemic ones. The diversity of endemicc plants consists of 85 Altai-Sayanian species (5.6%) and 85 narrow local Preenisenian endemics (1.8%) [Kuminova, 1976]. Mountains of the Northern Russia are characterized by low degree of species diversisty and minute amount of endemic species. There are 412 vascular plants in

Table 1. Diversity of flora and fauna in the mountain regions of Russia (after ANENKHONOV, 2001; AMIRKHANOV et all., 2002; GROSSHEIM, 1949; KUMINOVA 1960, 1976; MALYSHEV, 1988; VOROSHILOV, 1985,) In the brackets – number of endemic (for all groups) and rare, including endangered (for vertebrates) taxa

Regions	Vascular plants	Lichens (genera)	Mammals	Birds	Reptiles	Amphibia	Fishes
The Khibini	429	188	47(0;1)	161(0;12)	2(0;0)	3(0;0)	29(0;2)
The Greater Caucasus	6350(1600)	218	126(26;16)	253(13;52)	73(24;14)	11(5;6)	73(5;11)
The Polar Urals	460	136	36(0;0)	114(0;12)	1(0;0)	1(0;0)	34(0;2)
The Subpolar Urals (mountain taiga, northern taiga and tundra)	611	179	45(0;1)	128(0;7)	3(0;0)	4(0;0)	28(0;1)
The Central and Southern Urals	1495	182	72(0;1)	227(0;26)	7(0;0)	8(0;0)	53(0;2)
The Southern Urals (forests, the upper Ural-river)	815	179	90(0;2)	244(0;30)	10(0;0)	11(0;0)	67(0;7)
The Kuznetskiy Alatay	820	203	77(0;3)	240(0;19)	5(0;0)	3(0;0)	29(0;0)
The Altai (**A**), the Sayany (**S**), the Tuva-mountains (**T**), the Khamar-Daban (**Kh**)	**A** – 1840(113); **S** – 973; **T** – 1782; **Kh** – 1242	**A, S** – 224	111(16;11)	294(16;37)	10(3;2)	5(0;0)	34(2;0)
The Byrranga-mountain	–	–	42(0;1)	129(0;13)	0	0	34(0;0)
Putoranskoe upland (the central and southern parts), Leno-Olenyokskoe upland	412(7)	403	43(0;1)	139(0;15)	1(0;0)	3(0;0)	37(0;1)
Angaro-Tunguskoe upland; the Yeniseiskiy range	818	–	57(0;1)	209(0;18)	4(0;0)	4(0;0)	31(0;1)
Tungusskoe; Northern Baikalskoe (**NB**), Patomskoe (**P**) uplands, Olekmo-Charskoe plateau and Stanovoe high plateaus, the Stanovoi range (**S**)	**NB** – 593; **P** – 702; **S** – 684	– – **C** – 190	80(1;5)	280(0;33)	5(0;0)	4(0;0)	101(0;2)

Continue tab. 1

Regions	Vascular plants	Lichens (genera)	Mammals	Birds	Reptiles	Amphibia	Fishes
Sayan region plateau; the Baikal region mountains	1037	–	77(0;0)	254(0;14)	6(0;0)	5(0;0)	33(0;0)
Vitimskoe and Selenginsko-Olyokminskoe high plateaus	857	–	90(1;1)	273(0;17)	8(0;1)	5(0;0)	90(0;1)
Chitinskoe-Daurskoe lowland (southern part)	870	130	40(0;4)	170(0;25)	3(1;1)	3(0;0)	15(0;0)
Plateau between the Malkhanskiy and Daurskiy ranges	965	–	55(0;4)	193(1;25)	3(0;1)	3(0;0)	34(0;0)
Yano-Oimyakonskaya mountain oblast (region)	643	146	50(0;0)	167(0;9)	1(0;0)	2(0;0)	45(0;0)
Anyuisko-Chukotskaya and Anadyrskaya mountain regions (**A**), Koryakskoe plateau (**K**)	**A** – 931; **K** – 847	165	48(1;9)	160(9;25)	0	1(0;0)	38(7;2)
Okhotskaya mountain oblast (region)	901	–	55(0;8)	170(0;18)	0	2(0;0)	36(0;0)
The Sredinny Range (Kamchatka peninsula)	931	153	43(1;8)	126(2;10)	0	1(0;0)	19(1;1)
Kuril islands	918	171	32(1;11)	117(4;18)	5(4;2)	1(0;0)	28(0;0)
Sakhalin (southern taiga)	1173	380	41(0;2)	160 (1;28)	2(0;0)	3(0;0)	32(2;1)
Sakhalin (central taiga)			45(0;2)	153(0;25)	2(0;0)	4(0;0)	26(0;1)
The Far East mountains	1838	205	91(18;15)	266(34;63)	15(11;5)	8(2;1)	99(34;6)

the Putoran-mountain, and only 7 species of them (1.7%) could be considered as endemics [Kuvaev, 1980].

Fauna of the most of the Russian mountains is not original. It has few of endemics. For example, there is only one endemic subspecies of northern pica among vertebrates in the Urals. But in the mountains, located near the Southern border of Russia, the number of endemics is rather high: 42 species – in the Caucasus, 35 species – in the Sayany, Altai, Tyva and Transbaikalian mountains, 95 species – in the mountains of the Far East.

The highest number of endemics is observed in high mountains. Strongly rugged relief and insuperable abiotic (from the top) and biotic (from the bottom) obstacles strengthen high mountain's isolation. The extraordinary environment forms specific communities and life forms of the organisms. These factors cause the astonishing biodiversity in the high levels of the mountains. Thus, in the Greater Caucasus flora of the alpine belt consists of 800 vascular plant species, 420 species of them (more than 50%) are endemics [Belonovskaya et al., 1998]. The high mountain mammals' fauna is characterized by Promethean vole – the species of the endemic genera *Prometheomys* and by Caucasian stone goats (*Capra caucasica* and *C. cylindricornis*), the birds' fauna is characterized by Caucasian black grouse and Caucasian snowcock.

LANDSCAPES DIVERSITY

The mountains are characterized by increased ecosystems' diversity per unit of area, high nature borders' saturation and biotic complexes' patchiness. As well as in the case with the regularities of species richness distribution, the complexity of altitudinal zonality structure in many respects depends on the combination of warm and moistening. Thus the mountains of the arctic and tundra zone are characterized by the simplest altitudinal belts' composition. The mountains of the taiga zone have more complex structure of the altitudinal zonality. In the mountain regions situated in the South, in the broad-leaved forests or steppe zone changing of mountain belts – analogues of almost all latitudinal zones of Russia are observed (Table 2).

The concrete set of the altitudinal belts and regularities of their changing are found very specific not only in the separate mountains, but often in the separate parts of one mountain region. For example, on the Greater Caucasus 8 types and 7 variants of altitudinal zonality can be differentiated, and on the Northern Caucasus – 4 and 2 of them correspondingly. On the Urals, due to its meridional extension, one or several types of altitudinal zonality structure go with each latitudinal zone. As a result 7 types and 4 variants of altitudinal zonality are distinguished there [Gorchakovskiy, 1968]. In the Altai there are 4 and 3 correspondingly, and in the Sikhote-Alin – 4 and 4.

Table 2. Altitudinal zonality structures' diversity in the mountains regions in Russia (according to Ogureeva, 1999)

Latitudinal zone	Number of mountain regions	Number of altitudinal zonality types	Number of altitudinal zonality variants
Arctic and tundra	10 (including the Polar Ural)	9	8
Taiga (boreal)	65 (including the Northern and Middle Ural)	40	71
Broad-leaved forests (nemoral)	10 (including the Southern Ural and the Caucasus)	16	16

Table 3. Number of endangered plant species (Red data book of RSFSR, 1988) and endangered animals (Red data book of Russia, 2001) (including * – endemic, ** – relict), of the mountain regions

Region	Plant species: rare, with local area and under conservation					Animals species: rare, with local area and under conservation						
						Invertebrates		Vertebrates				Total
	Lichens	Mosses	Ferns	Angio-sperm	Total	Annelida	Insects	Fishes	Amphibia	Fishes	Mammals	
The Khibins	1	1	–	5(1*)	**7**	–	–	–	–	–	–	**–**
The Caucasus	7	2	1(1*)	119(62*)	**129**	2(1*)	6(4*,1**)	1(1*)	10(7*)	5(1*)	8	**32**
The Ural	4	–	–	14(7*)	**18**	1(1*)	6(1**)	–	–	1	–	**8**
The Kuznetskiy Alatay, the Salairian range	2	–	–	3(1*)	**5**	2(2*)	–	–	–	–	–	**2**
The Altai	3	1	1	27(19*)	**32**	2(2*)	5(3*)	–	–	4(1*)	4(1*)	**15**
The Sayany	2	4(1**)	–	14(10*)	**20**	–	1(1*).	–	–	1	3(1*)	**5**
Tuva	1	–	–	20(10*)	**21**	–	4(2*)	–	–	1(1*)	4	**9**
Baikal region mountains	6	–	–	7(6*)	**13**	–	2(1*)	–	–	1	2	**5**
Buryatia, Chitinskiy region	3	–	–	11(5*)	**14**	–	1	–	1	1	3	**6**
North-Eastern Asia: Magadanskaya oblast (region), Yakutia, Chu-kotskaya AO,	4	1	–	9(8*)	**14**	–	–	–	–	–	3	**3**
Kamchatka	1	–	–	2(1*)	**3**	–	–	–	–	–	–	**–**
Kurilian islands	1	–	1	11	**13**	1	1	–	–	1	–	**3**
Khabarovskiy krai (ter-ritory)	2	–	–	1	**3**	-	2(1*,1**)	–	1	2(1*)	–	**5**
Primoriskiy krai (territory)	7	–	1	18(7*)	**26**	1(1*)	10(1*,1**)	–	1	3(1*,1**)	3	**18**
Sakhalin	5	–	1	6(1*)	**12**	-	3(1*)	–	–	2(1*)	1	**6**

RARE SPECIES AND ECOSYSTEMS OF THE RUSSIAN MOUNTAINS

Due to high environmental instability and biotic systems' vulnerability great amount of rare and endangered plant and animal species, mentioned in the Red data books of Russia are met in the mountains [Red data book..., 1988, 2001]. Among these 533 plant species there are 282 mountain ones and among 415 animal species – 95 (Table 3).

Insufficient minuteness and lack of unificated methods of the vegetation survey prevent to reveal rare ecosystems in the mountains in full extent. Nowadays there are only preliminary data about quantity of the rare plant communities in the mountains of Siberia and former USSR [Green data book of Siberia, 1996, Red data book..., 1997]. Meanwhile only 100 mountain communities of various ranks, chosen by various criteria, are called rare and endangered, worthy of conservation (Table 4).

MOUNTAIN ECOSYSTEMS' TRANSFORMATION

Favorable environments, high diversity of high-yield ecosystems have been attractive for man during all time. Thus, even from the middle of Holocene, human economic activity became an important factor, which has, to some extent, had an influence on the trend and intensity of changes in primary mountain vegetation communities. Each historical period of the socio-economic and political development of the mountain regions was characterized by various combinations of impacts and by different loads on the natural ecosystems. From the beginning of historical time to the end of the 19th century the forms of using the natural resources remained practically unchanged. The gradual increase in the load and the development of the new lands were the main process. A sharp leap in the transformation of natural environment began from the middle of the 20th century and this caused a destabilization of ecosystems. At that traditional forms (hunting, timber cutting, cattle breeding, ploughing of land) were intensified, and some previously unknown forms appeared. For example, assignment territories by the collective farms in combination with high livestock and allotment of lands for industrial projects, roads, water amelioration, ploughing up limited development of traditional pasturing, which took in account the natural peculiarities of natural forage grounds (moistening of slopes, degradation of grass layer, seasons of using). During this period some new types of economic impact such as mining (including open cast), industrial and civil building, industrial forest cutting, recreation (popular mountain-skiing and summer tourism) were added. If in the past ecosystems could adapt themselves to new conditions because of the low intensity and uniformity of the impact, nowadays the high speed of transformations and change in the forms of impact in one area (felling, then hay-mowing, then grazing, then ploughing, then building) make it very hard for ecosystem biota to adapt. In many cases they exclude the ecosystems' self-recovery possibilities [Belonovskaya, 2000].

The main centers of ancient settlings and, therefore, of land degradation were the low and middle mountains of the Greater Caucasus, Urals, Southern Siberia and Transbaikalia mountains. On these territories natural ecosystems are destroyed and replaced by their less valuable and productive modifications and also by anthropogenic ecological complexes. Other mountains regions are not characterized by so sustained history of developing and have comparably small localities of anthropogenic destructions.

According to the First National Report "Biological diversity conservation of Russian Federation" [1997] almost 67% of the whole mountains area of Russia is occupied by transformed ecosystems (Table 5). The 29,2% of this territory is totally transformed.

Among the most typical processes of the mountains ecosystems' and their biodiversity

Table 4. Number of the endangered mountain ecosystems in the mountains of Russia

Mountain region	Type of vegetative	Number of associations
The Greater Caucasus	Forests	8
	Highmountain meadows	6
The Southern Urals	Mountain steppes	4
	Forests	3
	Highmountain meadows	1 alliance and 2 subaliances
	Spring communities	2
The Altai	Mountain steppes	7
	Forests	10
The Kuznetskiy Alatay	Mountain steppes	1
	Highmountain meadows	5
Sayany	Mountain steppes	2
	Forests	8
Tuva	Mountain steppes	7
	Forests	2
	Highmountain meadows	6
Baikal region	Forests	2
Transbaikalia region	Mountain steppes	6
	Forests	5
Buryatia	Mountain steppes	2
	Highmountain meadows	1
Yakutia	Mountain tundra	2
	Mountain steppes	2
	Forests	4
	Highmountain meadows	1
Aldan	Tundra-steppe	1
	Forests	2
The Chekanovskiy range	Mountain tundra	1
Far East mountains	Mountain tundra	1
	Forests	5

transformation the following could be mentioned:

- fragmentation of the ecosystem cover, its ecotonization, and forming of the nature "isles" in the man-caused and agrarian landscapes;
- unification of the vegetative cover and biota; disappearance of the altitudinal belts' limits, anthropogenic convergent phenomena in the composition and structure of the biota communities;
- indigenous floras' and faunas' pauperization, increasing of the rare and alien species' share in their composition, intensification of biotic exchange and confusion, floristic and faunal complexes' transformation, biota synanthropization, contemporary "movements" of the areas' limits [Tishkov et al., 1995];

Table 5. Degree and main factors of anthropogenic transformation of the mountain regions in Russian Federation (according to The First National report..., 1997; Regions of Russia, 1999 with additions and changes)

Region	Constituent entity of Russian Federation with the prevalence of the mountain territories	Area, thousand square km	Ratio of entirely anthropogenic disturbed lands, %	Main factors of anthropogenic transformation
North of Russia	Murmanskaya oblast (region)	145.0	3,6	Mining, air pollution, building
The Northern Caucasus	Krasnodrskiy krai (territory)	76.0	61,1	Ploughing, recreation
	Adygeya	8.0	60,9	Cattle-breeding, ploughing
	Stavropolskiy krai (territory)	67.0	65,2	Plouhing, cattle-breeding, building
	Karachaevo-Cherkessia	14.0	39,2	Cattle-breeding, ploughing, felling, recreation
	Kabardino-Balkaria	12.0	39,0	Cattle-breeding, ploughing, felling, mining, recreation
	Northern Ossetia	8.0	36,5	Cattle-breeding, ploughing
	Ingushetia	4.2	30,3	Cattle-breeding, ploughing, felling, recreation
	Ichkeria	14.8	30,5	Cattle-breeding, military activities
	Daghestan	50.0	18,1	Cattle-breeding, ploughing
The Urals	Bashkiria	144.0	43,1	Cattle-breeding, ploughing, felling, mining
	Sverdlovskaya oblast (region)	195.0	12,2	Mining, natural pollution, felling
Southern Siberia and Transbaikalia	Kemerovskaya oblast (region)	96.0	23,2	Mining, building, felling, ploughing
	Altai	93.0	19,1	Cattle-breeding, ploughing, felling, recreation, building
	Khakasia	62.0	24,5	Cattle-breeding, mining, building, felling, air pollution
	Krasnoyarskiy krai (territory)	710.0	5,2	Mining, air pollution, building, felling
	Buryatia	351.0	10,7	Cattle-breeding, mining, building
	Tyva	170.0	10,5	Cattle-breeding, ploughing
Northern Siberia	Yakutiya	3103.2	1,5	Mining, felling
	Evenkiya (north of Krasnoyarskiy krai)	768.0	1,4	Felling
	Taimyrskiy autonomous okrug	862.1	0,5	Mining, air pollution
	Kamchatkiy krai	170.0	2,6	Felling, building, recreation
	Magadanskaya oblast (region)	461.0	0,5	Mining, building
Far East	Primoriskiy krai (region)	166.0	7,8	Felling, building, mining

– replacement of the natural ecosystems by their anthropogenic modifications, including cultivated crops, highlands, secondary forests, etc.

Current mountain biodiversity status and problems of its conservation and use in Russia

Recently, the mountain biodiversity status could be characterized extentially as critical one. On the one hand it is explained by continuance of high and above all uncontrolled anthropogenic load on the ecosystems and with insufficient development of the mountain protected territories' network, on the other hand. All these is redoubled by centralized authority's weakening, absence of administration's control and practically total lack of environmental actions' financial backing at the local level. The biodiversity status is negatively influenced by poaching, which is caused by poverty and wide unemployment among local population. Unprecedented increase of "private" weapons, local wars and armed interethnic conflicts also create considerable threat for mountain vegetative cover and wildlife. For example, the local military conflicts affected 30–35% of the Greater Caucasus territory in general, caused the extinction of the whole hoofed animals' populations, unique protected ecosystems' destruction. The use of modern weapon technologies during local conflicts results the irreversible erosion, which cause the impossibility of ecosystem reconstruction. The wars' and conflicts' consequences double difficulties concerned with reservation and sustainable use of biodiversity resources. After military activities termination large territory of the region is found in the area of weakly forecasting catastrophic changes of the nature complexes.

But, in spite of such pessimistic forecast, the search of ways for reduction of the man-induced negative effect is possible. The specificity of anthropogenic mountain ecosystems transformation lies in the fact, that due to the transitory locations on the slopes of high potential energy caused by dissected relief and sometimes by special conditions of redundant wetting, biota of mountain ecosystems, taken separately, are more vulnerable to many aspects of anthropogenic impact on its structure and functioning, than that of plain ecosystems. An equal intensity of load leads to more severe results and a greater degree of transformation in the mountains than on the plain thanks to the "cascade" effect. On the other hand, the mosaic structure of ecosystem cover and the proximity of analogous ecosystems with differing degrees of accessibility (and therefore safety) combine with the more intensive biological relations allow the restoration of the biotic structure of destroyed ecosystems via the active inter ecosystem's exchange. Thus the biological diversity conservation can be guaranteed more easily in mountains than on the plain, where horizontal links between isolated fragments of ecosystems are far weaker, and the changes in the destroyed fragments more severe [Belonovskaya, 2000].

Such specificity of mountain ecosystems permits to maintain stability for anthropogenic impact and restore ecosystem cover's structure after application of conservation regime. That's why among recommended measures for reservation of biodiversity in the mountain territories of Russian Federation, the creation of natural protected areas' network becomes very important. This network is a kind of nature preservation framework, which maintains the biodiversity on all levels of its display [Tishkov, 1995].

Nowadays the ratio of protected territories in the mountain region, which are "the highest biodiversity's zones", for some extent exceed the mean value of the country (about 3–4%), but considerably yield to that in Russian arctic Region, where biodiversity conservation problems are not so vexed as in the mountains. Complete data of the protected areas' network in the mountain regions of Russia are represented in Table 6.

Table 6. Geographical distribution of the mountain protected areas (reserves and national parks) in Russia and some characteristics of their biodiversity

Region	Reserves	Area, hectar	National parks	Area, hectar	Ratio of endangered animal species, %				Number of rare plant species (including endemics)	
					vascular plants	fishes	birds	mammals		
The Khibins	2	325.893	–		2	6	6	0	7	(1)
The Northern Caucasus	6	502.46	3	345.3	4	9	13	11	134	(65)
The Ural	9	1452.676	4	2117.15	3	10	9	3	10	(9)
The Kuznetskiy Alatay	1	412.9			1	3	5	1		
The Altai	3	1073.609	1	418,200	8	8	7	5	47	(26)
The Western Sayany	4	9699.18	1	39,178	3	6	6	2		
The Eastern Sayany	1	300,390	1	1183,700	4	1	5	5		
Middle Sibirian plateau	2	3669.179			1	2	5	1	9	(5)
Baikal region and Transbaikalia mountains	5	2023.155	3	801.2	1,5	1,5	4,5	1,5		
Eastern Siberia	5	2629.456	–	–	0,5	1,5	8,5	2		
The Far East	9	2913.507	–	–	4	6	10	6	25	(9)

Results of the analysis of protected natural areas existence in different mountain regions of Russia show some disparity between quantity and square of the reserves and values of local biodiversity uniqueness. The greatest deviations are noted for the Northern Caucasus: the least area of protected territories and cluster characterizing of their distribution cannot conserve the greatest flora and fauna uniqueness in a proper way. The problem of fragmentation overcoming has not been solved yet (comparably great amount of reserves and national parks with slight total area doesn't correspond to the nature conservation framework – ecological network of protected areas in no way).

There is a sufficiently large degree of uniqueness and large spaces of protected territories in the Urals, Altai and Primoriskiy krai. However only formal quantities biodiversity features registration could hardly show a reality of sufficiency of the protected territories' forms in a region. It's necessary to take into account biota's composition quality and its representativeness on the protected area. In each specific case, the analysis of biota's diversity, with character and (or) unique species and communities, inhabited on the protected territories, needs to be held. Thus, as for rare mountain animal species there are comparably few problems, because a lot of reserves were found for the purpose of their conservation. 75–90% of rare species of mountain animals are presented in reserves. It's quite another situation, concerning rare and endogenous plants. They are presented in reserves only for 55–60%.

Traditionally the foundation of reserves and other types of the protected areas in the mountain regions of the former USSR based on the principle of "unique high mountain (generally subalpine and alpine) ecosystems' priority". The greatest number of flora and fauna endemic species has been found there. According to some structural and functional characteristics high mountain ecosystems cannot be compared with their plain analogues. Especially it is typical for the Greater Caucasus. The main reserves of the Northern Caucasus are situated in the high mountains while the territories in the middle and low belts with their high biodiversity have not been protected yet.

One fact has also to be mentioned: the principle of "protected priority of high mountains" was associated not only with doubtless natural uniqueness of the high mountain ecosystems, but also with the peculiarities and spatial organization of mountain land use: at the moment of the reserves' foundation only high mountain territories could pretend to the status of "wildlife territories"; while the most transformed landscapes of middle and, especially, low belts and lowlands, where the absence of protected areas with strict regime of reservation occurs practically. The wildlife sanctuaries are not taken from the land use and are actually related to the protected area in formal sense. Besides, within the limits of some reservations, difficult to access territories are "lifeless", practically they are lack of biota (rock-crevices, screes, glacio-nival landscapes), in the same time the landscapes, most valuable for reservation (first of all mountain forests) are represented unsufficiently.

For example, in the Kabardino-Balkarskiy reserve rock crevices, screes, subnival and glacio-nival landscapes occupy nearly 55% of the total territory, while forests grow on the less than 4.5% of the reserve's area. On the opposite, in the Russian part of the Eastern Caucasus (Daghestan) almost the high mountains have appeared to be lack of preservation. "The internal structure" of the protected areas in the Urals looks to be more optimal: owing to the absence of the large high mountain with rock crevies, screes and glacio-nival landscapes the share of the biotic complexes here happens to be higher (particularly, ratio of the forests in the area of many reserves reaches 85–95%).

The other problem deals with the protected territories' limits, which often is marked arbitrarily and is not related with nature borders. In optimal case they correspond to the longitudinal parts of the river valleys and mainly – to the land use or administrative borders. By our opinion, it is effective to orient on the river-basins limits as the natural spatial units of the mountain territory, while planning the configurations of the protected areas (especially in the high mountains). In the same time within every basin there are fragments of various altitudinal belts isolated from typologically similar belts of adjacent valleys by watersheds. Each basin according to its altitudinal status is characterized by certain complex of exogenic processes (for example glacio-nival in the highlands, erosion in the middle belt, etc.). The observation these processes in the aspect of their relations with biota has to become one of the purposes of the protected territory, as plant reduction stages caused with avalanches, mudflows, landslips, etc. are also natural variants of the mountain ecosystems as valuable as typical complexes of altitudinal belts.

At present the main direction of the mountain protected areas' network's development should become the overcoming of its "fragmentarity": inclusion of the "not high mountain" landscapes and ecosystems to the preservation regime for the achievement of the complete altitudinal belts' spectra. This process could develop both in the way of the enlargement of the existing protected areas, first of all reserves, and in the way of foundation of the new ones. In the same time, in the condition of the increasing of politic and economic independence of the autonomies and authority centralization, the possibility of considerable "noncommercial" reserves' areas' enlargement could hardly be forecasted. In this case the priority should be given not to the reserves', but to the national parks' development. The last permit combine recreational (economic) and nature-oriented activity. The creation of new protected areas is especially effective in the densely populated and industrial regions. On the other hand, even in the condition of the "land use press", increasing creation of new reserves with comparably small areas ("microreserves"), is quite possible. It doesn't contradict with the principle of the sufficiency of the reserve's area: in the mountains the natural abiotic processes and biota's vital activity often run on the comparably small space. It's quite enough for allocation of the complete natural complex, which could become the object of conservation.

In contrast with the old-aged developed territories in the mountains regions of the North and North-East of Russia the diversity of the landscapes and ecosystems are almost represented in the protected areas. Moreover considerable part of these regions is hardly accessible and doesn't need the introduction of special conservation regime. Evidently, for some similar regions the main tendency of environmental activity's perfection has to be prevented of the negative consequences of the large-scale open mining of the mountain chemical mineral raw materials and anthropogenic pollution. In any case the development of the regional and local protected areas' network (wildlife sanctuaries, national monuments, small reserves, animal reproduction zones, etc.) could make up the deficit of the total ecosystem's diversity presentation in the Russian federal mountain protected areas' network.

It is necessary to note, that all above mentioned measures, directed to the regional protected areas network's optimization, have to be fortified by improvement both by federal and regional environmental legislation, the main role of which is to solve the problems of wildlife conservation and land use by civilized methods. Lawmaking of the constituent entity of the Russian Federation with mountain territories according to its traditions and priorities could define itself, how many, where and what status of protected areas have to be created. But all of them are authorized to occupy not less than 15–20% of the region territory. Only in this case a region (on the assumption of the principles of the nature protection ubiquity) could turn to the model of the sustainable development. Using only territorial forms of nature protection, there are no perspectives of the mountain flora and fauna conservation.

Therefore, in addition to the territorial forms of protection for the mountain territories, the system of management strategies ought to be changed. For that, the establishment of the exclusive land use regime on the non-protected territories, including preservation of extensive management forms, directed to the spared regime of the nature resources use, is required.

STRATEGIC PRIORITIES OF BIODIVERSITY CONSERVATION

Among the priorities for the preservation of the Russian mountain biodiversity the following ones can be mentioned:

1. Legislation and ecological regulation development;

2. Progress in the international relationship of the mountain biota conservation;

3. Removal of the socio-political, economic and administrative obstacles for introduction of the regional adapted types of biodiversity conservation management;

4. Restoration and enlargement of the mountain regions biodiversity conservation measures' information support;

5. Realization of the large-scale activities for the ecologic reconstruction of the disturbed mountain territories;

6. Development of the scientific (biologic and geographic) surveys, among which the most actual are following:

- analysis of the specific features of the mountains as the extreme (borderline) environment for organisms and communities: ultraviolet and other insolation parameters, daily range of temperature, short vegetative period, low air pressure, wind's regime, environmental unpredictability;

- research of the specific features of the mountain relief as a special environmental factor, affecting biodiversity: natural barriers, isolation, high degree of the habitats' diversity and patchiness, river-valleys' and intermountain basins' drainage;

- the mountain biota evolution, including mountains-plains' relationship survey;

- the high latitude mountains survey;

- survey of the local specificity of the man-mountain ecosystems' mutual relation, combining ecologic and sociologic approaches;

- development of the ideas of the altitudinal and basin mountain territories' structures;

- study of the correlation of the environmental and anthropogenic factors of the mountain ecosystems' evolution, identification of the mountain landuse retrospectives and perspectives, elaboration of the biodiversity conservation economic mechanisms and evaluation of the input of the mountain ecosystems into the global biosphere functioning;

- development of the scientific legislative and normative bases of the mountain ecosystems and biodiversity conservation and use;

- elaboration of the principles of the mountain protected territories and its regional ecologic networks' establishment.

CONCLUSION

What should be done for increasing of the efficiency of the Russian mountain territories biodiversity conservation?

First of all, it is necessary to change the strategy of the protected areas system's establishment by the way of realization of the principle of the ubiquity of the environmental conservation and development of the protected areas ecological networks.

In the second place, it is necessary to maintain the extensive agriculture and to revive the traditional land use in the mountain regions on the base of the examples of the international and national legislative initiatives, regional and multiregional agreements; to introduce the economic incentives for the agrarian activities and the development of the mountain ecologic tourism and other recreational use of the nature ecosystems.

In the third place, it is necessary to develop large-scale activities for the reconstruction of the disturbed ecosystems. Regional ecological funds have to be created for financial support of these activities. These establishments ought to be fulfilled by deductions of subsurface, forest and land use, plant and animal resources utilization. It is important to organize the mountain wild flora's nursery-gardens and centers of rare animals breeding for the planting and seeds materials' supplying.

In the fourth place, the actions on the biodiversity inventory and on the monitoring of their status on the base of the representative reserves and national parks, using the data of the long-term biota and ecosystems observations need to be carried out.

In the fifth place, the development of ecologic and economic evaluation of the mountain territories, their nature resources and consequences of the economic activity has to be realized on a broader scale. In perspective it permits to include the nature capital into the parameters of the regional richness, to practice use of economic mechanism of stimulation for passing to the sustainable use of the mountain biological resources both during the choice of the alternative nature ecosystems use and during the cases when there elimination or degradation are planned.

And finally, in the sixth place, it is necessary to recommend the regions to accept special legislative acts for biodiversity conservation, mountain land use, and participation of local communities in the managing of these processes. ■

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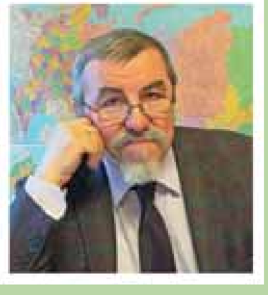

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DEBRIS FLOW AND LANDSLIDE HAZARDS UNDER CERTAIN TYPES OF ATMOSPHERIC CIRCULATION

ABSTRACT. Conditions of formation and development of landslides and debris flows in the Black Sea coast of the Caucasus and on Sakhalin Island were considered. They are formed under the influence of heavy rainfall under the influence of the Mediterranean cyclones outlet in the Black Sea coast of the Caucasus and of the Pacific cyclones outlet on Sakhalin Island in the same macro-circulation processes. Activity of landslides and debris flows in these regions has been shown to be connected with certain types of atmospheric circulation during the XX – the beginning of the XXI century. Based on these results, possible increase in the activity of landslides and debris flows, in the Black Sea coast of the Caucasus and Sakhalin Island, is suggested.

KEY WORDS: debris flow, landslide, atmospheric circulation, Black Sea coast of the Caucasus, Sakhalin Island

INTRODUCTION

Assessment of a debris flow and landslide hazard in the current period of unstable climate and possible extreme situations is very important. It is especially important for the Caucasian Black Sea coast. These processes, which constantly threaten tourism and the economy there, result from mass construction projects such as those expected in preparation for the XXII Olympic Winter Games of 2014 in Sochi. Assessment of a debris flow and landslide hazard on Sakhalin Island is also very important in connection with the increase of the natural extremes frequency. More than 100 towns and villages are subjected to the influence of these processes. Annually, landslides remove from the use dozens kilometers of railways and highways and complicate the construction of many objects. Direct damage to roads and highways alone is estimated to be hundred thousands of rubles annually; the indirect damage associated with lost economic benefits from prolonged interrupted road network conductivity and construction is also high, but it is difficult to estimate it exactly. This paper presents the assessment of a hazard of debris flow and landslide made through analysis of their activity and the degree to which they affect the territory. Data on the debris flow and landslide activity in the past and present were analyzed using data on basic variable factors of their formation – meteorological and anthropogenic, in their interaction with geomorphological conditions.

METHODS AND DATA

Initial data in the assessment of a mudflow hazard included information on previous debris flows in the region under study, the data of the Sakhalin hydro-geological expedition and other organizations as well as meteorological data: air temperature and precipitation measurements from the nearest *hydrometeorological* stations *and the history of* alternation of *elementary circulation mechanisms* ((abbreviated to ECM) *in the atmosphere of the Northern Hemisphere according to the classification system by B.L. Dzerdzeevskii [Dzerdzeevskii, 1962; Kononova, 2010, 2011].* For each case of mud flow and landslide occurrence, the circulation type and meteorological indicators were identified.

CONTENT OF INVESTIGATIONS

The basic characteristics that are used to assess the hazard of debris flows and landslides include intensity of these processes on a territory, sizes of simultaneously formed debris flow cones, discharges and velocities of debris flows, and activity of debris flows and landslides manifestations. Here, activity of a process may be defined as the frequency of natural hazards or duration of the period between them [Landslides and mudflows 1988; Natural hazards of Russia, 2002]. The area destruction by debris flow and landslide is a typical occurrence; their activity depends on meteorological factors, seismic factors and human activity [Sheko, Malneva, 2002].

Debris flow activity changes with time and is subject to cyclic variations of different duration, depending on the factors causing debris flow development. The debris flow and landslide hazards in a particular basin or a region depend on the overall activity, which directly depends on the weather extremes [Lin, Lee, 2008; Ma, Huang, Xie, Zhong, 2008; Kononova, Malneva, 2007].

At present, the Black Sea coast of the Caucasus is characterized by a low hazard of debris flows. Predominantly, the debris flows there have a capacity of 10,000 m^3or less and a low frequency (once per 15–30 years). In the highlands, the debris flow frequency is higher: once per 8–15 years. The generating sources of the most hazardous debris flows are located in the belts of high and medium-height mountains. The capacity of debris flows can change from a few tens and hundreds m^3 to 100,000 m^3 or more. Activity of debris flows is closely connected with the regime of precipitation.

GENERAL CHARACTERISTICS OF DEBRIS FLOW AREAS

Depending on the factors that cause formation of debris flows, the following debris flow-hazardous regions in the Black Sea coast of the Caucasus can be distinguished in the territory under investigation:

Debris-flows that are formed on small watercourses and ravines flowing directly into the Black Sea. Their activity is especially high in the area of Novorossiysk city where water-stony debris flows are formed predominantly due to intensive rainfalls and dumps from cement quarries. The slopes are composed of the Upper-Cretaceous flysch and loose sediments of 2–3 m and sometimes up to 10 m thick. Debris flows along these watercourses have often damaged railways (in 1946, 1950, 1953 and 1958, as well as in 2009 and 2010), causing interruptions in train traffic, sometimes for 10 days. In the area stretching from Tuapse to Adler, the debris flows are formed mainly in landslide-generating sites. The character of these debris flows is usually erosive due to washing-out of accumulated sediments in stream channels [Landslides and mudflows, 1988].

Debris flows in high and medium-height areas of the Main Caucasian Ridge, which form due to washing-out of loose fragmental rock material entering the channels of temporary and small water streams in the form of mud avalanches, slides, and debris. In the alpine zone, ancient moraines play a great role in the formation of hard material.

Until the 1950s, recoding of debris flow manifestations was not conducted in the above-mentioned regions, with the exception of the most hazardous territories, i.e. the cities of Novorossiysk and Tuapse. Presently, data on the number of previous debris flows are also insufficient. In the 1970s, scientists from VSEGINGEO carried out a geo-engineering study of the Black Sea coast and the adjacent mountainous territory. As a result of these investigations, a map was compiled, identifying the watercourses in the areas of Novorossiysk and Tuapse and some watercourses in the highland zone of the Mzymta River Basin as debris flow-hazardous. The dense forests of the highland and medium-height areas and small-scaled investigations (1:200000) made it impossible to characterize the debris flow streams of this territory in more detail, but it was noted that no high intensity of debris flows was observed. According to the data obtained during investigations in recent years, 40 mudflow-hazardous streams were registered in the Krasnaya Polyana area, 37 of them located in the Mzymta River basin (mainly from the northern slope of Aibga Ridge) and 3 streams located in the basin of the Psou River (the southern slope of Aibga Ridge).

It is noted that the most hazardous debris flows are formed in high mountains and medium-height areas along watercourses that cut through cirque moraines or along channels filled with slide material in the zone of clayey shale and argillites (streamlet Galion – 2, Vodopadnaya, Tobias, Sulimovsky and others). Due to the steep slopes of channels, floods in small debris flow-hazardous basins are characterized by short lag times, sharp rises and falls of water levels, and high water discharges.

As follows from these studies, during recent years the debris flow hazard on the investigated territory has grown, mainly as a consequence of the increased intensity of anthropogenic impacts and, in particular, by deforestation and the related erosion on the slopes. Generally, such tendency was observed in the Caucasus during the past several decades.

An increase in the intensity and activity of the debris flow process is considerably connected with the geological conditions of a territory under investigation and is observed in areas composed by metamorphic, terrigenic and flysch rocks of different ages, especially of the Lower- and the Middle-Jurassic period. The strength of clayey and aspid slates, found in the upstream of Mzymta River, is highly dependent on the wetting degree. Of attention is the slight ductility of argillites, clayey shale, and aleurolites to weathering processes, especially in the areas of tectonic crushing. In many cases rocks are soaked and swollen or become even fluent. On clayey shale, such a zone with highly soaking heavy loams with inclusion of rock debris can have a thickness of 1 to 5 m. Typical for such rocks is a decrease in resistance to shearing and development of a sliding process, including in sites of originating debris flows. Simultaneous with this is decreasing resistance to erosive wash-out. It is natural that in the zone of the Lower-Jurassic and the Eocene-Oligocene clayey rocks that are less resistant to denudation, and the loamy slope formations of different genesis, mud-stony streams varying in thickness and density develop.

Investigations of the conditions of forming debris flows on the Black Sea coast of Caucasus and in the adjacent mountainous areas have established that the basic factor influencing their activity is the degree and regime of territory wetting.

Analysis of all known cases of debris flow formation makes it possible to note that a close linkage exists between precipitation and debris flows in the region under investigation, especially in lowlands [Methods of permanent forecast of exogenic geological processes, 1984]. Thus, in the area of Tuapse and Novorossiysk, the daily precipitation amount during mudflows exceeds, as a rule, 100 mm. Sources of hard stony streams there are small-sized landslides, detrital cones of ravines, covers of alluvial sediments at slope foots, and sediments from the channels washed out by floor erosion. The high mudflow hazard of the Tuapse region is evidenced by the sad events that occurred in the beginning of August 1991, which struck the mountains and the coast in the area of Tuapse-Sochi and spread to the northern macro-slope up to Maikop City. During the night from July 31 to August 1, heavy rain fell in these areas. The rainfall caused a high water level in the rivers

Table 1. Daily precipitation sums in August 2002

Settlement	Date	Daily precipitation sums (mm).	Long-term period average monthly precipitation sums (mm)
Novorossiysk	5	69.0	45
	6	12.8	
	7	8.0	
	8	58.2	
Anapa	5	24.6	34
	6	62.4	
	7	61.9	
	8	55.5	

and activated mudflows. A similar tragedy occurred there in October 2010.

In the area of Novorossiysk, the catastrophic manifestation of mudflows in August 2002 was also caused by anomalous precipitation. The center of catastrophic events was in the area of Novorossiysk city. Heavy rains covered the entire Krasnodar Region and caused mud streams. The precipitation amounts for those days are presented in Table 1.

Thus, on some days (5 and 8 August, in Novorossiysk, and August, 6–8 in Anapa), daily precipitation sums exceeded the long-term monthly averages.

The above-indicated precipitation amounts are indeed high. However, in July in the same area, the rainfall was also heavy, Novorosiysk, 23 July – 42.4 mm, 24 July – 89.9 mm), yet here were no reports of floods or debris flows. The first significant manifestation of debris flows happened on 6 August and the next rains fell on the territory when it was already conditioned for the intensification of exogenic processes by the weather of the previous period, thereby causing mass debris flows and intensification of landslides in the surface sediments. This event is evidence that previously existing meteorological factors play a significant role in the exacerbation of the effect of short-term precipitation on debris flow generation.

It is known that in the northwestern part of the Black Sea coast, the most mudflow-hazardous in the sliding and erosive-sliding sites were the years with increased humidity – 1960, 1962, 1967, 1970, etc. In these years, the meteorological stations of Anapa and Novorossiysk recorded an increase of days with heavy rainfall. In the area of Tuapse and Novorossiysk, the daily precipitation amount exceeded 100 mm in all cases of debris flows. As we have established, in this part of Caucasus, the daily maximum precipitation is highest in those years when the monthly and annual precipitation amounts considerably exceed the long-term period average precipitation sums.

It should be noted that the multi-year course of the annual precipitation on the Black Sea coast and in the adjacent territory of the North Caucasus (Sochi, Krasnaya Polyana) varies little. The seasonal variation in precipitation is also similar among stations in this region.

In several years (1924, 1932, 1937, 1939, 1940, 1953, 1955, 1958, 1967, 1977, 1988 – 1989, 2002), annual precipitation far exceeded the norm. The territory under investigation is characterized by a high homogeneity of the multi-year precipitation regime, as confirmed by the high correlation coefficients between the series of annual precipitation at different meteorological points. These coefficients are equal to: Achishkho – Krasnaya Polyana – 0.89; Achishkho – Goitkh – 0.76; Sochi – Krasnaya Polyana – 0.89. However, according to the values of heat and moisture provision, the regime of meteorological factors in the highlands and medium-height areas significantly differs from that of the coast and the piedmont areas by both the sum of precipitation and the years with precipitation extremes.

Debris flows on the Sakhalin Island. The geological structure of the Sakhalin Island is dominated by the loose types: argillite, clays, aleurolite. Argillites practically become soggy easily. The clays also become soggy easily and particularly quickly lose strength when the mode of moistening changes. The territory is dominated by the areas where temperature and moisture regimes fluctuations occur frequently during springtime, which cause loss of strength of soils and increase of their weight, promoting landslides.

The high activity of landslide and mud flow processes depends, first, on meteorological factors: atmospheric precipitation and air temperature. In the last years, the highest activity was in 2002; the territory was subjected to extreme fluctuations of moistening.

FEATURES OF ATMOSPHERIC CIRCULATION

Debris flow formation on the investigated territory depends not only on absolute values of air temperature and precipitation amounts, but also on the character of weather in general which can be quantitatively expressed by the number of days with various macro-circulation processes in the Northern Hemisphere [Dzerdzeevskii, 1962].

For analysis of circulation conditions it is reasonable to use the classification of elementary circulation mechanisms (ECMs) of the Northern Hemisphere, developed by B.L. Dzerdzeevskii jointly with his graduate students The information on the classification can be found also in [Kononova, 2010] or on the website www.atmospheric-circulation.ru [Kononova, 2011]. The entire variety of circulation processes in the Northern Hemisphere is represented in this classification by 41 ECMs. For each ECM the dynamic schemes of cyclone movement and anticyclone position is given, allowing the modeling of the manifestation of each ECM in any region of the Northern Hemisphere.

The history of ECM variability is compiled from 1899 to the present, indicating the appropriate ECM for each day. By comparing the time of debris flow intensification with the calendar of ECM alternation, we established the specific ECMs at which debris flows have occurred. In the erosion sites, these are the ECMs that cause intensive destruction of rocks due to frequent changes of their wetting state into drying and freezing into thawing, as well as intensive run-off of weathering products and wash-out of channel sediments.

In the sliding sites for the formation of debris flows, of importance are precipitation amounts and regimes that cause decreased slope stability. Here, debris flows are correlated with those macro-circulation processes at which the probability of rainfalls is 60% or greater, or 10% or less, the latter most often characterized by heavy rains.

It was established that the most dangerous weather for sites of debris flow origination in the research areas on the Black Sea coast and in the adjacent territory of the North Caucasus is connected with those ECM patterns at which Mediterranean cyclones move over the Black Sea coast of the Caucasus. The unstable weather, brought by these ECMs, forms favorable conditions for alternate wetting-drying of easily breakable rocks in debris flow-generating sites and accumulation of loose detrital rock materials; intensive rainfalls cause run-off of crushed rock materials and formation of liquid debris flows. The same ECMs are dangerous for the watershed of the Mzymta River and the adjacent areas of the Krasnodar Region. Their dynamic schemes are shown in Figure 1. In

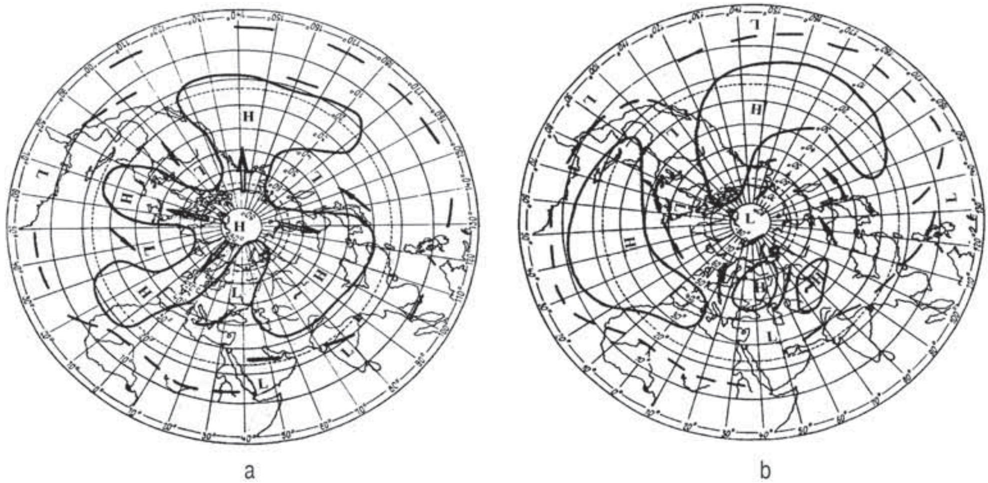

Fig. 1. Dynamic scheme of ECMs 12a (a) and 13s (b):
Letters 'H' and 'L' denote high atmosphere pressure (anticyclone) and low atmospheric pressure (cyclone), respectively

these schemes, it is clear that the southern cyclones enter the Black Sea coast of the Caucasus and Sakhalin.

On Sakhalin Island, in the same ECMs, the weather extremes are formed due to the Pacific southern cyclones outlet. The most significant precipitation on territory of Sakhalin and in the other parts of the Far East region are connected with ECM 13s (Viakhtu, 16.09.52 – 33.8 mm per day, Holmsk, 23.07.57 – 25.8 mm); ECM 9a, as well as ECM types 8 and 12. The frequency of these ECMs is increasing at present.

The typhoon output frequency on Sakhalin increases under ECM 13s. The calculations based on weather maps show that, in the last decennial events, frequency of typhoons near Sakhalin increased. The most powerful typhoons on Sakhalin for the last decennial events and types of atmospheric circulation, existed at this time, are presented in Table 2.

As defined earlier, very dangerous, for debris flow and landslide processes, is also weather under ECM 12a. Under this ECM, Sakhalin influenced by the area with considerable changes of weather that promoted mud

Table 2. The strongest typhoons in the Pacific and ECM in the period of its action over Sakhalin

Year	Date	Name of typhoon	ECM in the period of typhoons activity
1961	September 16–17		5d
1972	September 12–16	"Maria"	13s, 12a
1981	August 5–6	"Fillis"	13s
1992	August 14–17	"Robin"	13s
1996	September 23–26	"Violetta"	9b, 13s
2000	September 5–6	"Saomai"	13s
2002	July 11–15	"Chataan"	13s, 3
2002	September 2–3	"Rusa"	13s

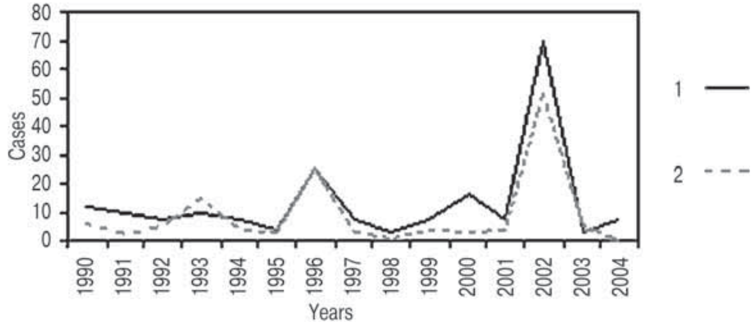

Fig. 2. Mud flow and landslide processes activity in the Makarov area during 1990–2004.

1 – landslide, 2 – mud flow

flows. In all cases, the activity of landslide and mud flow on Sakhalin was primarily associated with typhoons; weather patterns that existed for the entire period prior to the occurrence of these hazards are of great importance. For the center of Sakhalin, mud flows on clay types were associated with the most dangerous weather under ECM 13s, when intensive moistening promoted formation of debris flow. Changes of landslide and debris flow activities (per year) in 1990–2004 are shown at Figure 2.

In 2004–2008, the conditions were virtually completely stable in all areas of the observations, both on the western and eastern coast, which was due to the lack of humidity. [Gensiorovsky, Kazakov, 2009]; there was only a local increase in occurrences in Makarov in the spring of 2007, but this was due to the intensive melting of snow (there were superficial landslides and mud flows within a very small area).

In 2009, on 22–24 June, there was a strong intensification of landslides and debris flow on Sakhalin Island [Gensiorovsky, Kazakov, 2009] at ECM 12bs (June 22) and ECM 12a (June 23–24). There were more than 50 cases of debris flow (mostly mud-stone and mud flow). Intense landslide activity was also recorded. These were mainly mud-streams – small- and medium-power landslides typical for this area.

In 2010 on Sakhalin, there were two periods of intensification on the western (Kholmsk and Nevelsk areas) and southern (Korsakov) coast. According to the information received from Yu.V. Gensiorovsky and N.A. Kazakov,

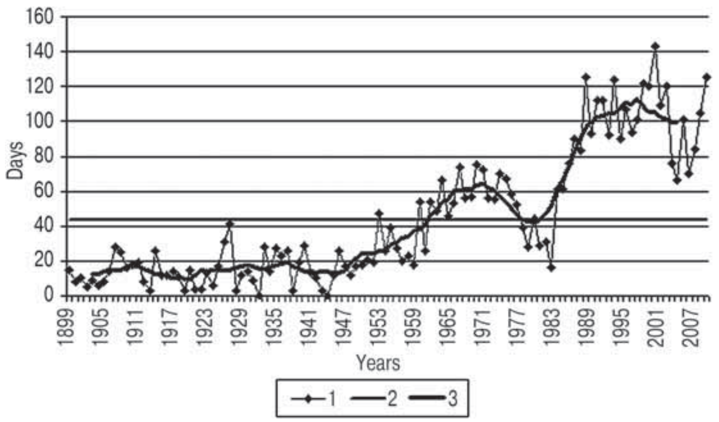

Fig. 3.Total annual duration of ECM 12a and 13s for 1899-2010:

1 – annual duration, 2 – average for 1899 – 2010, 3 – annual duration smoothed over 10 years the massive intensification of events occurred in Nevelsk and Korsakov on 28–30 July (on 28 – ECM 8vs, on 29-30 – ECM 13s); on 10–12 August (ECM 9a), the massive intensification was recorded in the Kholmsk district [Musohranova, Gensiorovsky, Kazakov, 2010].

The total annual duration of these ECMs (Fig. 3) according to 2010 data significantly exceeds the average duration for 1899–2010. The recent tendency is depicted by curve 3 (10-year smoothing). As shown, the total annual duration of precipitation-forming ECMs, for the Black Sea coast and Sakhalin in the modern period, is the highest of all time since 1899. This suggests that, in the nearest 10–15 years, the risk of debris flows in these regions will remain high.

ANTHROPOGENIC INFLUENCE

The natural conditions of mudflow formation on the territory under study are significantly disturbed by anthropogenic activities, the intensity of which is presently increasing rapidly. All this considerably affects the geological environment. Land development causes flooding of the ground strata, rise of the groundwater level, soaking of the soil and a decline of its strength, which, in much of the region, is not high, as described above. When the natural and anthropogenic factors act jointly, the hazard of mud flows in rock complexes will be especially high.

Taking into account the construction of the Olympic buildings in Krasnaya Polyana, generation of stony components will considerably increase and, with anomalous wetting, can lead to formation of debris flows with a capacity of up to 200,000 m^3 [Malneva et al, 2008].

The hazard of debris flow formation is explained by the fact that even small debris flows formed, for example, in water streams on the slope of the Aibga Ridge, can act jointly with the active landslides developed on the left- and right-hand shores of the Mzymta River. As a result, the Mzymta can be dammed by a catastrophic debris flow. Therefore, special attention should be given to the assessment of the present-day activity of landslides of different genetic types and to their possible manifestations as sources of the hard component of debris flows.

Attention should be also paid to other areas with high landslide intensity in the Mzymta River basin, in particular, in the basin of the Medoveevka River, which can be associated with large-volume debris flows. Additionally, a very dangerous area is the basin of the Kepshi River, characterized by an extremely high risk of debris flows that are connected with landslide-originating sites. With the intensification of a landslide, the formation of a catastrophic debris flow of a capacity of up to 300,000 m^3 is possible.

CONCLUSIONS

1. In the nearest years, one should expect an increased debris flow hazard on the Black Sea coast, in the adjacent mountainous areas and on Sakhalin due to the increasing intensity and activity of the debris flow formation process as a result of natural and anthropogenic factors.

2. With a considerable increase in debris flow hazard, debris flows in this region can form in locations with no previous debris flow activity. Due to the expected increasing technogenic load connected with the Olympic Games of 2014, the total impact of natural and anthropogenic factors can be especially high. Many economic objectives can be hindered by even small debris flows. Thus, for certain structures, including oil and gas pipelines and highways, even debris flows of low capacity will be dangerous. They can interrupt traffic for an extended period of time and cause significant material damage.

3. In connection with the current character of the atmosphere circulation and the high frequency of the south cyclone and the typhoon outlets in the years ahead, there exists a high danger of intensification of the landslides, debris flows and other disastrous natural processes on Sakhalin island. The

area of Makarov requires special attention; there, the landslides and debris flows are already intense and the intensification of these processes is possible in future years.

4. Although it is not possible to prevent catastrophic events, their negative consequences can be minimized through systematic monitoring of hazardous exogenic processes.

ACKNOWLEDGEMENT

This article was performed within the Russian Foundation for Basic Research, Project 11-05-00573. ■

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SUSPENDED AND DISSOLVED MATTER FLUXES IN THE UPPER SELENGA RIVER BASIN

ABSTRACT. We synthesized recent field-based estimates of the dissolved ions (K^+ Na^+ Ca^{2+} Mg^{2+} Cl^- SO_4^{2-} HCO_3^-), biogens (NO_3^-, NO_2^-, PO_4^{3-})(C, mg/l), heavy metal (Fe_{sum}, Mn, Pb) and dissolved load (DL, kg/day), as far as suspended sediment concentration (SSC, mg/l) and suspended load (SL, kg/day) along upper Selenga river and its tributaries based on literature review and preliminary results of our 2011 field campaign. The crucial task of this paper is to provide full review of Russian, Mongolian and English-language literature which concern the matter fluxes in the upper part of Selenga river (within Mongolia). The exist estimates are compared with locations of 3 main matter sources within basin: mining and industry, river-bank erosion and slope wash. The heaviest increase of suspended and dissolved matter transport is indicated along Tuul-Orkhon river system (right tributary of the Selenga River where Mongolia capital Ulanbaatar, gold mine Zaamar and few other mines are located). In measurement campaigns conducted in 2005, 2006 and 2008 the increase directly after the Zaamar mining site was between 167 to 383 kg/day for Fe, between 15 and 5260 kg/day for Mn. Our field campaign indicated increase of suspended load along Tuul river from 4280 kg/day at the upstream point to 712000 kg/day below Ulaanbaatar and Zaamar. The results provide evidence on a potential connection between increased dissolved and suspended matter fluxes in transboundary rivers and zones of matter supply at industrial and mining centers,

along eroded river banks and pastured lands. The gaps in the understanding of matter load fluxes within this basin are discussed with regards to determining further goals of hydrological and geochemical surveys.

KEY WORDS: mass flow, suspended and dissolved matter transport, transboundary rivers

INTRODUCTION

Matter supply into water systems affects humans and the natural environment world-wide. Both natural processes, such as dissolution of substances from weathering soil and rock, and anthropogenic activities, particularly from the agriculture and industry sectors (UNEP, 2009), can cause suspended and dissolved matter transport. Suspended and dissolved particles transported by river flow can originate either from input into channels from drainage basins (basin-sourced sediment) or from particle detachment within the channels themselves from their beds and banks (channel-sourced sediment). On any river one can find intensively eroded channel banks and recently formed accumulative within-channel bars. The different sources and characteristics of the channel particles, as well as the different river processes, induce heterogeneities in particle compositions and ultimately determine the unequal fall velocities and sediment distributions. Vertical sediment fluxes significantly correlate with transporting capacity. Near-bottom sediment exchange is the result of general laws of matter movement which are governed by the turbulent diffusion equation [Alexeevsky, 2006]:

$$\frac{\partial s}{\partial t}=\frac{A}{\rho}\left(\frac{\partial^2 s}{\partial x^2}+\frac{\partial^2 s}{\partial y^2}+\frac{\partial^2 s}{\partial z^2}\right)- -\left(v\frac{\partial s}{\partial x}+u\frac{\partial s}{sy}+w\frac{\partial s}{\partial z}\right)-\omega\frac{\partial s}{\partial y}, \quad (1)$$

where the different terms reflect impacts of turbulent transport, advection, dispersion, convection and gravity, respectively, and A is the turbulent exchange coefficient, ρ – water density, ***s*** – suspended sediment concentration at the point, ***u***, ***v***, ***w*** – local velocity vectors. In basin-scale transport assessments, a crucial task is connected with the quantification of the advection and dispersion terms. Key challenges are furthermore to identify the exact locations of main sources in river basins, and the different contributions of natural and anthropogenic impacts.

Understanding of matter fluxes along river system depends on the monitoring system. In transboundary river systems, single and coherent monitoring is often incomplete due to administrative reasons. Large efforts in terms of field measurement campaigns and (numerical) transport modeling are then typically needed for relevant pollution prediction and prevention. The transboundary river system of Selenga is particularly challenging, being for instance the biggest tributary of Lake Baikal, the largest freshwater reservoir of the world. Selenga River contributes with about 50% of the total inflow into Baikal. It originates in the mountainous part of Mongolia and then drains into Russia. There are numerous industries and agricultural activities within the Selenga drainage basin that affect the water quality of the river system. Historically the principal land use is grazing. Other land uses include mining, forestry, and row crop agriculture. In the Mongolian part of the basin, waters of the Orkhon river, downstream Tuul river, and the Eroo rivers are reported to get impacted [Integrated Water, 2010]. Orkhon, Tuul, Kharaa and Khans are experiencing increased pollution by urbanization and industrial activities within the basin [MNE, 2007; Batimaa et.al, 2011]. At the same time rivers drain broad alluvial valleys and thus are distinguished by high rates of bank erosion. Matter fluxes of the rivers is effected by both natural (bank erosion) and anthropogenic (mining and slope wash from the deforestated lands and pastures) drivers.

Suspended and dissolved matter fluxes have been reported to increase in recent times [Boyle et al., 1998; Khazheeva et al., 2006].

At the same time, constant observations of sediment and dissolved matter mass flows in the upper Selenga basin (within Mongolia) have never been performed [Ecosystems..., 2003]. Therefore field surveys are considered to be the main source of information for suspended and dissolved matter fluxes analyses. Although extensive research has been conducted on the water quality of Lake Baikal and on the Russian reaches of the Selenga river [Munguntsetseg, 1984; Ubuganov et al., 1998; Dambiev and Mairanovsky, 2001; Garmaeva, 2001; Korytny et al., 2003; Khazheeva et al., 2004], limited information is available on the conditions of the upstream basin, in Mongolian rivers. Few studies have addressed matter movement in small catchments [Dallas, 1999; Onda et. al, 2007]. Long-term abundant research has been performed by IWRM MoMo project in the Khara river basin [IWRM-MOMO www.iwrm-momo.de] which include study on material flow and mass balances within inter- and transdisciplinary approach of the project. Full review of the single observations of water quality and suspended load of the whole Mongolian part of the basin was done earlier by Soviet [Kuznetsov, 1955; Hydrological regime..., 1977] and Mongolian scientists [Batimaa, 2000]. Limited field campaigns have recently focused on the investigation of the whole Selenga river basin [Stubblefield et.al, 2005; AATA, 2008; Baljinnyam et.al, 2009; Integrated water..., 2010; MCA 2011] and were recently complemented by our field works in 2011. The latter included measurements in the Selenga river (Mongolia and Russia) in 2011 to understand current sediment and dissolved loads of the transboundary river system during summer floods.

In the current paper we mainly focus on combining in-situ measurements with syntheses of field study results in the upper Selenga basin. A main difficulty of this work was to interpret and combine suspended sediment concentration (SSC) and dissolved concentration data and river discharge data (Q) in such a way that mass flows (Mf) could be estimated. The difficulty is generally to find data with sufficient spatial and temporal resolution, such that for instance the sampling points and sampling time for the concentration measurements are consistent with existing discharge measurement data series. Uncertain mass flow estimates of water-borne pollutants are an issue in many regions of the world due to shortcomings within monitoring systems [e.g. Zhulidov et al., 2003; Bring and Destouni, 2009].

This paper focuses on generating a contemporary full review of hydrochemical data, illustrating the suspended and dissolved matter transport. The paper aims at providing an understanding of the sources of matter input into river systems and its qualitative assessment. The work more specifically aims at quantifying downstream impacts of various sources based on limited monitoring data, a condition that the presently considered region shares with many fast developing regions of the world. Understanding of diffuse as well as point source zones of matter supply is essential to the knowledge needed for more detailed impact assessments and management decisions, regarding remediation planning and measures.

METHODS AND MATERIAL

The study area covers the upper part of the Selenga basin within Mongolia (Fig. 1). The Mongolian portion of the Selenga River watershed is composed predominantly of broad alluvial valleys flowing through steppe grasslands with source areas in taiga and mountain ecosystems. Maximum river discharge is driven by the spring melt of the accumulated snowpack. A second peak in river hydrographs is observed in late summer, August or September, during the rainy season. Our field campaign was conducted during the summer runoff increase and thus under the conditions of significant increase in sediment and dissolved matter concentrations.

Existing estimates of suspended and dissolved solids concentration were synthesized and analyzed in terms of spatial distribution in river basin, its temporal variability and possible linking with various sources of matter supply. We used gathered data to assess mass flow in a river which represents the matter mass that passes through a cross section (also referred to as a control plane) of the river per unit of time. Mass flows are products of local concentrations and discharges, according to

$$Mf = C_i Q_i, \quad (2)$$

where C_i is the concentration (SSC or C) at the control plane for (given) time t_i, and Q_i is the water discharge through the control plane for (given) time t_i. Time period was applied as 1 day, therefore the MF (both DL and SL) was estimated as

$$Mf = 86\,400\, C_i Q_i. \quad (3)$$

The analyzed dissolved and suspended matter concentrations (dissolved and particulate) were synthesized from our 2011 measurements and reviews and reports devoted to measurements campaigns in rivers of the region [Kuznetsov, 1955; Votincev K.K. et al., 1965; Hydrologic regime..., 1977; Stubblefield et al., 2005; AATA 2008; Integrated Water..., 2010]. Gathered information covered observations at Tuul, Orkhon, Selenga, Eroo, Khangal and Egiin-Gol rivers at 14 gauging stations.

In our 2011 (July–August) field campaign water samples for total suspended sediment concentration (SSC) assessment were collected from the rivers of the Selenga basin in Mongolia. The hydrological field measurements included discharge, turbidity (T), suspended sediment concentration (SSC) and major dissolved ions concentration (Ca^{2+}, Mg^{2+}, K^+, Na^+, Cl^-, SO_4^{2-}, HCO_3^-). This paper does not introduce to the results of our samples analyses of biogens (nitrogen and phosphorous) and heavy metals (such as Zn, Cu, Ni, Cd, Pb) content in water and in sediments (bed and suspended).

In all reported works the discharge measurement and sampling procedures followed standard methods. Depth-integrated water samples were collected with a GR-16M bottle sampler at the midstream. Turbidity was measured on site using portable "HACH" 2100P meter. To study SSC the samples were filtered through pre-weighed membrane and paper filters with the "Millipore" filtration system. The samples were then oven-dried and re-weighed. Discharges were determined from bridges, by boat or by wading in two ways. In the first case, flows were measured with a hydrometric propeller ISP-1 at the one-fifth depths of each width increment. The total water discharges were calculated by multiplying the discharge flow velocities with cross-sectional areas of the rivers. The total sediment discharges were calculated by multiplying sediment-load velocities with average SSC-values and cross-sectional areas of the rivers. When the depth was more than 1.5 meters the Acoustic Doppler Profiler (ADP) was used.

For the present study we used information only from the stations, where any relevant hydrochemical measurements have earlier been performed. Observations at 14 stations from total 35 were used for present analyses, comprising data on suspended sediment load (SSC and SL) and concentration of dissolved ions (Ca^{2+}, Mg^{2+}, K^+, Na^+, Cl^-, SO_4^{2-}, HCO_3^-). Documented field monitoring stations are located at Tuul river (T): upstream from Ulaanbaator (T-1), at Ulaanbaatar (T-2), downstream from Ulaanbaatar (T-5), upstream from Zaamar goldfield (T-3), at Zaamar (T-4) and near the confluence with Orkhon river (T-6); Orkhon river at Kharkhorin Town (O-1), downstream from confluence with Tuul river (O-6),downstream from confluence with Tuul river (O-8) and above Selenga river (O-9); low reach of Egiin-Gol river (EG), low reach of Eroo river (ER) and Khangal river downstream from Erdenet (H-1) and Selenga river near Hutyk village (S-1).

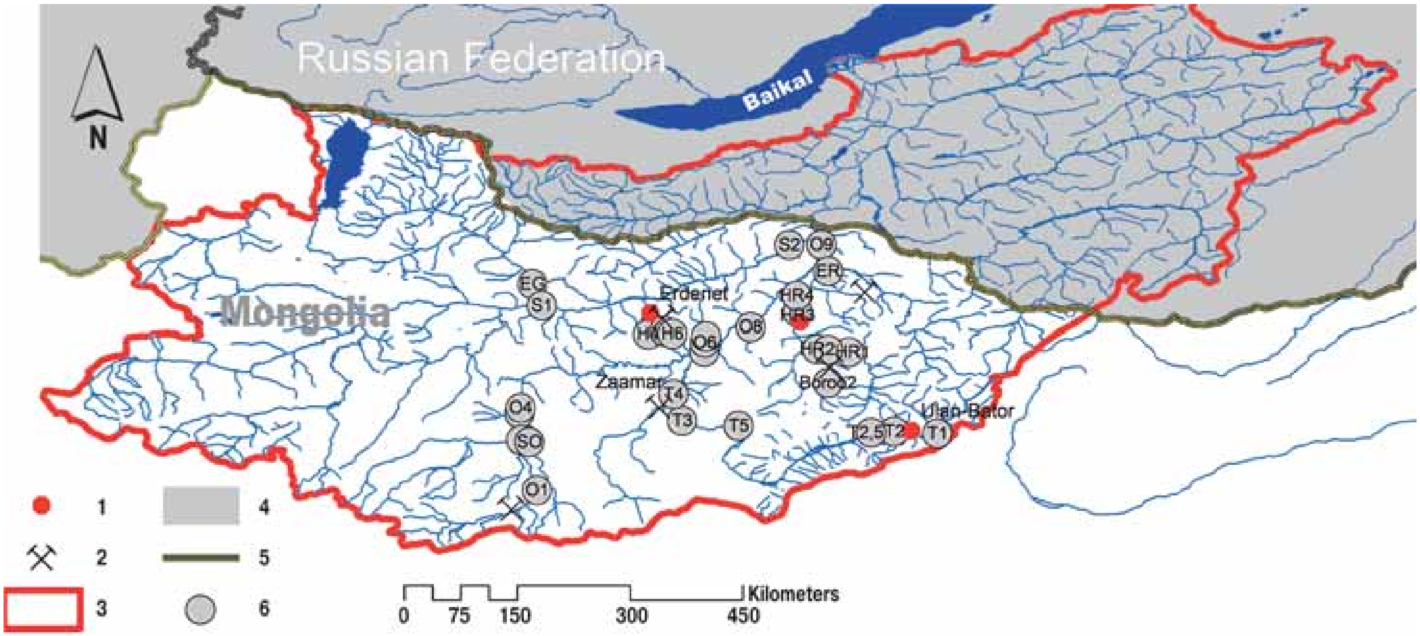

Fig. 1. Sampling points and measured turbidity in the upper Selenga river basin during 2011 field campaign:

1 –cities; 2 – mining areas; 3 – Selenga basin watershed; 4 – territory of Russian Federation; 5 – state border; 6 – sampling points

CONTEMPORARY ASSESSMENTS OF SUSPENDED AND DISSOLVED MATTER FLUXES

The synthesized data concerning suspended sediment load is presented in table 1, whereas table 2 is devoted to dissolved load. Analyses of the contemporary spatial distribution of water quality parameters in the upper Selenga rivers demonstrate, that there are few driving forces in supply of material into river networks. The main sources are primarily associated with mining activities, in-channel processes and slope erosion (Fig. 2).

According to existing estimates, considerable increase of dissolved load is observed along the Tuul river. Mass flows are relatively low upstream, but can increase by orders of magnitudes directly indicating a significant impact from the mining activities, Ulaanbaatar

a

b

c

Fig. 2. Main sources of matter supply

a – mining (Zaamar),
b – in-channel (bank) erosion
(Orkhon river upstream from Tuul confluence),
c – slope wash (near Kharkhorin village)

Table 1. Estimates of suspended sediment concentration (SSC) and suspended load (SL) along upper Selenga rivers

Station	Description	Date	SSC, mg/l	Q, m^3/s	Mass flow, kg/day, 10^3	Reference
T-1	Tuul river upstream from Ulaanbaatar	23 Jul 2011	1,68	29,5	$4{,}3 \cdot 10^3$	Present study
T-2	Tuul river downstream from Ulaanbaatar	1959–61	41,8	55,0	$198{,}6 \cdot 10^3$	Hydrologic regime..., 1977
		25 Jul 2011	5,86	22,8	$11{,}5 \cdot 10^3$	Present study
T-3	Tuul river upstream from Zaamar	27 Jul 2011	107	33,4	$308{,}8 \cdot 10^3$	Present study
T-4	Tuul river at Zaamar	1935	330	34,0	$969{,}4 \cdot 10^3$	Hydrologic regime..., 1977
		26 Jul 2011	289	28,5	$711{,}6 \cdot 10^3$	Present study
T-6	Tuul river upstream confluence with Orkhon river	3 May 1934	79,0	17,7	$120{,}8 \cdot 10^3$	Kuznetsov, 1955
		4 Aug 1934	643	65,3	$3627{,}8 \cdot 10^3$	Kuznetsov, 1955
		26 Aug 1934	716	33,5	$2072{,}4 \cdot 10^3$	Kuznetsov, 1955
		17 Oct 1934	11,0	20,0	$19{,}0 \cdot 10^3$	Kuznetsov, 1955
		7–12 Aug 2001	59	11	$56{,}1 \cdot 10^3$	Stubblefield et.al, 2005
		18–24 Aug 2001	74	15	$95{,}9 \cdot 10^3$	Stubblefield et.al, 2005
		6 Aug 2011	184	29,2	$464{,}2 \cdot 10^3$	Present study
O-1	Orkhon river at Kharkhorin Town	1964–65	41,7	32,9	$118{,}5 \cdot 10^3$	Hydrologic regime..., 1977
		28–30 Aug 2011	1261	–	–	Present study
O-6	Orkhon river upstream from the confluence with Tuul river	7–12 Aug 2001	68	25	$146{,}9 \cdot 10^3$	Stubblefield et.al, 2005
		18–24 Aug 2001	27	27	$63{,}0 \cdot 10^3$	Stubblefield et.al, 2005
		6 Aug 2011	215	–	–	Present study
O-8	Orkhon river downstream from the confluence with Tuul river	5 May 1934	121	22,3	$233{,}1 \cdot 10^3$	Kuznetsov, 1955
		6 Jul 1934	227	71,4	$1400{,}4 \cdot 10^3$	Kuznetsov, 1955
		28 Jul 1934	1695	283	$41444{,}8 \cdot 10^3$	Kuznetsov, 1955
		17 Aug 1934	144	88,2	$1097{,}3 \cdot 10^3$	Kuznetsov, 1955
		19 Oct 1934	9,70	61,9	$51{,}9 \cdot 10^3$	Kuznetsov, 1955
		7 Aug 2011	141	–	–	Present study
O-9	Orkhon river above confluence with Selenga river	1961–62	110	81,9	$778{,}4 \cdot 10^3$	Hydrologic regime..., 1977
		7–12 Aug 2001	39	70	$235{,}9 \cdot 10^3$	Stubblefield et.al, 2005
		18–24 Aug 2001	37	125	$399{,}6 \cdot 10^3$	Stubblefield et.al, 2005
		11 Aug 2011	63,4	250	$1369{,}4 \cdot 10^3$	Present study
S-1	Selenga river near Hutyk village	18–24 Aug 2001	11,5	434	$431{,}2 \cdot 10^3$	Stubblefield et.al, 2005
		2 Aug 2011	114	178	$1753{,}2 \cdot 10^3$	Present study
EG	Egiin-Gol river, downstream	7–12 Aug 2001	27	–	–	Stubblefield et.al, 2005
		2 Aug 2011	83,2	–	–	Present study
ER	Eroo river upstream confluence with Orkhon river	7–12 Aug 2001	7	26	$15{,}7 \cdot 10^3$	Stubblefield et.al, 2005
		18–24 Aug 2001	32	51	$141{,}0 \cdot 10^3$	Stubblefield et.al, 2005
		11 Aug 2011	7,26	51,1	$32{,}1 \cdot 10^3$	Present study

Table 2. Estimates of dissolved solid concentrations along upper Selenga rivers

Station	Description	Date	DSC, mg/l														Reference
			Σions	K^+	Na^+	Ca^{2+}	Mg^{2+}	Cl^-	SO_4^{2-}	HCO_3^-	Fe_{sum}	Mn	Pb	NO_3^-	NO_2^-	PO_4^{3-}	
T-1	Tuul river upstream from Ulaanbaatar	Jun 2008	–	10,2		2,4	0,2	6,0	0,0	8,9	131,0	–	–	4,2	0,4	–	Integrated Water..., 2010
		Jul 2009	–	10,0		2,4	0,1	7,0	0,0	3,6	–			4,8	0,1	–	
		23 Jul 2011	–	12,1	6,8	0,6	2,8	3,7	–	–	–	–	–	–	0,2	0,20	Present study
T-2	Tuul river at Ulaanbaatar	5 Jun 1953	54,8	0,5	12,5	0,9	2,4	7,4	31,1	–	–	–	–	–	–		Hydrologic regime..., 1977
		20 May 1963	91,1	15,4		10,1	0,6	14,2	2,0	48,8	–	–	–	–	–	–	
		27 Jul 1954	51,0	0,6		10,2	2,2	7,5	2,1	27,4	–	–	–	1,0	–	–	
		28 Jun 1956	111,4	18,4		8,0	3,6	11,6	15,0	54,8	–	–	–	–	–	–	
		15 Oct 1971	449,3	35,6		51,9	11,4	31,6	14,8	298,8	–	–	–	5,2	–	–	
		16 Mar 1963	370,1	0,5		60,0	22,8	14,2	4,2	268,4	–	–	–	–	–	–	
		Jun 2008	–	12,0		2,4	0,2	9,0	0,0	7,1	178,6			6,4	0,0	–	Integrated Water..., 2010
		Jul 2009	–	20,0		1,2	3,1	20,0	0,0	17,8	102,2	–	–	24,2	0,2	–	
		24 Jul 2011	–	0,7	9,5	1,1	2,4	4,5	–	–	-	–	–	–	3,1	3,10	Present study
T-5	Tuul river downstream from Ulaanbaatar, near Lun	Jun 2008	–	20,0		4,9	0,2	29,4	0,0	21,3	222,5	–	–	50,9	0,8	–	Integrated Water....., 2010
		27 Jul 2011	–	2,55		9,4	17,4	3,1	10,8	11,2	–	–	–	–	–	3,2	Present study
T-3	Tuul river upstream from Zaamar	27 Jul 2011	–	1,7	18,7	3,4	11,9	12,9	–	–	–	–	–	–	3,0	3,00	Present study
		Jun 2008	–	31,1		22,5	0,2	36,0	0,0	42,6	254,7	–	–	53,8	0,0	–	Integrated Water..., 2010
T-4	Tuul river at Zaamar	Jun 2008	–	30,1		23,7	0,2	20,1	0,0	39,1	255,0	–	–	40,5	0,3	–	Integrated Water..., 2010
		Jul 2008	–	–		–	–	–	–	–	170,0	25.7	0.34	–	–	–	AATA, 2008
		26 Jul 2011	–	2,1		13,5	20,1	3,9	11,4	15,4	–	–	–	–	–	–	Present study
T-6	Tuul river before confluence with Orkhon river	Jul 2008	–	-		–	–	–	–	–	240,0	413	0,4	–	–	–	AATA, 2008
		6 Aug 2011	–	1,8	22,6	4,7	13,5	17,8	–	–	–	–	–	–	4,6	4,64	Present study

Continue table 2

Station	Description	Date	DSC, mg/l													Reference
			Σions	K^+	Na^+	Ca^{2+}	Mg^{2+}	Cl^-	SO_4^{2-}	HCO_3^-	Fe_{sum}	Mn	Pb	NO_3^-	NO_2^-	PO_4^{3-}	
O-1	Orkhon river at Kharkhorin Town	Jun 2008	–	30,1		2,4	4,0	16,0	0,0	35,5	410,9	–	–	–	30,1	–	Integrated Water..., 2010
		29 Jun 2011	–	1,54	9,3	1,9	1,3	5,3	–	–		–	–	–	–	–	Present study
O-8	Orkhon river downstream from the confluence with Tuul river	25 Sep 1971	266,0	23,2		34,0	9,2	6,3	25,5	167,8	–	–	–	–	–	–	Hydrologic regime..., 1977
		October 2005	–	–		–	–	–	–	–	53,0	–	–	–	–	–	Integrated Water..., 2010
		June 2006	–	–		–	–	–	–	–	80,9	–	–	–	–	–	
		7 Aug 2011	–	2,15	22,9	5,1	3,7	11,3	–	–		–	–	–	4,9	4,92	Present study
O-9	Orkhon river above Selenga river	Apr–Jul 1945, Mar, Jun 1946	–	12,6-22,4		21,1–38,5	4,1–7,7	4,2–12,6	10,8–26,4	91,5-152,5	–	–	–	–	–	–	Votincev K.K. et al., 1965
		Jul – Aug 2002–2009	–	–	–	–	–	–	–	–	–	–	–	–	–	–	Bayaraa U., 2010
		Jul 2007	–	13,9		30,1	7,3	5,3	17,3	134,2	52,4		–	–	0,0	0,0	Integrated Water, 2010
		12 Aug 2011	–	2,0	23,2	5,3	4,1	11,5	–	–		–	–	–	–	–	Present study
S-1	Selenga river near Hutyk village	Jul 2007	–	12,4		40,1	12,2	3,6	27,0	170,8	122,9		–	–	0,2	–	Integrated Water..., 2010
		2 Aug 2011	–	1,3	21,5	4,1	1,5	8,2	–	–		–	–	–	–	–	Present study
EG	Egiin-Gol river, downstream	1959-74	77,6–377,8	4,8-31,3		5,0-44,1	1,5-15,8	14,2	4,0-10,0	36,6-268,4	–	–	–	–	–	–	Hydrologic regime..., 1977
		2 Aug 2011	–	1,7	33,1	6,3	0,5	13,6	–	–		–	–	–	–	–	Present study
ER	Eroo river upstream confluence with Orkhon river	Jul 2007	–	7,3		14,0	3,0	3,6	4,0	67,1	83,7		–	–	0,0	–	Integrated Water..., 2010
		11 Aug 2011	–	1,1	9,7	1,9	1,2	4,6	–	–	–	–	–	–	–	–	Present study
H-1	Khangal river downstream from Erdenet	Jul 2007	–	23,3		134,3	57,8	32,0	300,0	292,8	101,0	–	–	–	0,0	–	Integrated Water..., 2010
		Jul 2009	–	115,2		38,9	2,8	200,0	0,0	26,6	200,8	–	–	–	0,2	–	
		4 Aug 2011	–	2,5	33,9	111,5	36,7	33,9	16,8	263,6	0,84		–		7,11		

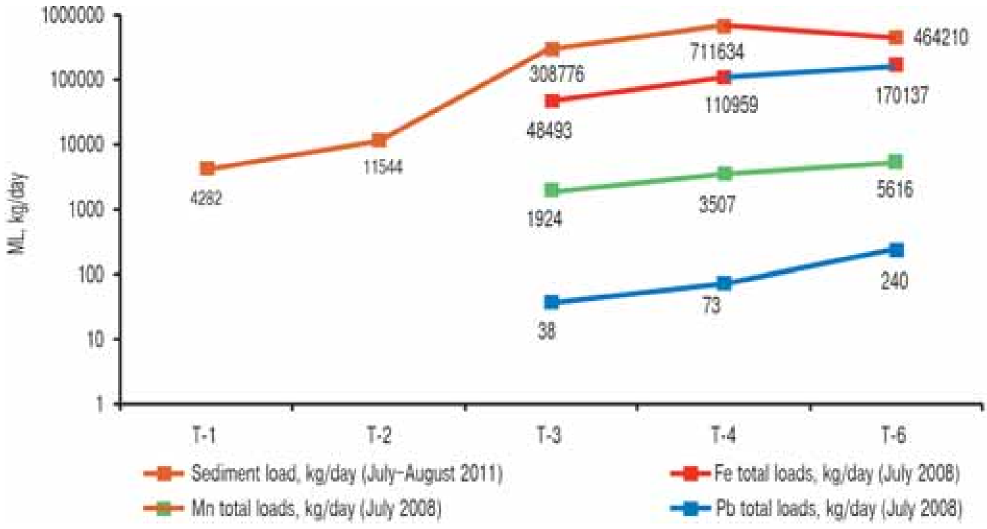

Fig. 3. Estimated mass flows (kg/day) of total suspended and dissolved load at five different sampling points along the Tuul River (numbers according to tables 1–2)

and agricultural sector. More specifically, the three considered measurement campaigns conducted in 2005, 2006 and 2008 [AATA, 2008] showed that the increase directly downstream of the mining site (from dissolved concentrations) were found to be between 167 to 383 kg/day for Fe, between 15 and 5260 kg/day for Mn, and between3.6 to 4.6 kg/day for Pb, compared with values upstream the site. Previously [Stubblefield et.al, 2005] reported increase of SSC and total phosphorus along Tuul river. Our field campaign indicated increase of suspended load along Tuul river from 4280 kg/day at the upstream point to 712000 kg/day below Ulaanbaatar and Zaamar (Fig. 3).

Rapidly changing hydrological characteristics of rivers prevent adoption of results of in-situ sampling for temporal analyses. At the points where measurements were conducted several time in the 20th and 21st centuries (e.g. T-6, O-8) the significant fluctuations of both SSC and DSC are indicated. At the Tuul river upstream from the confluence with Orkhon river (T-6 station) measurements were done 7 times, SSC varied between 11 mg/l at 7 Oct 1934 to 716 mg/l at 26 Aug 1934. Maximal SSL was 3627,8 • 10^3 kg/day at 4 Aug 1934 indicating the significant impact of water discharge on sediment load.

Reported values of major ions concentration evidence up to 5 times change between measurements. For example, at the downstream reach of Orkhon river (above confluence with Selenga river) (O-9 station) major ions concentration varied up to 6 times between Jul, 2009 and Aug 2011. Simultaneously ions concentrations were highest during low water period [Votincev et al., 1965], and decreased significantly during high water periods (e.g. our field measurement during August 2011).

The following part of the paper is devoted to the analyses of main sources of matter supply within basin.

POINT SOURCES

Mining and industry

In recent years, exploration for natural resources has increased rapidly. Many river basins are used intensively for mining of gold, silver, and coal, supplying also precious stones, gravel, and other natural resources. A total of 784 enterprises are engaged in mining, of which 204 small-scale gold mining companies are operating on 6,065,298 hectares of land [Batimaa, 2011]. Some of the gold miners are reported to use mercury in the gold extraction. The surface water inventory revealed that gold mining activity affects 28 rivers in 8 provinces of Mongolia. Many square kilometers of the river terraces are heavily disturbed. Flooding could breach thin strips of land separating dredge pits from river channels, resulting in massive sediment loading.

The most significant evidences of mining impact on suspended and dissolved matter fluxes of upper Selenga rivers exists along the Tuul river where the Zaamar Goldfield is located. The gold mining in the Zaamar Goldfield has been active since the seventies [Karpoff and Roscoe, 2005]. Today the area has the greatest gold production in Mongolia with 147 tons produced from 1998 to 2007 [AATA, 2008]. The largest and most recent gold mine in the Zaamar Goldfield is the Big Bend Placer Gold Mining Project (Big Bend).

Besides gold mines, Ulaanbaatar with its livestock and tourist camps is regarded to be a main source of matter supply into the river [Batimaa et al..., 2011]. There are currently 26 wastewater treatment plants in Ulaanbaatar, but 14 are not functioning [Tuvshinjargal, 2009]. All of the remaining 12 treatment plants are discharging into the Tuul river. The observed data from different sources (table 1–2) demonstrate elevated loading of SSC and total phosphorus along Tuul river downstream of Ulaanbaatar and Zaamar goldfield. In all mining regions of the Tuul River the fluxes of matter were observed to spike during rainfall. This leads to longitudinal increase of suspended loads and heavy metal mass flows. Due to the incorporation of local discharges with local concentrations, suspended loads and mass flows are reported to increase up to 100 times.

Another example of mining activities impact on water quality was observed in the mountainous headwaters of the Yeroo River [Stubblefield et al., 2005].Tributary drainages undergoing mining had total phosphorus concentrations 8 to 15 times higher than the main stream. SSC was 7 to 12 times higher, and turbidity was 8 times higher.

Special type of material supply is reported in the area Erdenet city which is the second largest industrial and mining city with 100 000 inhabitants in Mongolia. Today the Erdenet Mining Corporation (EMC) extracts 25.5 million tons of ores and produces 500 thousand tons of copper and 2 thousand tons of molybdenum concentrates per year. Significant increase of dissolved ions concentration in the Khangal river which originated from Erdenet and drained by wastewaters from mining ponds was up to 100 times in comparison with background values [Baljinnyam et.al, 2009; Integrated water..., 2010]. We also indicated elevated loading of dissolved ions (see Table 2). At the same time low water discharge of the Khangal river (below 1 m^3/s in August, 2011) provide fast decrease of dissolved solids concentration downstream along river network.

DIFFUSE SOURCES

In-channel erosion

Despite the fact that different hydrologic characteristics of Mongolian river systems are widely studied by Mongolian and foreign scientists, there are still many unsolved problems related to their channel processes. To the best of our knowledge and based on our literature search, no research have ever been conducted on the allocation and spread of different types of river channels, no available estimations on intensity and direction of the horizontal channel deformations, no data on different characteristics of erosion and accumulation processes in river valleys and watersheds. The only one major scientific work in this area is the PhD thesis of Mongolian scientists Natsag Zhamsrangiyna, regarding "River profiles and the formation of river channels in Selenga basin in Mongolia". This work was done in the mid of 70s on the Faculty of Geography, Lomonosov Moscow State

University. Being a research fellow in the Russian Academy of Sciences, Institutes of Geography and Permafrost, Natsag was an active participant of joint Russian-Mongolian expeditions. That allowed him to use field data on channel morphology, composition, distribution of river sediments, and hydrological characteristics. In the dissertation and scientific papers, Natsag tries to connect the main factors which influence on the formation of river channels (geomorphologic and geologic features of a territory, hydrologic regime, and alluvial sediments) with channel morphology and vertical channel deformations. He emphasized the importance of geomorphologic features which influence on the formation of river channel profiles, their shape and development.

The Selenga basin zoning was done on the basis of channel-formation activity of rivers. According to such a zoning the territory was divided into three districts: the Upper Selenga district, the Orkhon-Selenga district and the Khantay district. Each district has its own specific conditions of channel-forming determined by effective water discharge and character of inundation of floodplains. In conditions of free development of channel deformations in Upper Selenga and Khantay districts multi-thread channels are widespread due to regular and long-term floodings. In the Orkhon-Selenga district, along with multi-thread channels, meanders forming in both free and adapted conditions are also widespread. These results provide us with understanding of crucial role of channel evolution in matter supply to rivers. At the same time the absence of exact descriptions of channel development is still prevents from a complete assessment of channel erosion contribution to total sediment and dissolved matter fluxes.

Soil erosion

Overgrazing and land-use mismanagement are considered to be main causes of soil erosion and land degradation in the upper Selenga basin rivers. Grassland vegetation has been reported to have decreased recently due to overgrazing by an increasing number of livestock [Chuluun and Ojima, 2001]. In general, the soil in a semiarid area has low organic content and a large percentage of silt portions, which results in a high susceptibility to soil crusting. The decrease in grassland vegetation increases

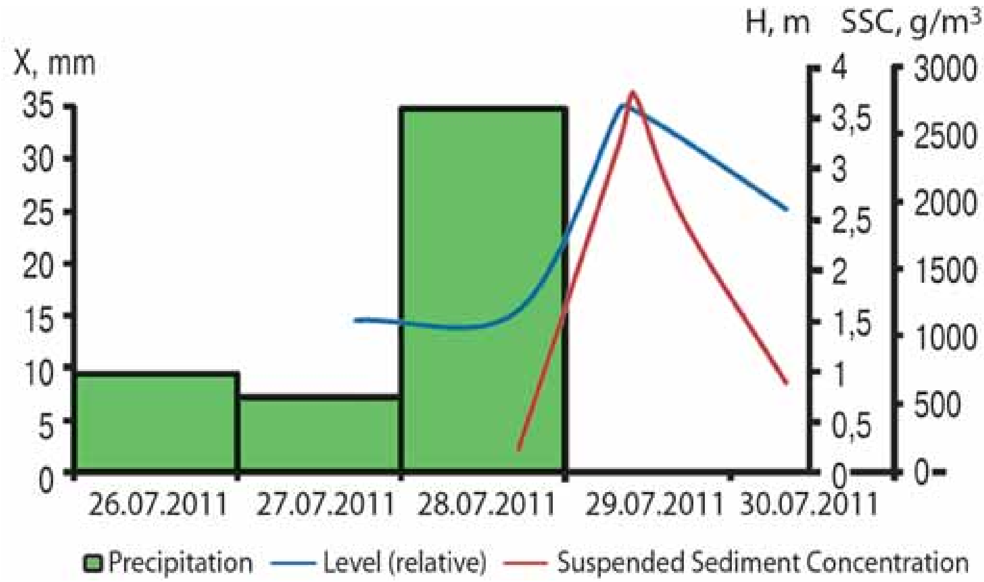

Fig. 4. Water level and SSC change at Orkhon river after period of heavy rainfall (27-07/2011–30-07/2011)

the raindrop impact on the soil surface, splash erosion, and susceptibility to surface sealing, thereby causing enhanced water erosion. Therefore, the surface vegetation cover is considered to be the primary reason for soil erosion [Onda et al., 2006].

Increase of erosion process intensity in the first two-thirds of the 20th century in the Selenga River watershed and a reduction of this intensity in the last third of the century is identified by [Korytny et al., 2003]. Changes in the river network structure (the order of rivers, lengths, etc.) as a result of agricultural activity during the 20th century are regarded to be a driving factor of this increase. The soil erosion rate was observed to be directly proportional to the severity of grazing [Chen et al., 2007].

Exact links between field data available on soil erosion and land degradation processes and matter movement along waterways are limited. Nevertheless some data show evidence that large floods, the rarest of hydrological events, can have the biggest impact, carrying the most sediment and dissolved matter mostly due to surface erosion. Observations made upstream of the Kharkhorin village at the Orkhon river at 29–31 of July demonstrate a significant increase of suspended load due to heavy rains and water level increase (Fig. 4). Our estimates show that the sediment load was about 3000 tons per day, which exceeds the average value for this period 10 times. It should be noted that the upstream reaches of these rivers contain large gold mining areas. Thus, the rates of matter increase could also be affected by mining.

CONCLUSION

Synthesis of recent field campaigns data [Stubblefield et al., 2005; AATA 2008; Baljinnyam et al., 2009; Integrated Water..., 2010], reviews of mid-century observations [Kuznetsov, 1955; Hydrological regime..., 1977] and field works carried out by our team in 2011, provide new evidence from in-situ sampling of rapidly changing characteristics of rivers.

Various types of mining activities appear to provide significant changes in suspended or dissolved load. Open-cast gold mines of Tuul and Orkhon river basin lead to significant increase of SSC and SL. Flooding could breach thin strips of land separating dredge pits from river channels, resulting in massive sediment loading, as it was observed in the studied rivers. Elevated loading of dissolved ions was observed below ore mining and ore processing factory of the Erdenet in the Khangal river. At the same time low water discharge of the Khangal river provide fast decrease of dissolved solids concentration downstream along river network (below Khangal river confluence with large Orkon river). Observed increase of dissolved solid load along mining zone could be compared with total water-borne mass flow of metals to surface waters in England and Wales (which is 1509 kg/day for Fe, 13.9 kg/day for Mn and 50.6 kg/day for Pb) [Mayes et al. 2010].

Mass flows in the Upper Selenga river basin are somewhat different from both suspended (SSC) and dissolved solids concentration measurements. For instance, mass flows of Fe were increasing below Zaamar goldfield and downstream at a much higher rate than concentrations do. This is due to incorporation of local discharges with local concentrations and discharges increase considerably at downstream locations of the river system. Mass flows are relatively low at the mining site, but can increase by orders of magnitudes directly after the site indicating a significant impact from the mining activities.

More generally a main result is that while both suspended and dissolved material is provided from different sources, the total annual mass flow mostly depends on specific hydrological events. Large floods can have the biggest impact, carrying the most sediment from the surface – both from mined and non-mined lands, and reworking channel and floodplain geometry. 137Cs inventory for un-mined basins showed [Onda et al., 2006] that that the high sediment yields in the former case might be due to the susceptibility to erosion by recent over grazing. Industry accelerates both watershed and channel erosion and thus increases contributions from all sources. Further understanding of sources contribution, as far as understanding of sediment and dissolved matter regional budget could be done on joining large-scaled and small-scaled observations.

Potentially important questions that have not been addressed include effects of sediment and dissolved matter fluxes in ground waters. Wastewaters in the area of mining and industrial centers can cause serious alterations in groundwater recharge. Since groundwater is the main drinking water source in the region [AATA, 2008] and pollution of aquifers is often irreversible due to very slow recharge rates [Zandaryaa et al. 2008] – the process should thus be controlled.

Overall, to increase the knowledge about sediment and dissolved matter fluxes spreading and long term effects in this region, hydrological measurement and monitoring need to be extended. Simultaneous monitoring of both discharges and concentrations is essential for the reliability of mass flow estimations. If such extensive monitoring would be implemented, this would considerably decrease uncertainties in future (mass flow) investigations. Addressing of individual (and combined) effects of multiple upstream matter source zones on downstream mass flows would be of great value, from both scientific and pollution management perspectives.

ACKNOWLEDGEMENTS

The work at Baikal lake basin is implemented under support of Russian-Mongolian complex biological expedition RAS-MAS, Russian Ministry of Science and Education project "Development of scientific basics of monitoring and forecasting of Selenga rivers basin for transboundary transport of pollutants control and their intake to Baikal lake", Russian geographical society grant "Expedition Selenga-Biakal", Fund for Support of Lake Baikal Protection grant. ■

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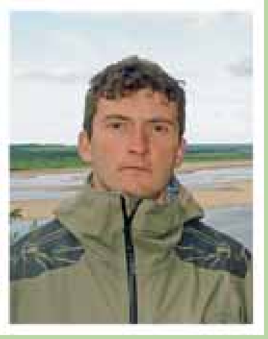

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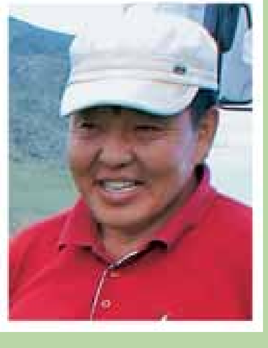

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AGRICULTURAL CHANGE IN THE RUSSIAN GRAIN BELT: A CASE STUDY OF SAMARA OBLAST

ABSTRACT. Change in agricultural land use in Samara Oblast is analyzed on the basis of agricultural statistics, field observations, and satellite imagery. Besides the general decline in animal husbandry, three drivers of spatial change are uncovered – accessibility to the major urban areas, natural setting, and ethnic mix. Land surface phenology metrics are in line with these drivers. In particular, satellite imagery confirms the large amount of fallowed land in Samara. Overall, land abandonment reached its peak in the late 1990s, and was subsequently reversed but the amount of land used in crop farming has not reached the 1990 level. Spatial differentiation is also analyzed across three types of farms – former collective and state farms, household farms, and registered family businesses.

KEY WORDS: agriculture, land use, spatial change, land abandonment, field observations, satellite imagery

INTRODUCTION

Agricultural land use in Russia is undergoing profound changes. These changes arise from the combined effects of introducing capitalism and ongoing rural depopulation. As previous work has shown, in European Russia rural population density is an effective predictor of agricultural productivity [Ioffe et al. 2004, Ioffe 2005]. However, population density itself is under the influence of such factors as the harshness of rural environment (as characterized by the variability of temperature and moisture regimes) and the accessibility of major urban centers [Nefedova 2003].

Kazakhstan, Russia, and Ukraine are often mentioned as the countries with the world's greatest unrealized food production potential [Fay and Patel 2008]. There is a significant gap between potential (i.e., based on natural soil fertility) and actual yields in these countries. This gap is likely to offset the potential yield increase due to climate change [Olesen and Bindi 2002]. Current inefficiencies will need to be addressed to realize the actual yield increase. Some argue that agricultural land transition is one process that needs to occur to improve productivity and efficiency [Lerman and Shagaida 2007]. Potential gains due to projected climate change could be offset by increases in the frequency or shifts in the seasonality of extreme weather (e.g., droughts, [Dronin and Kirilenko 2011]).

In this paper, we will highlight agricultural land use change in Samara Oblast, a region situated within Russia's black-soil (Chernozem) grain belt. We visited this region in the summer of 2010 and performed extensive interviews with district administrators, farm managers and other members of the population. Remote sensing was used to advance our understanding of ongoing agricultural changes in the region over the past ten years.

In what follows, we will focus on the peculiarities of the case study region, methods used to evaluate land use change, and on principal results emphasizing the drivers of spatial differentiation of agricultural land use.

THE CASE STUDY REGION

Samara oblast (53,600 km^2) is located in the middle of the Russian grain belt, in the central Volga River basin in southern Russia bordering northern Kazakhstan (Fig. 1). We chose Samara because the oblast is representative of a) European Russia's south, a macro-region with high natural soil fertility and with only moderate (not drastic) rural depopulation, and b) quite a few Russian regions (north and south) whose regional capitals are very large (close to or over one million people). This second characteristic generates a suburb-periphery land use intensity and productivity gradient within the oblast.

The cities of Samara and Togliatti are the oblast's largest cities with 1.1 million and 720 thousand residents, respectively. In 2010, Samara oblast's population density was 59.2 people/km^2. The rural population density was 11.5 people/km^2. Ethnic Russians dominate Samara's population (83.6%); Chuvash (6%) and Tatars (4.3%) are the largest minorities. Non-Russians predominantly live in the northern areas of Samara oblast. The oblast consists of 27 lower level administrative units (rayons) comparable to counties in the United States.

The oblast is located across the ecotone of forest steppe, with patches of broadleaf forests interspersed with steppe in the north; regular steppe in the middle; and dry steppe in the south. There are about three million hectares of arable land in the region; the main crops are grain, sunflower, sugar beets, and potatoes. According to official statistics, agricultural land in Samara occupies 76% of the territory, with 58% of the territory classified as arable land [Agriculture Samara 2008]. In general, the natural conditions are favorable for agriculture, but despite the frequent droughts that affect the southern part of the oblast, there is limited irrigation. Land abandonment in this area was moderate compared to other oblasts

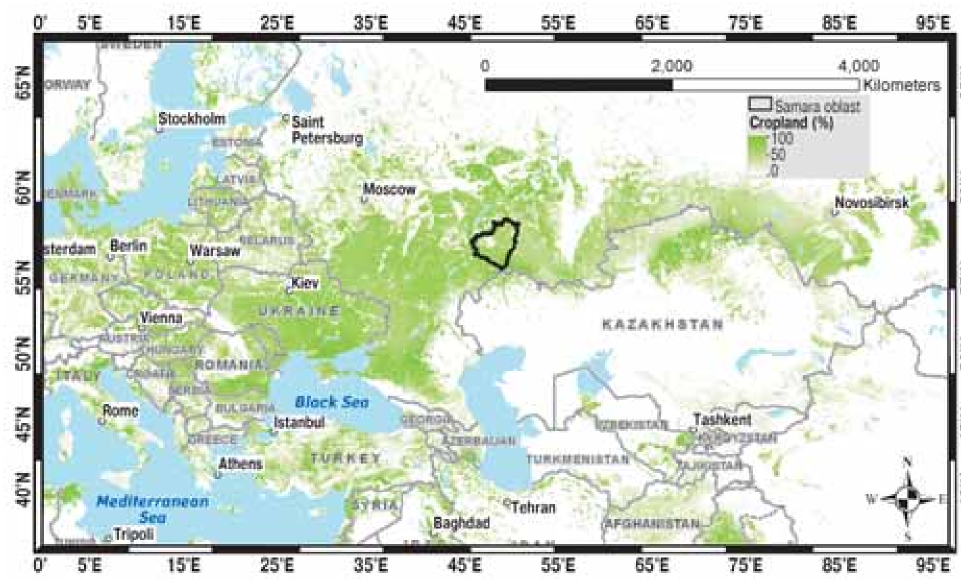

Fig. 1. Overview of estimated croplands in the region in the year 2000. Samara oblast is located in the middle of the Russian grain belt. The cropland dataset is from Ramankutty et al. [2008] and has a spatial resolution of 0.05° lat/lon

in Russia; about 69% of the area cultivated in 1990 was still cultivated in 2006. Other regions, such as Kostroma oblast, situated farther upstream (along the Volga River), experienced widespread land abandonment; only 55% of the 1990 cultivated area was still cultivated in 2006.

Grain production reveals strong inter-annual variability. In 2009, a third of the crop production was lost in Samara; in the widespread and extreme drought of 2010, this area lost about 40%. While the agricultural potential for the southern rayons is lowest as a result of frequent droughts, nearly 75% of the land area is plowed. Grain yields in these rayons are low and unstable; agriculture is risky, especially now that the number of cattle on large farms drastically declined from 1012 thousand in 1990 to 212 thousand in 2009 [Agriculture Samara, 2004, s.224, 2009 s.100–101].

Russian farmers employ a variety of crop-rotation schemes. In this area, the farmers previously used a seven-year rotation which typically included only one year of fallow and a variety of grain crops in the remaining six years. The fallow year is used to increase subsurface moisture in periods when there is no drought. Farm managers in Samara indicated that the crop rotation schedules are changing from a seven-year crop cycle focused on grain production to a three-year crop cycle focused on the production of sunflower. The new rotation schedule is fallow-grain-sunflower, which ensures a higher profit margin compared with grain alone. The number of cropped years gives an indication of the type of crop cycle that is applied. Crop cycles that include sunflower see increased numbers of fallow years compared to grain based crop cycles. In addition, drier areas are predicted to reveal more fallow years either due to decisions by farm managers or as a result of ongoing droughts. According to farm managers interviewed, far southern Samara tends to experience agricultural drought about half the time.

DATA AND METHODS

1. Field data collection

During a field trip in May 2010 we collected official statistical yearbook data and updated lower level rayon data collected previously [Nefedova 2005, Samara oblast' 2006, Ioffe et al. 2006, Pallot and Nefedova 2007]. We visited typical settlements and enterprises in four selected ***rayons*** (Kinel-Cherkassky, Pokhvistnevsky, Bolshechernigovsky and Pestravsky) within the study region and interviewed rural administration heads, farm managers, and the local population. The four selected rayons are located in east central and far southern Samara. We conducted twenty five loosely structured interviews in four different rayons. Each interview lasted between 30 to 90 minutes. The interviews were typically attended by one to five respondents. We aimed at interviewing a large cross section of people with agricultural interest within Samara. Among the experts we interviewed were Samara's Ministers of Economics and of Agriculture and the head of Samara's Land Use Committee. In addition, we spoke with one local agronomist and heads of one agricultural company (Simko) and four agricultural cooperatives. We spoke with nine different rayon and city administrators, several registered independent farmers as well as household farmers and one owner of a private greenhouse with 4000 tomato plants. We also spoke with the owners of a sausage factory with sixty employees located in a rural Tatar village. Among the farmers and administrators interviewed, there were people from Baskhir, Tatar, and Chuvash ethnicities. The information collected during this fieldwork period provides a largely improved understanding of the economic and rural social situation [Ioffe et al. 2011]. We asked every participant questions with respect to population dynamics, unemployment, subsidies and taxes, and their perceptions of drought and climate change. When appropriate, we also asked to see farms and crops and asked about crop varieties and rotation schemes.

2. Landsat Data

The series of Landsat satellites has measured the Earth's changing land surface since the launch of Landsat 1 in 1972. During the study period the United States Geological Survey (USGS) operated Landsat 5 equipped with the Thematic Mapper (TM) sensor and Landsat 7 with the Enhanced Thematic Mapper Plus (ETM+). Both satellites have a 16-day repeat time and provide multispectral imagery with a spatial resolution of 30m. All Landsat data held by USGS are freely available. Samara oblast is almost entirely covered by four Landsat tiles (WRS-2 P170R23, P169R22, P169R23 and P169R24, Table 1). We collected Landsat TM/ETM+ images for each tile between 2006 and 2010. Each tile was represented by images during the peak of the growing season and at least one shoulder season, with a focus on the fall as much as possible to enable capture of winter wheat growth (Table 1). All images where atmospherically corrected with the ENVI FLAASH routine. FLAASH is a first-principles atmospheric correction tool that corrects wavelengths in the visible through near-infrared and shortwave infrared regions and incorporates the MODTRAN4 radiation transfer code. After correction all available bands, except the thermal band, were stacked into one file per tile. We applied maximum likelihood classification with suitable training samples identified using Google Earth. We validated the results using validation samples identified using Google Earth, and supplemented by field photographs collected at the time of the interviews.

3. MODIS Data

The Moderate Resolution Imaging Spectroradiometer (MODIS) provides near-daily repeat coverage of the earth's surface since 2000 with 36 spectral bands and a swath width of approximately 2330 km. Seven bands are specifically designed for terrestrial remote sensing with a spatial resolution of 250 m (bands 1–2) and 500 m (bands 3–7). Each MODIS swath is divided into 10 by 10 degree tiles that are numbered vertically and horizontally. For this study we selected two MODIS products: 1) the Nadir BRDF-Adjusted Reflectance (NBAR) data set with a spatial resolution of 500 m (MCD43A4v5) and 2) the Land Surface Temperature (LST)/ Emissivity data with a spatial resolution of 1000m (MOD11A2v5) covering the tiles h20v03 and h21v03. The NBAR product is created with the use of bidirectional reflectance distribution functions which model reflectance to a nadir view [Lucht et al. 2000, Schaaf et al. 2002]. The sensors are operated by NASA on two satellites, Terra and Aqua, which have late morning and early afternoon daytime passes, respectively. These data products are freely available online.

We downloaded all available images between January 2002 and December 2009. We calculated the Normalized Difference Vegetation Index (NDVI) using the NBAR dataset. NDVI is a commonly used vegetation index, computed as (NIR – red)/(NIR + red) [Tucker 1979]. NDVI is calculated using the near infrared (841 to 876 nm) and red (620 to 670 nm) reflectance bands and is frequently used to monitor vegetation growth cycles

Table 1. Overview of the Landsat path/row coordinates and dates used to create the land cover classification

169/22	169/23	169/24	170/23
14 Jul 2006	2 Aug 2007	2 Aug 2007	29 Jul 2009
18 Aug 2007	18 Aug 2007	18 Aug 2007	16 Jul 2010
26 Oct 2009	5 Oct 2007	5 Oct 2007	27 Aug 2010
23 Jun 2010	23 Jun 2010	23 Jun 2010	2 Sep 2010
10 Aug 2010	25 Jul 2010	9 Jul 2010	24 May 2011
		10 Aug 2010	

and health [Tucker 1979, Myneni et al. 1997, Morisette et al. 2008]. NDVI is bounded between –1.0 and 1.0 with typical values for vegetation ranging between ~0.2 to ~0.85. Higher values indicate denser vegetation.

We selected the day and night temperature data from the MOD11A2 dataset. We calculated growing degree-days (AGDD) based on the minimum and maximum temperature data as follows:

$$GDD = \frac{\text{Nighttime Temperature} + \text{Daytime Temperature}}{2}. \qquad (1)$$

We accumulated 8-day GDD by simple summation commencing each 1 January when GDD exceeded the base 0°C:

$$AGDD_t = AGDD_{t-1} + \max(GDD_t, 0). \qquad (2)$$

We chose a base of 0°C for the AGDD calculations since this threshold is an often used value in modeling for high-latitude annual crops, such as spring wheat, and for perennial grasslands. Our study region is dominated by perennial grasslands and spring grains. We have successfully applied this method several times before [de Beurs and Henebry 2004, 2005a,b, 2008, 2010]. We applied a quadratic regression model linking AGDD with NDVI to determine simple land surface phenology metrics for each year (Fig. 2). The phenological metrics that we are investigating here are: 1) the timing of the start of the growing season; 2) the thermal time to peak measured in AGDD; 3) the height of the peak of the growing season in NDVI. Higher peaks indicate areas with denser (healthier) vegetation.

We linked the Landsat land cover map with the interannual variability in key phenological parameters derived from two MODIS tiles to derive the percent of cropland per MODIS pixel.

To determine whether a pixel was successfully sown during a particular year, we applied a series of basic decision rules. We aimed to distinguish between cropped pixels and

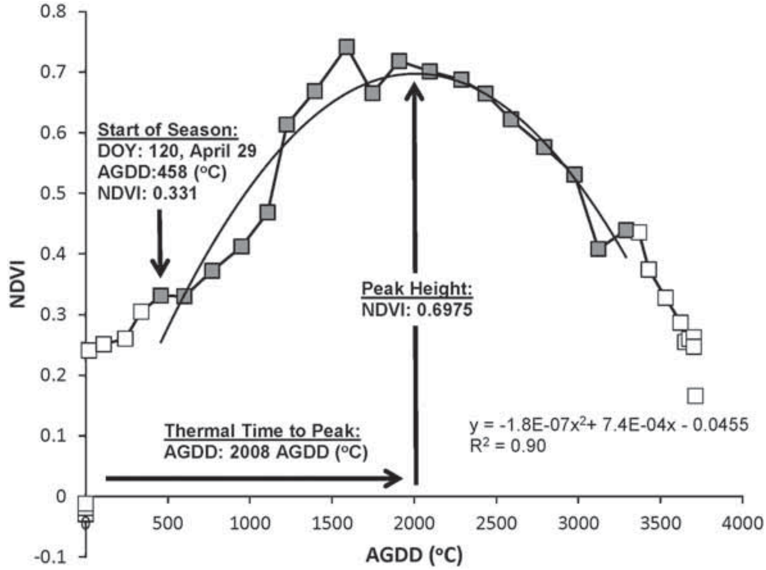

Fig. 2. Land surface phenology model for one grid cell.
In this grid cell the start of the growing season occurred on day 110 (DOY).
The thermal time to peak was 950 growing degree days and the height of the peak was 0.767

fallow pixels within the general class of cropland. The fallow pixels can lay fallow for multiple years and thus have a variety of vegetation types growing on them. However, the fallow pixels must have at least been cropped once during our study period as identified above to be counted as cropland. The phenology models tend to fail for newly fallow areas; thus, we assumed that if the model failed to fit a particular pixel, there were likely no crops in that pixel for that year. Crops, especially winter wheat, tend to peak sooner than vegetation growing on fallow fields; in addition, the NDVI during the peak of the growing season tends to be higher for crops than for vegetation growing on fallow fields. Accordingly, we identified the following classification rules and applied them to all pixels with a crop probability higher than 0.75:

1) If models fail $\rightarrow$ *no crops.*

If the peak height > μ *peak height* – σ *peak height*

AND peak timing (in AGDD) <
< 1100AGDD $\rightarrow$ *crops.*

where μ *peak height* is the average of the peak heights per pixel based on the years 2002 through 2009 and σ *peak height* is the standard deviation of the peak heights per pixel for the same years. We evaluated several cut-off degrees for AGDD and determined that a cut-off of 1100 degree days generates the most accurate results. We validated the results against statistical yearbook data indicating the number of hectares with successfully sown crops for each year separately between 2004 and 2008.

RESULTS AND DISCUSSION

1. Spatial differentiation of agriculture in Samara oblast

There are three aspects of spatial differentiation of agriculture: natural setting, location on the center-periphery axis, and ethnic makeup [Nefedova 2003]. We address these aspects in that order.

The natural setting of Samara oblast can be delineated ecoclimatically: the transition between forest-steppe and steppe is approximately at the latitude of the city of Samara (Fig. 3). As one proceeds south, patches of forests disappear and aridity increases. It reflects both natural (i.e., pertaining to biomes) and acquired agricultural contrasts between the north and the south of the region. In the next

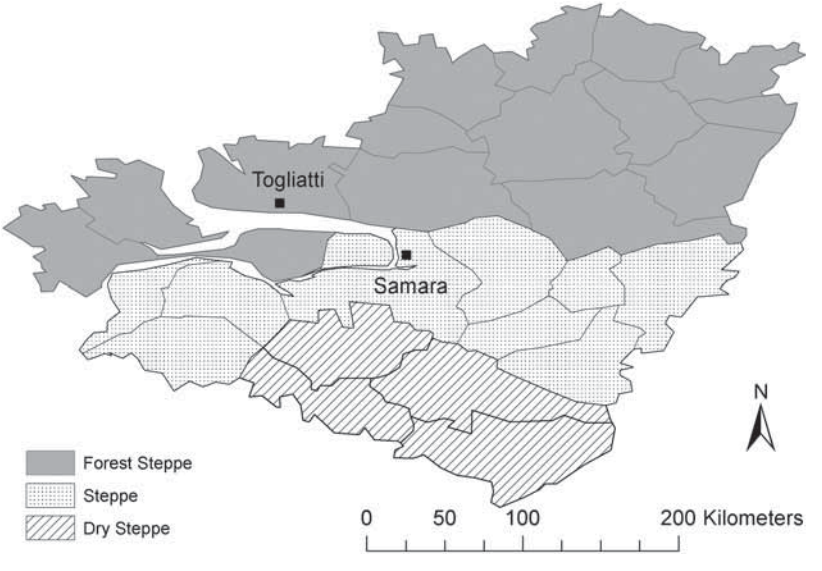

Fig. 3. Natural areas: forest steppe, steppe, dry steppe

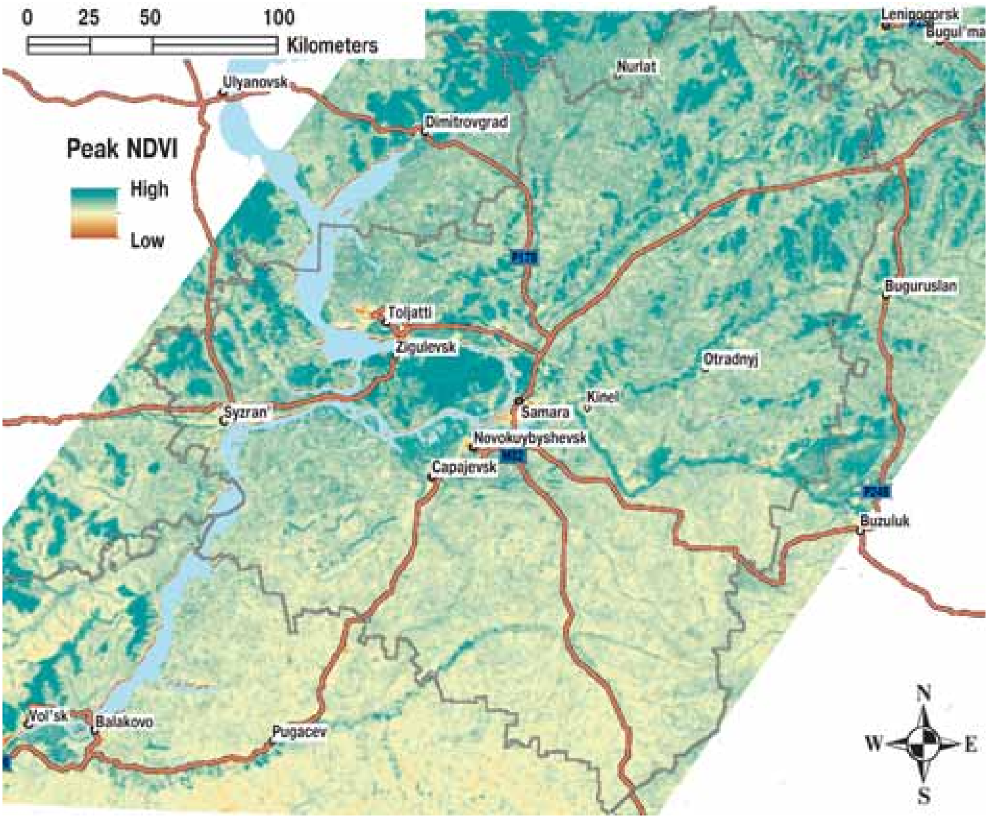

Fig. 4. Peak NDVI in Samara oblast based on satellite observations

step we analyze the phenological metrics defined above within each of the three steppe regions.

The land surface phenology models provide a sufficiently good fit for our further analyses: the average coefficient of determination (R^2) of the quadratic phenology model linking AGDD and NDVI for all pixels and all years (2002-2009) was 0.84. Based on the land surface phenology models we found that the average start of the vegetative growing season for Samara occurred on April 14 (day 104). However, the start of the growing season occurred about a week earlier for forested areas in the study region (day 96) and about a week later for croplands (day 112). Thus, the difference in the start of the growing season between the forested areas and the croplands is a little more than two weeks. We did not find significant differences in the start of the vegetative growing season for the three natural zones. The average start of the vegetative growing season was April 14 (day 104) for the forest steppe region, April 15 (day 105) for the steppe region and April 18 (day 108) for the dry-steppe region. Figure 4 provides the peak height for Samara. The average peak height of the growing season (measured in NDVI) is 0.72 with much higher peak values for forested areas (~0.8) compared to croplands (~0.65). Forested areas typically have denser vegetation cover than croplands resulting in higher peak heights. The peak height for both agricultural and non-agricultural areas is highest in the forest-steppe region (~0.71 and ~0.8, respectively). The peak height is lowest in the dry-steppe region (~0.65 and ~0.69, respectively). The difference between agricultural and non-agricultural areas is smaller in the dry steppe than in the forest steppe as a result of the makeup of the land cover in the regions (forest vs. grasslands).

On average the thermal time to the peak of the growing season was 1516 GDDs. The thermal time to peak is about 100 growing degree days later for agricultural areas than for non-agricultural areas in the dryland steppe. In the other regions, the thermal time to peak is later for non-agricultural areas: 23 growing degree days for the dry steppe and 46 growing degree days for the forest steppe region. The difference in the average time to peak for the agricultural regions and the non-agricultural regions is very small and insignificant. However, the agricultural areas while portraying a similar annual average, reveal much greater temporal variability. The inter-annual coefficient of variation (100 • standard deviation/mean) for the thermal time to peak is more than twice as large for agricultural areas as for non-agricultural areas in the forest steppe and steppe areas. For example, the coefficient of variation, calculated based on the years 2002 through 2009 is 23.8% for the agricultural regions, but only 11.7% for the non-agricultural regions. The dry steppe region reveals the smallest difference in coefficient of variation between agricultural and non-agricultural areas (29.2% for agricultural areas versus 17.0% for non-agricultural areas). The difference between the three different steppe regions is most likely a result of the makeup of the non-agricultural land cover which is predominantly grasslands in the dryland steppe, a mix of grassland and forests in the steppe and predominantly forests in the forest steppe.

The second aspect of the spatial differentiation has to do with the Samara-Togliatti urban agglomeration (Fig. 5). Districts adjacent to Samara and Togliatti (suburbs) have the highest population density and the highest livestock density. Though significant, these center-periphery productivity gradients are less pronounced than in the northern or non-black-earth half of European Russia.

The third aspect of spatial differentiation is ethnicity (Fig. 6). In the region's northeast, ethnic Russians are less than half of the population, and Chuvash, Tatars, and Mordvins communities are widespread.

Performance of large (collective) farms in the different zones, based on grain yields and on milk yield per cow, shows that the suburbs have had the highest yield, followed by the semi-suburbs (rayons that are second-order neighbors of large cities) and the remaining zones. Milk yields declined everywhere prior

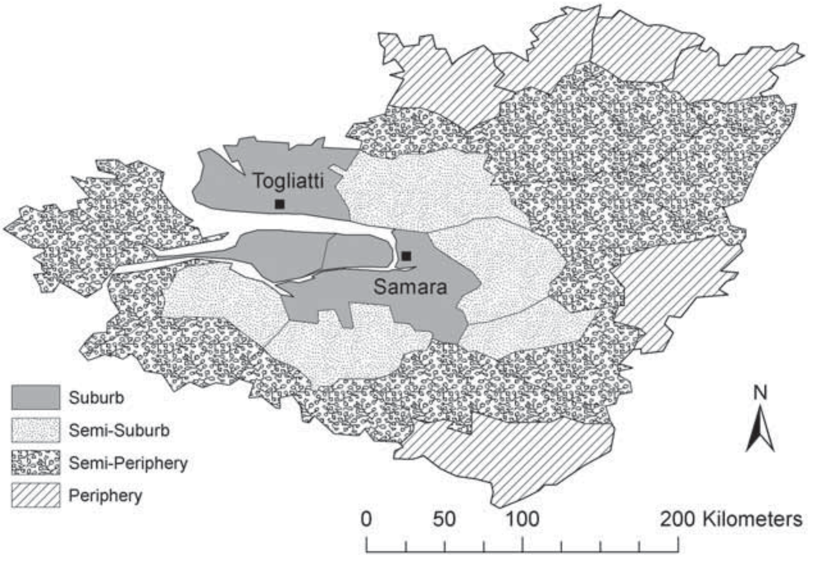

Fig. 5. Center-periphery contrasts: suburb, semi-suburb, semi-periphery, and periphery

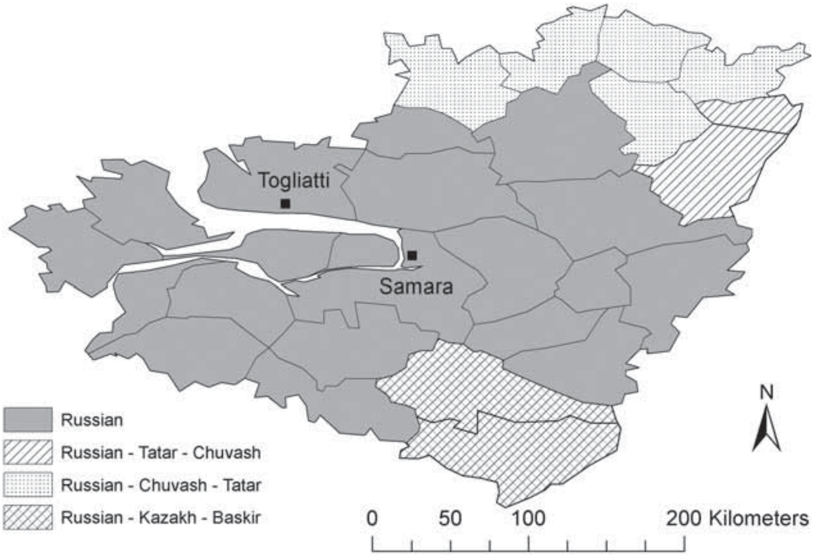

Fig. 6. National areas:

Russian; Russian–Tatar–Chuvash (Russian – less than 35%, Tatars – 20–80%, Chuvash – 5–25%); Russian–Chuvash–Tatar (Russian – less than 40%, Chuvash – 20–40%, Tatars – 5–20%); Russian–Kazakh–Bashkir (Russian – 60–80%, 4–10% of Kazakhs, Bashkirs 4–10%)

to 2000 and grain yields prior to 1997. After growth resumed, suburbs, semi-suburbs, and the districts on the East bank of the Volga River fared the best. Southern peripheral farms where the number of cattle has declined particularly sharply fare the worst.

In the household sector, spatial differentiation is also significant. For example, because large farms in the south have disposed of most cattle, the number of cattle on household farms is now at its highest in the south. In this zone and also in the ethnically mixed zone in the northwest, most large farms are strapped for cash and prefer to pay shareholders in kind (by grain), which stimulates animal husbandry on household farms [Pallot and Nefedova 2007]. In the suburbs, people do not hold a lot of cattle. At the same time, in the semi-peripheral zone, production of vegetables exceeds their consumption by a factor of four to five; here, household farms are de facto commercial producers of vegetables.

In the independent commercial farms (IF) sector, suburbia leads in terms of the sheer number of registered IFs. However, IFs have small land holdings in that zone. For example, in the Stavropol district (north of Togliatti), IF have on average 10 ha, grow potatoes and vegetables, and control about 4% of all farmland. In terms of IF's share of farmland, semi-suburb and southern zones lead, producing mostly grain; whereas, the zone with the highest share of non-Russians trails all the other zones.

2. Change in agriculture

From 1991 to 2000, gross agricultural output in Russia had declined by 40%, including by 60% in the collective-and-state-farm sector. Agricultural change in Samara Oblast approximates that of Russia as a whole, not only in terms of the overall output but also in terms of cattle (a drastic decline) and cropland (shrinkage) dynamics. From 1999 to 2009, growth in Russia's overall agriculture as well as Samara's was steady. While agriculture in Samara has left the crisis behind, its specialization is changing. As in much of Russia, crop farming is gaining ground and animal husbandry is fading into the background. Thus, the share of crops

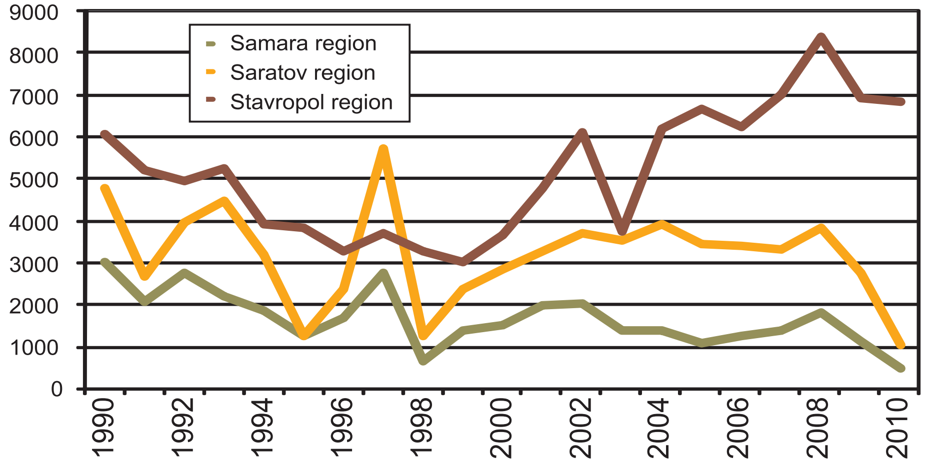

Fig. 7. The annual gross output of grain crops in the Volga region and in the Stavropol Territory in 1990–2010's, thousand tons.

Sources: *[Agriculture in Russia, 1998, 2002; Agriculture, hunting and forestry, 2004; Russia's Regions, 2008, 2010; Socioeconomic, 2011]*

in gross agricultural output increased from 41% in 1991 to 60% in 2003, only to slightly decline in subsequent years (to 56% in 2008). This change was largely conditioned by a drastic decline in cattle – from 1,012,000 head in 1991 to just 212,000 in 2008, although the numbers of pigs and poultry have been growing since 1997. The major specialization of Samara's agriculture is grain. However, due to periodic droughts, its output is unstable (Fig. 7). From 1970 to 2008, the coefficient of variation of grain output was as high as 37%. Grain in Samara is mainly produced on large farms (former collective and state farms). In addition, household farming operations are quite important, and many household farms are de facto commercial, that is, they are actively participating in market economy without registering as independent commercial farms (IF) and consequently without paying taxes on output, particularly in the grain and sunflower sectors.

Having emerged in the early 1990s, registered IF increased in numbers until 1996 and then began to decline. In the meantime, however, a number of the strongest IF took shape and began to expand. Today, the average size of Samara IF 90 ha, is 1.5 times that in Russia as a whole, and in the southern, drought-prone districts some IF reach 1000 ha. About two-thirds of IF land is sown with grain, which along with sunflower generates the bulk of IF profit. One has to keep in mind, though, that IF tend to under-report their output in order to evade taxes, and up to half of IF file no financial reports at all. In addition, IF can hardly employ as many people as collective farms once did, and they are even less likely to enter into symbiotic relationships with household farms (like former collective farms do). Thus, the implications of putative IF expansion across the entire countryside are ambiguous at best.

3. Changes in cropped areas

One of the peculiarities of the entire Volga Federal District, including Samara Oblast, is the large amount of land fallowed as a way to restore natural fertility. Altogether from 30% to 40% of arable land was fallowed up to 2009 (Fig. 8 and 9). Thus, the gap between cropland and total arable land amounts to ~900,000 ha. Part of that fallowed land (7%-8% of the total arable land) is actually abandoned. From 1990 to 2008, cropping area contracted almost everywhere, but particularly (by 40%) in the suburbs and on the east bank of the Volga River. Alongside the crisis of the 1990s, there have been competing claims on that land, including

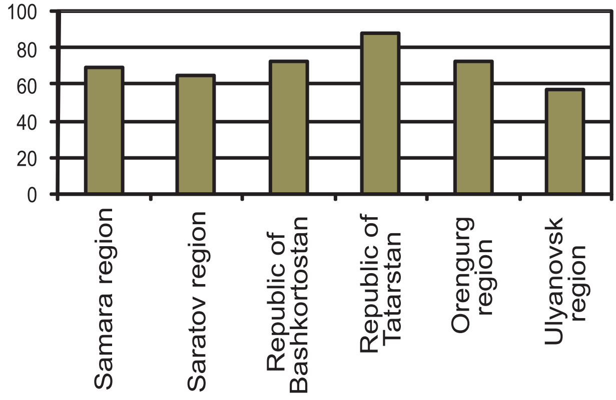

Fig. 8. 2009 area sown with crops as a percentage of that in 1990.

Source: *[Russia's Regions, 2010]*

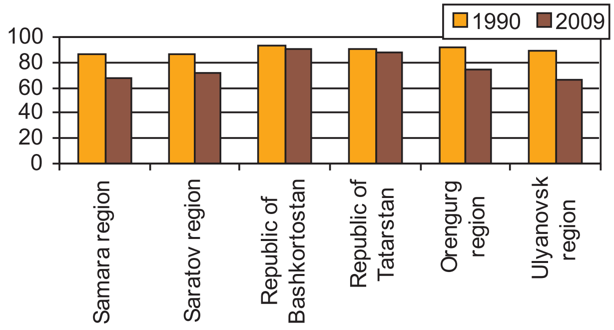

Fig. 9. Percentage share of the area sown with crops in the total arable land

demand generated by the dachniks, i.e., owners of summer homes.

By evaluating the phenological characteristics of the MODIS curves for each year, we determined annually whether a pixel was actually cropped or left fallow. We have compared the satellite estimated cropped areas with regional statistics (by rayon) and found that R^2_{adj} for the years 2004 through 2008 ranged between 0.86 and 0.92 (Fig. 10). We conclude that we can accurately estimate the total area cropped by rayon. Our satellite analysis confirms the relatively large amount of fallow land in Samara found in the agricultural statistics. Between 2002 and 2009 about 26% of the agricultural land was fallow with the highest amount of fallow land in 2009 (33%). The forest steppe region reveals the least amount of fallow land (17.6%), followed by the steppe region (21.4%). The dry steppes have the most fallow land (26.4%). Figure 11 provides a spatial overview of the number of times a particular area was cropped between 2002 and 2009.

Since 2000, shrinkage of cropland has stopped, and in some districts it has been reversed (Fig. 12, 13, 14, and 15). Returning abandoned land to agricultural use is much easier in the steppe biome than in the forest biome. Recovery of abandoned land has been particularly active in the south, in the semi-suburbs, and on the right bank. The share of cereals in the overall area sown with crops has been on the rise in the dry steppe districts of the south; by 2004 that share had reached 72% (Fig. 13). Such a dominance of grain disrupted the traditional crop rotation schedules and led to soil fatigue. By 2008, however, the share of cereal crops had declined to the initial 65%. In the districts where cereal crops did not dominate, as was

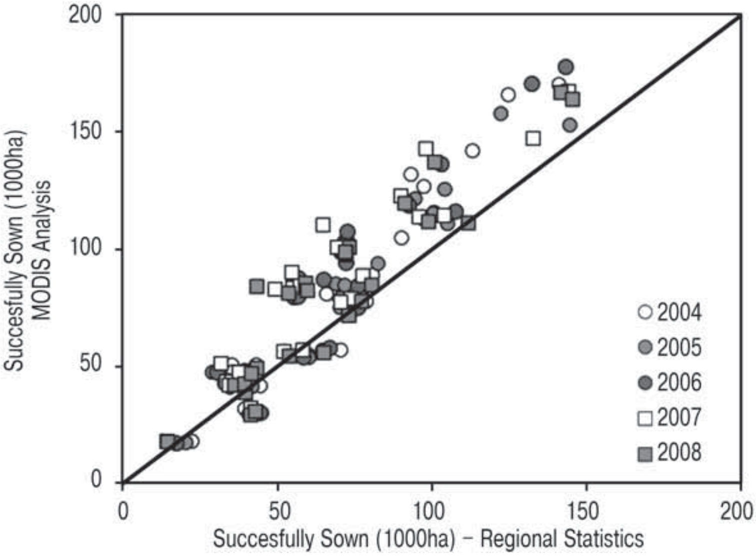

Fig. 10. The total area successfully sown by district of Samara region as observed by satellite data compared to the successfully sown data from regional statistics

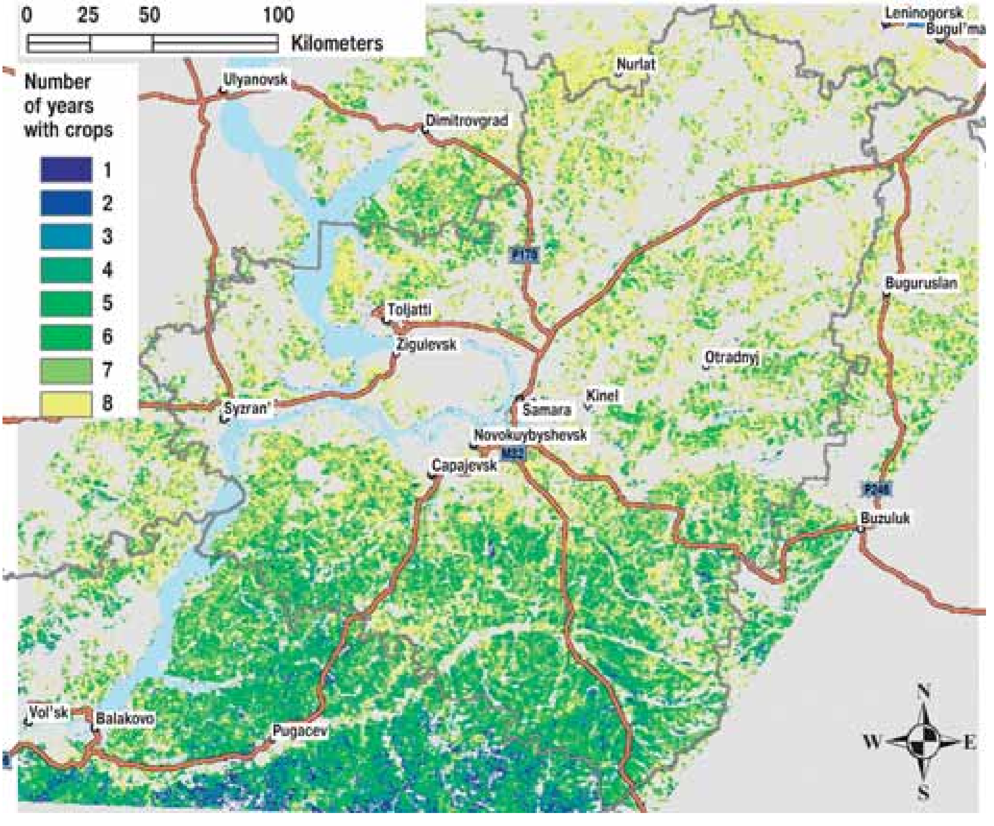

Fig. 11. Number of years with successfully sown crops between 2002 and 2009. Darker blue areas have fewer successfully sown crops (3–4 years). Greener areas have more successfully sown crops (6–8 crop years). Southern areas are troubled by droughts

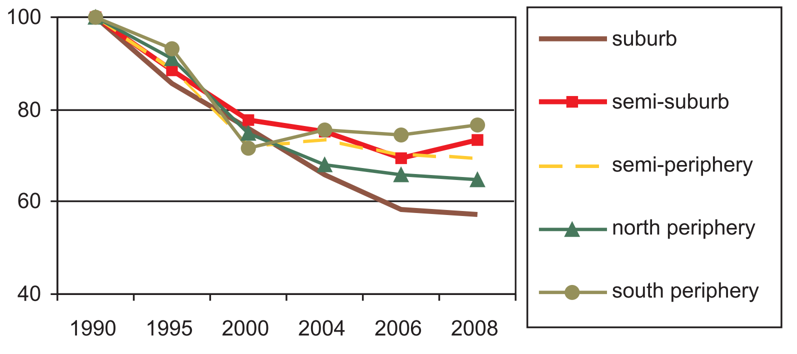

Fig. 12. Area under cultivation in different zones of Samara region as a percentage of that area in 1990.

Source: *[Agriculture, 2009]*

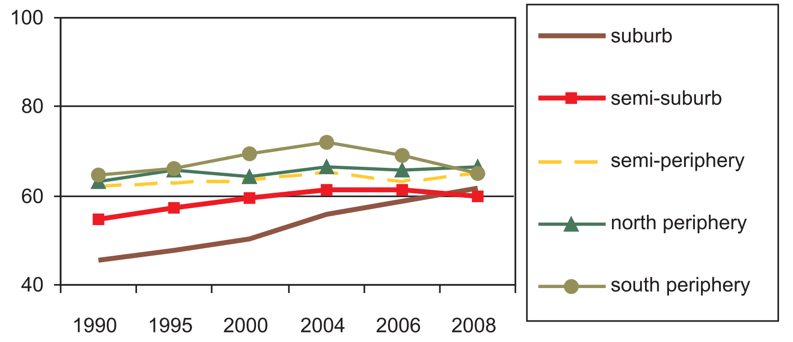

Fig. 13. Area sown with cereal crops in different zones of Samara region as a percentage of that area in 1990.

Source: *[Agriculture, 2009]*

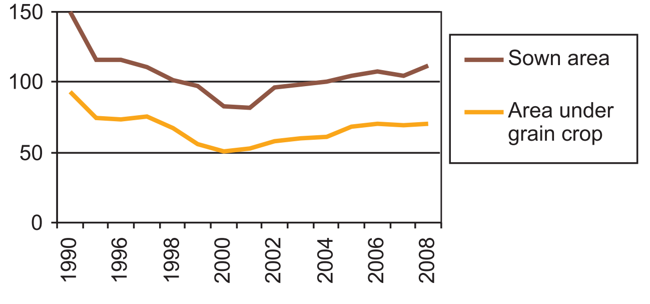

Fig. 14. Sown area and the area under cereal crops in the steppe Kinel-Cherkassy district in hectares

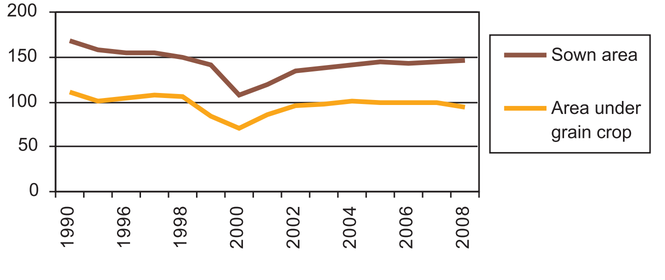

Fig. 15. Sown area and the area under cereal crops in the arid southern district Bolshechernigovsky in hectares

the case in the suburbs and semi-suburbs, the share of these crops has risen considerably. In the remaining districts, the *makeup* of the crops has not changed much, although along with returning formerly abandoned fields into cultivation (the process underway since 2000), the *acreage* under cereal crops expanded (Fig. 14 and 15).

CONCLUSIONS

The major aspects of agricultural change in the studied region of Samara are drastic declines in animal husbandry and shifts in crop rotation with emphases on fallowing more land than before for the sake of restoring fertility. In addition, there is a marked increase in sunflower cultivation, which ensures a higher profit margin as compared with cereal crops. The overall amount of land under cultivation sharply declined in the 1990s but has rebound since then. The spatial differentiation in the size of land sown with crops and the proportions of the three types of farms (former collective farms, household farms, and independent commercial family farms) depend on such drivers as distance from the two major cities, susceptibility to drought, and ethnic makeup. Land surface phenology metrics confirm the natural spatial differentiation of Samara oblast. The interannual coefficient of variation of the thermal time to peak is much larger in agricultural areas than in non-agricultural areas and this difference depends on the location of an area within Samara. Satellite analyses confirm the large amount of fallow land in Samara ranging from 17.6% in the northern forest steppe region to 26.4% in the southern dry steppes.

ACKNOWLEDGEMENTS

This research was supported in part by the NEESPI and NASA LCLUC project Land Abandonment in Russia: Understanding Recent Trends and Assessing Future Vulnerability and Adaptation to Changing Climate and Population Dynamics to all authors. We would like to thank P. de Beurs for the application development that allowed us to estimate the land surface phenology data efficiently. We would like to thank Geoff Henebry for his careful comments on this manuscript. ■

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ALL-RUSSIAN SCIENTIFIC AND PRACTICAL CONFERENCE "LANDSCAPE PLANNING"

In October 2011, the All-Russian scientific and practical conference "Landscape planning" was held at the Faculty of Geography of Lomonosov Moscow State University (MSU). The conference was organized by the joint efforts of the Faculty of Geography (MSU), the Institute of Geography (IG) of the Russian Academy of Sciences (RAS), the Russian Geographical Society, and the Russian Foundation for Basic Research. The conference was attended by more than 120 representatives of universities and academic science as well as by employees of engineering companies, federal authorities, and non-governmental organization.

Academician Nikolay S. Kasimov, Head of the Organizing Committee and Dean of the Faculty of Geography (MSU), opened the conference. Two plenary sessions were held. K.N. Dyakonov, Corresponding Member of the RAS, and A.V. Khoroshev (MSU) presented the concept of landscape planning, developed at MSU, and a review of current challenges and objectives in landscape planning. E.Yu. Kolbovsky (Yaroslavl) talked about "Landscape collisions and ecological problems in the system of strategic spatial planning". Academician L.G. Rudenko, Director of the IG of the National Academy of Sciences of Ukraine, presented the framework of landscape planning implementation in Ukraine. A. Herberg (the German Federal Agency for the Nature Protection) and Yu.M. Semyonov (the IG, the Siberian Branch of the RAS) reviewed European approaches and the experience of the Russian-German cooperation in landscape planning. S.D. Mityagin (the Institute of Urban Planning, St. Petersburg) demonstrated examples of the landscape approach implementation in the nature management planning at the regional level. Chief Architect of the Moscow Region Institute of Urban Planning, O.V. Malinova, discussed challenges for landscape planning emerging from projected expansion of Moscow. E.A. Shvarts (WWF) highlighted spatial problems in the living nature protection. A.V. Drozdov (IG, RAS) made a review of scientific, institutional, and legal foundations for landscape planning in Russia. S.V. Dolgov (the IG, the RAS) presented a hydrological approach to landscape planning and showed impressive examples of the need to adjust planning priorities in relation to the hydrological processes dynamics. Professor of Lvov University (Ukraine), V.N. Petlin, proposed a theory of the landscape spatio-temporal organization as a basis for planning decisions and emphasized the need to consider emergent effects in a landscape. I.V. Ivashkina (Institute of General Plan of Moscow) made the presentation "Urbodiagnostics of the present-day landscapes of Moscow and the Moscow region in the territorial planning system". Academician V.I. Kiryushin (Agricultural Academy) presented a concept of landscape-adaptive agriculture.

The presentations were made in three thematic sessions: "Theory, methods, legal issues, and education in landscape planning". "Landscape multifunctionality and regional practice of landscape planning", and "Landscape planning of protected natural, cultural, and historical areas". The presentations reflected a wide range of regional examples of functional zoning, ecological situations assessment, and spatial distribution of anthropogenic loads in a landscape. It is necessary to focus research on the development of the nature protection measures for the territorial planning schemes at various hierarchical levels. The presentations included different hierarchical levels of the landscape approach implementation in territorial planning: local level for functional zoning of cultural heritage objects, and micro- and mesoregional levels for planning suburban areas, intermountain depressions, river basins, etc.

More than 40 people participated in the workshop "Effective land use and landscape planning in development of general plans for urban and rural settlements". The workshop attracted big attention from the employees of engineering companies. The list of the discussion topics included: deficit of methodical and instructive materials, insufficient legal regulations, failures in implementing planning regulations, and poor participation of local communities in decision-making.

The conferences clearly demonstrated the need to implement the results of basic research in geography, ecology, architecture, and socio-economic sciences into practice of territorial planning. Discussions at the conference showed strong focus on modern approaches to the solution of the most crucial challenges:

- Determination of optimal spatial proportions of land use types in a landscape;
- Choice of hierarchical levels in land use decisions in respect to landscape hierarchy;
- Relations between natural and anthropogenic landscape diversity;
- Relations between landscape diversity and multifunctionality;
- Evaluation of the contribution of a local planned area to protection of landscape and biological diversity of a region or of a large river basin;
- Assessment of land use technologies impact at adjacent or remote parcels on biological diversity of key habitats and potential for their recovery;
- Interaction between anthropogenic loads and biological diversity;
- Design of landscape-ecological networks;
- Procedures of public participation in development of land use scenarios and coordination of stakeholders' interests.

The conference emphasized the investigation of opportunities provided by the present-day landscape analysis for the organization of economic activity including ecological examination and environmental impact assessment. Educational technologies in landscape planning were discussed as well.

The outcome of the conference demonstrated that landscape planning in Russia is now at the first stages of development. The participants came to an agreement that a lack of theoretical and methodological rationales, contradictions in use of terms, and the absence of sufficient legal regulations are the most critical challenges. Integration of approaches developed in landscape planning and landscape architecture is needed. Ideas of landscape planning now are being applied in various methodologies of sectoral planning (agriculture, forestry, urban, and recreation planning). However, landscape-planning is lacking the legal regulation to coordinate conflicting stakeholders' claims. Landscape planning is seen as a transdisciplinary field of knowledge and needs not to limit itself by ecological and socio-economic studies only. Development of humanistic approach and aesthetic criteria, and consideration of non-material interests are critically needed also. Representatives of engineering companies urged to develop quantitative criteria of optimal proportions of landscape elements and anthropogenic objects. Awareness of Russian experts in international experience of landscape and territorial planning is obviously insufficient. The tradition of the participatory approach and of public discussion of land use scenarios, highly developed in Europe, deserves special attention of Russian specialists.

The Conference decided to organize a permanent internet-based conference on the problems of landscape planning (http://www.landscape.edu.ru). The Conference recommended investigating a possibility to work out special legal regulations dealing with the implementation of landscape planning tools in the system of territorial planning in the Russian Federation.

The materials of the Conference were published in the book "Dyakonov K.N. (Ed.). 2011. Actual problems of landscape planning. Materials of the All-Russian scientific and practical conference. Moscow University Publishing House, Moscow. 320 p. ISBN 978-5-211-06258-0" (in Russian) (available at: http://www.landscape.edu.ru/science_landscape_planning_2011.shtml)

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IGU REGIONAL CONFERENCE IN SANTIAGO

A regional conference of the International Geographical Union (IGU) was held on 14–18 of November, 2011, in Santiago. From now on, for at least six years to come, these big events will be held every year by the IGU. The 2012 International Geographical Congress is scheduled to take place in Cologne; the Regional Conference in Kyoto is planned for 2013, in Krakow – for 2014, in Moscow – for 2015, and, finally, the Beijing Congress – for 2016. The IGU thinking is that every regional IGU network should conduct a large conference in its regions, of course, open to all geographers around the world and in cooperation with the IGU commissions.

Indeed, the large geographical conferences in Latin America have not been held in quite some time. Chilean geographers have taken the initiative to conduct in Santiago the International Cartographic Conference, which was successfully accomplished at the end of 2009, and then, the IGU Regional Conference. In this country, there is a significant community of geographers: at universities, there are six geographical departments. Geography is represented in a number of research institutions. In IGU, Chile is represented by the Institute of Military Geography (IMG). As in many other countries in Latin America and Southern Europe, military geographers are mainly engaged in the preparation and production of maps. In Chile, the IMG was created back in 1881. It is working on development of different GIS applications, the study of the national territory, and prevention and mitigation of natural disasters.

The Military School (Academy) of the Chilean army was chosen to be the venue of the conference; it has extensive, austere, and even rather gloomy but comfortable quarters of pre-war construction and a spacious and a well landscaped campus in one of the most prestigious areas conveniently located near a subway station. The Chilean army provided financial and technical support for the conference.

This choice was sharply criticized by a group of liberal Western geographers, mostly from English-speaking countries, who called to move or to boycott the conference, because during the anti-constitutional coup in September 1973, when the president S. Alende was assassinated, the Military School was a place of confinement, and even torture, for his supporters. However, Chile has long once again become a democratic state, and at the Military School, there are unlikely instructors who have witnessed or participated in the dramatic events of almost forty years ago. This problem was much discussed on a number of geographical sites and at the Executive Committee of the IGU.

The conference was opened with welcoming by Chilean colleagues and the President of the IGU, R. Abler, followed by a colorful show of a professional folklore ensemble. The participants were offered a number of scientific excursions, including visits to the IMG, the center of the Air Force aerial photogrammetry, and the hydrographic and oceanographic naval service in Valparaiso. The guests were present at the show of the riding club of the Military School, whose members often performed at the Olympic Games. Many participants were able to admire the magnificent view of Santiago during the evening gala dinner in the former summer residence of General Pinochet, located on the side of one of the mountains surrounding the city (now the Military Club). Before and after the conference, dozens of

1. Venue of the Conference

participants took the opportunity to get acquainted with the unique landscapes of Chile, including the tours offered by the Organizing Committee.

During the conference, the "commercial" exhibitions, the main exponents of which were software vendors from North and South America, took place, but there were also sections of the national committees, such as Japanese.

The conference went without any disruptions. Financial and commercial aspects of its organization were entrusted to a private firm, well proven in the preparation of the International Cartographic Conference. Since there were many participants from Latin American countries who do not always speak English with confidence, all sessions were provided with simultaneous translation. There was abundant technical staff (may be even excessive, as it felt at times), always ready to help in anything. However, the fee barely exceeded the amount of traditional $500; this was only possible thanks to sponsorship of a number of GIS-developers.

The Organizing Committee began its work four years prior to the conference. It devoted much attention to the dissemination of information about the conference online, at all possible geographical activities and through brochures, booklets, posters, articles in scientific and general press, e-mail, etc. Particular attention was paid to attracting sponsors.

There were 1124 conference applications. The IGU Executive Committee views it as an absolute success, especially considering the remoteness of Santiago from the European and North American research centers. All abstracts were reviewed and evaluated by the Scientific Committee on a number of parameters. In 38% cases, the applications included not only the usual abstracts, but also full reports! The organizers tirelessly demanded this in the e-mail letters to all participants. The abstracts and the full texts of the presentations were distributed to the participants on CD-ROMs.

The undoubted success of the IGU Organizing and Executive Committees was

2. The Opening Ceremony

the participation of all 36 commissions in a conference. Moreover, three commissions (gender geography, geography of tourism and leisure, and geography of global change), in addition to their sessions in Santiago, had conducted symposiums, prior to the conference, in Rio de Janeiro, Santiago, and Valparaiso, respectively.

There were 878 people at the conference. The IGU Executive Committee found the possibility to provide several dozen grants to attend the conference, mainly for young geographers and experts from countries with low income. In addition, several grants were issued to its members by the Association of American Geographers. More than 20 geographers came to Chile from Russia, among whom were Academicians P.Ya. Baklanov and N.S. Kasimov, Prof. A.A. Velichko, Corresponding Member of RAS S.A. Dobrolyubov, Vice President of the RGS K.V. Chistyakov, etc. The Russian participants were warmly received by Russian Ambassador M.I. Orlovets at his residence. Of course, the fact that Consul General in Santiago is a graduate of the Faculty of Geography of Moscow State University played a role.

The conference format was familiar: the predominant part of the reports was made at sessions organized by the IGU commissions. Besides the opening and closing ceremonies, there were three plenary sessions with brief presentations of M. Lagos (Chile), J. Zeiss (Canada), and N. Clifford (UK). In addition, 216 reports were presented as posters. The greatest number of reports was made at a session of the commissions on geography and the transformation of Cities (35), geography of tourism and leisure (31), land use and land cover change (30), natural disasters and risk (29), and cultural approach to geography (26). Twenty one commissions convened their organizational meeting at the conference.

Several events were timed to the conference: the scheduled session of the IGU Executive Committee, the traditional meeting of the Executive Committee with the chairmen of commissions, as well as several workshops, including the seminar by the IGU President R. Abler and a special meeting on the IGU-initiated program "International Year of Global Mutual Understanding".

Vladimir A. Kolosov

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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ISSN 2071-9388

SOCIALLY SCIENTIFIC MAGAZINE "GEOGRAPHY, ENVIRONMENT, SUSTAINABILITY"

No. 02(v. 05) 2012

FOUNDERS OF THE MAGAZINE: Faculty of Geography, M.V. Lomonosov Moscow State University and Institute of Geography of the Russian Academy of Sciences

The magazine is published with financial support of the Russian Geographical Society.

The magazine is registered in Federal service on supervision of observance of the legislation in sphere of mass communications and protection of a cultural heritage. The certificate of registration: ПИ МФС77-29285, 2007, August 30.

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Phone 7-495-9167574
Fax 7-495-9167673
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Sent into print 05.06.2012
Order N gi212

Format 32 × 46 cm/2
55 p. sh.
Digital print
Circulation 500 ex.