ENGINEERING FOR GREEN DEVELOPMENT

PROCEEDINGS OF THE 1ST RUSSIAN–JAPANESE COLLABORATION SEMINAR FOR SUSTAINABLE ENVIRONMENT

Editorial Board:
Kiichiro Hatoyama,
Yu.L. Mazurov,
A.A. Pakina

КАФЕДРА
РАЦИОНАЛЬНОГО
ПРИРОДОПОЛЬЗОВАНИЯ
ГЕОГРАФИЧЕСКИЙ ФАКУЛЬТЕТ
МГУ имени М.В. Ломоносова

MSU Publishers, 2014

УДК 504.06
ББК 20.18

*The publication is carried out with the support of the **Fund for Protection of Lake Baikal** (Russia) and Deputy of the State Duma of the Russian Federation **Mikhail Slipenchuk**.*

Engineering for Green Development: Proceedings of the 1st Russian-Japanese Collaboration Seminar for Sustainable Environment / Hatoyama, K., Yu.L. Mazurov and A.A. Pakina (Eds.). – M., MSU Publishers, 2014. – 252 p.

This volume presents the original academic and applied results in the field of environmental management for sustainable development obtained by Japanese and Russian researchers from the University of Tokyo and the Lomonosov Moscow State University. Materials included in the volume were presented at the 1st Russian-Japanese Collaboration Seminar for Sustainable Environment held in Moscow, Russia, 6–9 October 2013. The book is intended for researches, high-school teachers and students, all other readers interested in the engineering for green development and close fields.

УДК 504.06
ББК 20.18

The 1st Russian–Japanese Collaboration Seminar for Sustainable Environment

International Scientific Meeting held in Moscow, Russia
6–9 October 2013

ORGANIZED BY

- Department of Nature Management, Faculty of Geography, Lomonosov Moscow State University
- Department of Civil Engineering, The University of Tokio

STEERING COMMITTEE:

- **T. Koike** (co-chair), **M. Slipenchuk** (co-chair),
- S. Chalov, K. Hatoyama, S. Kirillov, Yu. Mazurov, A. Pakina

ORGANIZING TEAM:

- A. Klishina (coordinator),
- S. Golovkova (secretary of the Editorial Board),
- R. Mamedov, A. Sayanov, D. Papina, V. Toporina, A. Telelekova, A. Ustyantsev

Sustainable partnership — sustainable environment. Foreword and acknowledgement

This publication is a compilation of materials of the 1st Russian-Japanese workshop on environmental sustainability, held from 6 to 8 October 2013 at the Faculty of Geography at the Moscow State University. The purpose of the workshop was to identify perspectives on academic cooperation related to the nature of its activities of research teams in Russia and Japan.

The seminar was held during the *Week of Japan at the Moscow University*, in accordance with the agreement between the University of Tokyo and Lomonosov Moscow State University. The immediate impetus for the beginning of the contacts between the parties on environmental issues was the initiative of the Department of Nature Management (NM) and its leader prof. M.V. Slipenchuk to establish links between the Russian and Japanese counterparts. The first direct result of this initiative became signed in early 2013, in Tokyo, a memorandum of cooperation between the Department of Nature Management, Faculty of Geography of the Moscow State University and the Department of Civil Engineering of The University of Tokyo.

Research in the field of ecology, geo-ecology and nature management characterized by high demand in both countries. It would seem that it is quite natural in these conditions should be a high degree of cooperation between scientists and experts in Russia and Japan. However, until recently, the situation was exactly the opposite. Moreover, historically, that the activities and achievements of its neighbors on the planet we rather guessed than known. And it's clearly not in the interests of science and environmental management practices of both our countries.

The first contacts of colleagues from the University of Tokyo and Moscow State University demonstrated an understanding of the need to build relations of interaction and cooperation in all promising directions. But what is this trend? To answer this question it is necessary to have an objective view on academic potential partner. The parties were aware that the submission form — it is not easy and fast. The first step in this direction was to be scheduled for autumn 2013 seminar.

The seminar was attended by colleagues from the University of Tokyo — 7 teachers and 10 graduate students, undergraduates and students under the leadership of prof. Toshio Koike, the head of Department of Civil Engineering, The University of Tokyo. On the Russian side the seminar was attended by faculty staff, students and postgraduate students of the NM Department, as well as representatives from other departments such as these of: hydrology, glaciology and cryolithology, landscape geochemistry and soil geography, physical geography of the world and geoecology, socio-economic geography of foreign countries, as well as other educational, scientific and administrative structures of Moscow.

The opening of the seminar was attended by Vice-Rector of the Moscow State University prof. N.V. Syomin and Minister-Counsellor, Head of Information Department of the Embassy of Japan in Russia, Minister-Counsellor Mr. Kotaro Otsuki, who stressed the high importance of the event. A report on the modern geographical studies in Russia in the first day of the seminar was presented by the dean of the Faculty Academician N.S. Kasimov. Ms. P.V. Zakharova, director of the GPBU "Mosekomonitoring" at the Department of Natural Resources and Environmental Protection of the City of Moscow was a special guest and participant of the seminar. Co-chairs of the plenary session on the first seminar day were Prof. Toshio Koike and Prof. Yu.L. Mazurov.

On the same day in the recreation of the 18th floor of the MSU Main Building held a poster session, where it was represented by a total of about 30 posters of Japanese and Russian authors. The same evening, a welcome reception was held on behalf of the faculty and the department for the participants and guests of the seminar, which was held in a warm and friendly atmosphere.

On the second day three thematic sessions occurred in a new building of the Intellectual center of MSU. Their moderators were Dr. Kiichiro Hatoyama and Dr. S.R. Chalov. After that the participants attended the meeting with guests from Japan, arranged by Prof. M.V. Slipenchuk as a deputy of the State Duma of Russia in his public reception.

At the final session of the workshop, the sides discussed prospects for cooperation and outlined a plan of action. In particular, it was decided to hold a seminar in Tokyo back in 2014. It was also decided to prepare and release in English a compilation of seminar materials. The Japanese side noted the high scientific and organizational level of the event and expressed sincere gratitude to the Russian partners.

During their stay in Russia a small but rich cultural program has been offered for colleagues from the University of Tokyo. Japanese guests visited the Moscow Kremlin — Russia's main attraction, visited its cathedrals, also visited on the famous lookout on the top of the Vorobiovy Hills. Important place in the program took an excursion to the University's Museum of Earth Sciences, located on the upper floors of the historic Main Building of Moscow University. It was possible to find time for informal discussions during informal evening events.

What is the "bottom line" from the event held in the Year of Environment in the Russian Federation? The main thing — it is the conviction of Russian and Japanese scientists the chance to become real partners in the study of science relevant to the interests of our countries and environmental problems. Now there are essential knowledge and motivation skills to overcome cross-cultural barriers, vision of the concrete follow-up cooperation. In particular, the Japanese side is ready to take on different forms of education and training of our students and staff.

Seminar has clarified priorities in our interests. For Russians, innovative urboekological technologies are the most attractive as well as everything connected with geo-ecological bases of "green" economy. Japanese colleagues, seems to be particularly interested in our educational techniques and related issues. There are many another promising fields of mutual interest, for example, all linked to the preservation of our common natural and cultural heritage.

The workshop organizers are aware of the fact that its success was made possible primarily due to high professionalism and a sense of civic responsibility for environmentally sustainable future of human civilization of all its participants. In particular, we are grateful to the key participants of the emerging partnership from the Japanese side: prof. Toshio Koike and Dr. Kiichiro Hatoyama, who visited Moscow twice during the seminar preparation process to develop programs and addressing pressing organizational issues. The mentioned above Japanese colleagues have also played an important role in preparation for the publication of this collection.

It is very important that this seminar was supported at all stages of preparation and holding with the university administration and the Faculty of Geography, including directly MSU Rector Acad. V.A. Sadovnichiy, vice-rector prof. N.V. Syomin and dean of the faculty Acad. N.S. Kasimov, whom we also sincerely grateful.

In conclusion should be stated that the seminar itself and the publication of its materials were made possible due to the sponsorship of the Protection of Lake Baikal Foundation. Participants of the seminar and the authors of this publication express their deep gratitude to this foundation.

Fortunately, our cooperation from the very first steps develops favorable political background what is naturally rather than by chance. We feel the interest and support from the political and business circles in Japan and Russia. Now — it's up to experts in the field of ecology and environmental policy, firstly — up to young scientists and teachers. The future belongs to those who understand that the key to a sustainable environment in our time is becoming a factor of sustainable partnership of professionals.

Yuri Mazurov
Coordinator of cooperation from the Russian side

Toshio Koike
Head of Department of Civil Engineering, the University of Tokyo

Opening address

It is my great honor to have the first Russia-Japan collaboration seminar for environmental sustainability, here in the Faculty of Geography, Moscow State University. First of all, I would express my sincere thanks especially to the leaders of this project, Prof. Yuri Mazurov and Dr. Kiichiro Hatoyama, for their tremendous efforts for preparing this meeting.

As Prof. Syomin mentioned, with regard to the environmental sustainability, we have a serious problem now. There are so many significant crises which have taken place, including the huge natural disasters, earthquakes, tsunami, and floods-droughts-heat wave, which are related to climate change, and the instability in the supply of water, food, and energy. The pandemic of infectious disease also happened in the world. So these serious crisis cause considerable of loss of human life and property, and their impacts have been expanding beyond the regional and national boundary to the global scale.

To address these issues which are caused by basically global and borderless economic or social activities, we need to share our scientific knowledge on these issues firstly, and then consider preparation ourselves for such events in advance of their occurring. Finally, we can construct the trans-boundary corporation framework toward social resilience. We need to have such a holistic and sharable knowledge for addressing these issues. For that purpose, we need to enhance our communication and exchange our understanding, ideas and experiences beyond disciplines and geographical areas. Russia and Japan are neighboring countries, but we recognize large differences in the natural environmental and socio-economic situations, and historical experiences between two countries. We need to share our scientific knowledge for understating of different topics between two countries.

Today and tomorrow, we will have series of oral presentations and also poster presentations. I do expect our fruitful discussions and exchanges of our understanding, and we would make a plan of our way forward at the end of this seminar.

Thank you very much.

Mikhail Slipenchuk
Head of the Department of Nature Management, Faculty of Geography, MSU, Dr. Sc. (Economics)

Special message

Dear colleagues, dear friends!

It is difficult to overestimate the role of science in the modern society. It has a huge impact on many areas of human life and activity, acting as a social force that helps to promptly respond to the most pressing challenges of the modern world.

Today, in an open world community scientific competition among economically developed countries, which is based on the struggle for new technologies and new resources, grows more and more. a principle: “Who owns the knowledge — owns the future” becomes the main slogan.

At the same time, in the era of globalization the only way to effectively study and protect the environment is to be together, uniting the efforts of different countries, creating preconditions for closer international cooperation. It is difficult to imagine that contemporary problems of nature can be resolved without taking into account the totality of the world’s economic and environmental ties.

Finally, it is impossible to solve research problems in isolation, forming a basic scientific understanding of the Earth’s natural resources, especially those with unique character. The implementation of the Baikal region development program can serve a good example of the effectiveness of such international cooperation.

The Faculty of Geography of the Lomonosov Moscow State University maintains constant scientific ties with many leading universities in the world. And I am very glad that the University of Tokyo has become a part of this number. I am sure that the first joint workshop, which we hold, will be a new impetus to the further expansion and strengthening of scientific and humanitarian ties between the two countries. It is crucial for closer relations of our people, for establishing more friendly ties and improving mutual understanding.

Synthesis of basic research, conducted by Russian scientists for decades, and practical achievements, supported by the latest technology used by our Japanese colleagues, can give a strong synergistic effect in the development of the whole modern geographical science, and above all, environment.

I would like to express my deep appreciation for the assistance in the organization of the seminar to the Faculty of Geography of the Lomonosov Moscow State University represented by its dean, Academician N. Kasimov and our Japanese colleagues, employees of the Department of Civil Engineering of the Tokyo University, headed by Professor Toshio Koike.

Toshio Koike
Department of Civil Engineering, the University of Tokyo

Data and model integration promoting inter-disciplinarity and trans-disciplinarity

SCIENTIFIC KNOWLEDGE AND ITS LIMITATION

What is scientific knowledge? We create some hypothesis based on theories, develop models, and implement experimental observation for validation of the hypothesis. This approach is called deductive inference. Based on the accumulation of factual knowledge, we can form the hypothesis. This approach is called inductive inference. Scientific knowledge is called formal knowledge which can be transferred and shared among wide scientific communities. By publishing paper and promoting communication, we exchange the factual knowledge. Such widely shared factual knowledge is defined as scientific knowledge. We are doing science in this way. During past one hundred years, this scientific knowledge has been increasing explosively. Differentiation and systematization have proceeded, and then a large number of disciplines have been established.

However, it is very difficult to reflect accumulated sub-system knowledge to holistic knowledge. Knowledge on a whole system can be rarely introduced to a targeted subsystem. In many cases, knowledge in one discipline is inapplicable to others. We are far from solution of issues across disciplines. It is critically important to establish inter-disciplinarity and create scientific knowledge crossing disciplines. To realize the benefits of scientific knowledge in society, we need to combine scientific knowledge in the natural world, the socio-economic world and the recognition world and to develop trans-disciplinarity as well as inter-disciplinarity.

How can we develop inter-disciplinarity and trans-disciplinarity? We need to share the data and information and develop inter-linkage of our knowledge by developing models and exchanging tools. Based on this kind of scientific activities, we can corporate between science community and society by making effective use of opportunities.

DATA INTEGRATION

With regard to "data and information sharing", this chart shows the increase in computer speed and data amount up to 2020, which was predicted in 2001. In 2011, our government developed the fastest computer "K", which is a 8 peta-flops machine. The prediction of computer speed is correct. Meanwhile, the predicted amount of data shows 2 or 3 PB around 2012. Actually, the data used for the 5th Assessment Report of IPCC was 2.6PB, while the data for the IPPC AR4 was 40 TB. At this moment we need to have data management capability much larger than the prediction.

It is said that scientists and experts usually use 80% of their research time for data management. Only 20% can be used for purely scientific activities. This ratio can be accepted to me. By introducing computer science and technology, we would change this ratio contrarily. I want to use 80% of my time for scientific study.

To realize it, our government has been supporting to develop a data system called "Data Integration and Analysis System (DIAS)", as one of the national key projects promoted by Council for Science and Technology Policy (CSTP) from 2006 to 2010. a follow up 5-year project is also ongoing. There two essential aims of DIAS, one is to create knowledge enabling us to solve problems and the other to generate socio-economic benefits. DIAS consists of mainly four components, including data injection, data management, data integration, and data interoperability. Prof. Shibasaki, one of our colleague, is leading the data interpretability system development.

We are now tackling a large increase in diversity of the Earth observation data. Prof. Shibasaki is leading the ontology system by developing the technical term dictionary and geographical dictionary, and also making a metadata design based on international standards.

We are also tackling large increase in the volume of the Earth observation data. This is the record of the change in amount of data in our storage. We can identify exponential increase in the amount. In past, almost all of the large data came from satellite, but nowadays, model outputs occupy the largest amount of our storage. According to recent development of computer integration technology, we can store 2.7 PB only by using two racks, and then, manage the huge increase in volume of data.

DIAS can accelerate the data archiving by including data loading, quality checking, meta-data registration, in collaboration with science and technology groups. We are enriching our system data searching capability. DIAS is also enabling us to do integrated research and to realize inter-disciplinarity. Basically we are now working in the fields of climate, water resources, food, fishery, and biodiversity through collaboration among different disciplines.

INTER-LINKAGE

We are now developing integration and inter-linkage system by using the DIAS. I'm a water guy, so I'm focusing on water. a model assessment strategy in preparation for the IPCC AR5 was published by Nature in 2010. It addresses the climate change in collaboration among the climate models, the integrated assessment models including energy, economy, agriculture, health and energy, and the models of adaptation, vulnerability and human settlement and infrastructure. You can identify that water is located at the center. If a water guy can develop an interrelated system with each component, we can address the integrated crisis in collaboration with various disciplines. For that purpose, we are now developing a water-related data and model integration system, called as Water Cycle Integrator (WCI).

We have archived various satellite data. These satellite data can provide various hydrological information, like cloud, rainfall, soil moisture, or land surface snow. We can validate these satellite products by using land observation in-situ data. We can also develop water cycle models by coupling in-situ data and satellite data. The, we can simulate river flow and other hydrological parameters. They can also be validated by in-situ data. We also archived model outputs from weather prediction models, seasonal prediction models and climate projection models. Some model outputs are archived online basis, yet other models, for example climate projection model is archived offline basis. After model evaluation and bias correction, the outputs can be used as inputs into the hydrological models, for predicting the hydrological parameters. Also by combining satellite data and the models, we have already developed a data assimilation system. This can improve our prediction capability of the hydrological phenomena. The WCI can provide with a better prediction of the hydrological parameters for integrated water resources management (IWRM), and also for climate change impact assessment and adaptation.

To make maximum use of the hydrological information in other socio-economic areas, we need to collaborate with other disciplines, including urban engineering group, agricultural group, and biodiversity group. By exchanging data and models beyond disciplines, we can provide usable information for environmental conservation and also information agricultural support.

As one of the WCI applications, I am now introducing a case in Tunisia in collaboration with JICA (this is the framework of Japan's ODA). The northern part of Tunisia faces to the Mediterranean Sea, and the southern part is the Sahara desert. The annual rainfall gradient from north to south is very large. In the Mediterranean Sea area, they have lot of rainfall. It is very dry in the Sahara desert. This is the general condition of rainfall in this region.

By applying some criteria to the climate model outputs, six models, which can express the regional climate, were selected. After model bias correction by using the in-situ data, we can compare the annual and seasonal average rainfall between in past 1980-2000 and in future 2046-2065. We can identify very clear decrease trends of the annual rainfall in future. All of the selected climate projection models show same change. The spatial distribution of the seasonal rainfall shows the clear decrease by 20% to 30%. Bigger decrease can be seen in drier season and in drier area. The clear decrease trend can be explained by introducing the change of the Hadley circulation accelerated by the global warming. This physical understanding is consistent to the result of numerical simulation.

By using the gravity sensor on the satellite, we can measure variation of the terrestrial water storage. Terrestrial water storage includes three components; surface water, soil moisture and ground water. In the semi-arid region, we can neglect the effect of the surface water. Meanwhile, soil moisture can be estimated by using the microwave remote sensing and the data assimilation system. Then, we can estimate the variation of the ground water by subtracting the soil moisture derived from the terrestrial water storage. The estimated ground water level variation from the two satellite sensors, gravity and microwave, can be validated with the in-situ ground water data. So we have a confidence in this estimate of ground water variation. This can be used for validation of the hydrological model simulation. By introducing climate projection model output after the bias correction into the validated hydrological model, we can predict the change in ground water from 2011 to 2100. We can get very clear decreasing trend of ground water resource.

Mr. Sawada, who is a PhD student in our laboratory, developed the vegetation growth model fully coupled with the hydrological model. He introduced the effect of the vegetation growth into the hydrological model. He could validate the coupled model by using the satellite data. Furthermore, he compared the simulated model output of the vegetation with the national wheat production in Tunisia and showed a very good agreement. He showed this information can be used for agricultural monitoring and also agricultural draught monitoring.

OPPORTUNITIES

Lastly, I will introduce an opportunity. Group on Earth Observations (GEO) is an intergovernmental collaboration framework, including 89 member countries and European Commission, and 67 participating organizations. Russia is also one of the Executive Members of this framework. Based on our agreement during the Rio+10 held in Johannesburg in 2002, the 1st Summit was held in 2003. The 2nd

Summit was held in Tokyo in 2004, hosted by the Prime Minister Mr. Koizumi. The GEO was established at the 3rd Summit in Brussels in 2005. GEO, an intergovernmental body, has been developing Global Earth Observation System of Systems (GEOSS) by coordinating various observation systems and data infrastructure, and making usable information for nine social benefit areas, health, disasters, weather, energy, water, climate, agriculture, ecology and biodiversity. The vision for GEOSS is to realize a future wherein decisions and actions for the benefit of humankind are informed by coordinated, comprehensive and sustained Earth observations and information.

Under this framework, we developed the GEOSS Asian Water Cycle Initiative (AWCI) to promote integrated water resource management by making usable information from GEOSS in November, 2005. Each member country identified one river basin as a demonstration basin. In case of Cambodia, the 1st stakeholder meeting identified a strategy for addressing the water-related issues, including flood, droughts and agricultural productivity. They are strongly affected by the climate change and the basin development of Mekong river. The participants in the meeting agreed to enhance the real time rainfall measurement and the soil moisture measurement capability for increasing agriculture productivities. Through the interviews to the farmers, we developed a water cycle - rice production coupled model in corroboration with agriculture science group. The observed data and model outputs are now disseminated with real-time basis from the DIAS. The DIAS climate change impact assessment tools are now being used by the officials in the country. Furthermore, on-the-job-training (OJT) is now being done between the central governmental officials and local division leaders. So this is just one of example of the GEOSS/AWCI.

Based on these experiences in Asia, we are now working with Africa. We agreed with a basic idea of implementation and we made a statement which are passed to the Rio+20. In February this year, we made a draft implementation plan. The 1st GEOSS Africa & Asia Joint Water Cycle Symposium will be held in our campus at end of November 2013. This will be a very nice opportunities for corporation between Asia and Africa.

CONCLUSION

To get holistic solutions across disciplines and lead people to take actions, we need to promote inter-disciplinarity and trans-disciplinarity. For that purpose, we need to develop a data system, build inter-linkage systems among different disciplines, and create opportunities where we can work together. Thank you for your attention.

Q&A

Q

Dear Professor, I'm very impressed with your presentation. I see it is a really work creating social meanings and informative to our seminar.

A

We need to identify different types of accuracies in climate projection models, hydrological models and satellite remote sensing. With regards to climate projection models, they still have big uncertainty. We need to correct the bias by using in-situ data and/or downscale by using fine resolution models dynamically. With regards to hydrological models, our group has been making efforts to develop a sophisticated and integrated model, which can simulates not only the water flow but also energy budget very well, including floods and droughts for long term continuously without any tuning. We are now developing a system for parameter estimation within heterogeneous river basin by coupling data assimilation. The last component is the accuracy of the satellite remote sensing. We can use electromagnetic information directly from satellites. The electromagnetic wave propagation model has been developed. We have to make further efforts for developing methods for converting the electromagnetic wave propagation information to the hydrological parameters. For each component, we still have some issues. We need to improve our modeling capability step by step.

Wataru Takeuchi
Department of Civil Engineering, the University of Tokyo

Quantifying carbon emissions from Russia integrated with remote sensing and bio-geophysical modeling

BACKGROUND

First of all, I would like to thank you Prof. Hatoyama and Prof. Mazurov to give me a chance to talk today. I would like to introduce myself before going into a research topics. I was born in Ishikawa, Japan and studied remote sensing and GIS for terrestrial ecosystem monitoring at the department of civil engineering, graduate school of University of Tokyo. After that I have a chance to work at Asian Institute of Technology (AIT) to teach advance remote sensing from 2007 to 2009. AIT and our department has more than 30 years of history of collaboration and remote sensing and GIS, collectively called "geoinformatics" is widely known. It is a starting point for me to work internationally who studied only in Japan and it greatly extended my perspective to realize the importance of international collaboration work. From 2010 to 2012, I had a chance to work at Japan Society for Promotion of Sciences (JSPS) as a director of Bangkok office. JSPS is the national science funding agency of Japan and my job in Bangkok is to introduce Japanese government scholarship and financial support for postdoctoral researchers in Asia to work in Japan. It has more than 35 of years history and I found that so many researchers who got PhD and worked in Japan went back to their country and play important roles in a wide range of academic areas. I have visited 10 ASEAN and 8 SAAC countries to meet top university presidents to advertise our activities and supported an alumni society of JSPS in Thailand, Philippines, Bangladesh, India and Viet-

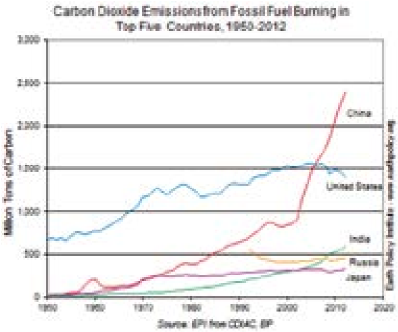


Fig. 1. Carbon dioxide emissions from fossil fuel burning in top five countries, 1950–2012

nam. It enhanced my experience to meet such a high rank resource persons in this region.

Let's move on to the research topic. Emission from forest reduction and degradation is one of the most important anthropogenic sources of carbon emissions to the atmosphere resulting in global warming [Yamagata, 2010]. A high-confidence forest carbon monitoring system for accounting emission from deforestation and forest degradation (REDD) is required to realize mitigation of global warming mitigation under the Post-Kyoto international framework.

What I have doing is to investigate the increase of forest fires, agriculture field burning, and methane emissions in wetland and permafrost area, as well as emission from industry, air pollutions monitoring from remote sensing and biophysical modeling.

Most European countries' emissions start decrease since last 5 years (Fig. 1). From 2020, developing countries start to share some amount of obligations to mitigate or reduce the emissions.

OBJECTIVE

This research is to devise a method to estimate the carbon dioxide (CO2) emissions from biomass burning such as forest fires and field burning in croplands in global scale.

The characteristics of atmospheric conditions are investigated over Global mega cities, which originates from industry, transport, field burning, etc.

BIOMASS BURNING AND IN-SITU MEASUREMENT

BIOMASS BURNING

Global above grand biomass mostly distributed in northern hemisphere (Fig. 2). Very high biomass is found in equator zone area at tropical forest including Indonesia, sub-Sahara and Amazon.

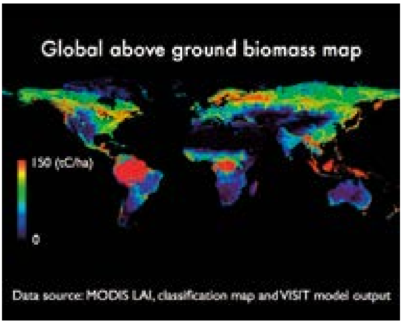


Fig. 2. Global above ground biomass

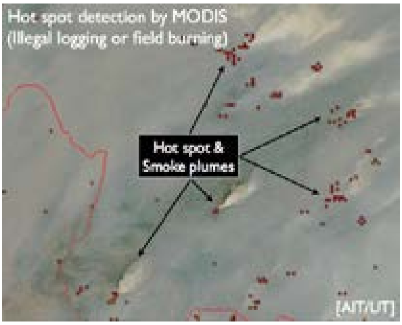


Fig. 3. Hot spot detection by MODIS (Illegal logging or field burning)

Hot spot of biomass burning detected by MODIS shows in Figure 3. This area covers triangle zone among Thailand, Laos and Myanmar. One of the advantages of remote sensing is to detect such big events periodically without going to the site very safely.

Figure 4 shows a time series of wild fire distribution in Asian region. A left figure shows a clear temporal variation of wild fires. A southern hemisphere in Indonesia and Malaysia has peak seasons from September to October, whereas a northern hemisphere in Thai-

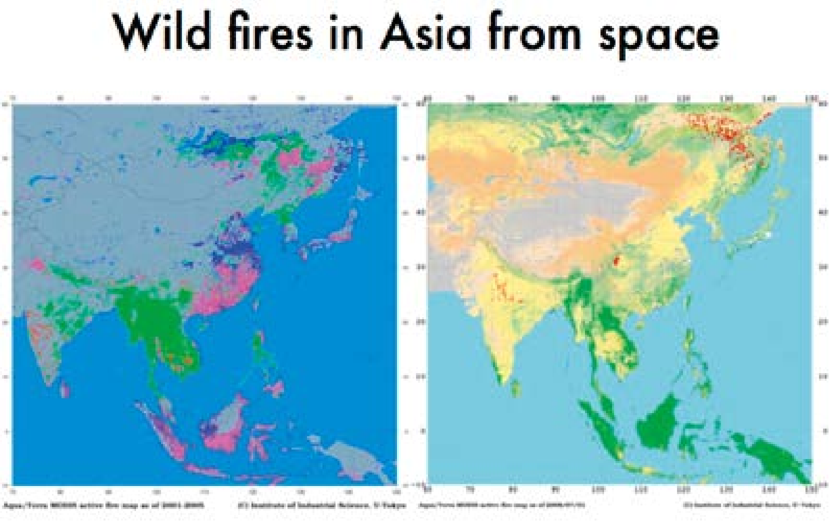


Fig. 4. Wild fires in Asia from space

land, Cambodia, Laos, Vietnam and Myanmar has its peaks from March to April. An equator line divides the area into two zones. We can see so many forest fires in Far East Russia in April as well as August along Amur river forested peat land zone. In China, Yangtze river is a border zone between wheat and rice cropping and it results in a different wild fire patterns.

IN-SITU MEASUREMENTS PARAMETERS

We have carried out a lot field survey as well as an in-house data processing on the server. The main parameters required for land cover and land use change studies for terrestrial ecosystem is shown as below:

- Latitude, longitude and altitude
- Wind speed
- Air temperature
- Soil temperature
- Relative air humidity
- Volumetric Water Content (VWC)
- Main species of the plant.

GPS PHOTO APP

We have developed an application to deal with GPS photo database. It could be free of charge downloaded for your iPhone or iPad. In this software, you can make a polygon and define some descriptions of land cover where you've been as shown in Figure 5. Now we have

Fig. 5. Examples for your iPhone and iPad

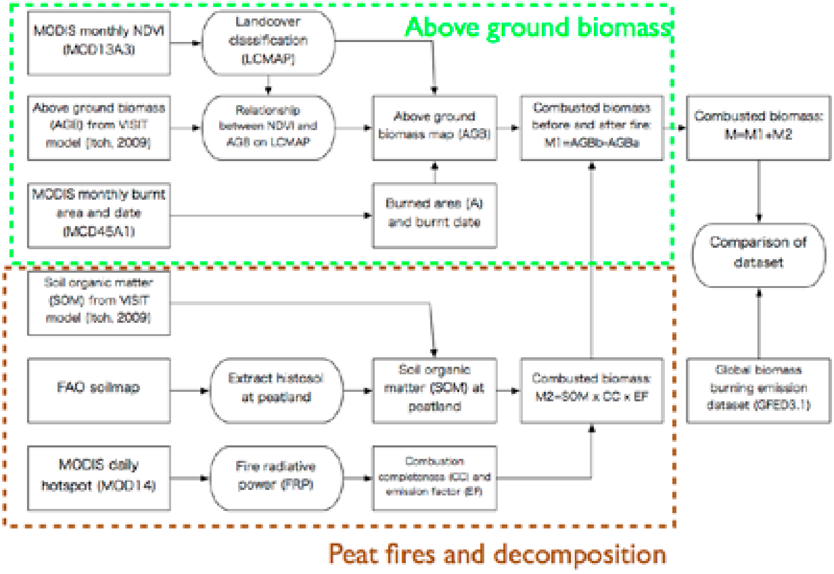


Fig. 6. Comparison of dataset model

more than 2000 users in the world, so we could share the data without going outside. We have proposed an international standard system along with German space agency (DLR), Oklahoma University (USA) and The University of Tokyo (Japan) under global land project (GLP).

GLOBAL CARBON EMISSION ESTIMATION

The carbon emission estimation includes two part of dataset, which are above ground biomass and peat fires and decomposition. The above ground biomass combusted biomass was estimated by MODIS data (NDVI and burnt area data) and VISIT model. The combusted biomass from peat fires and decomposition was using VISIT model, FAO soil map and MODIS daily hotspot data (Fig. 6).

From vegetation index we can identify the forest fire before and after forest fire. Once forest fire happened, the vegetation will gone, so we could see the land surface. From satellite visible image, will easily understand the changes before and after forest fire. The difficult in the carbon emission is to estimate the biomass. Because vegetation looks like the same as if we see from the above, namely all of

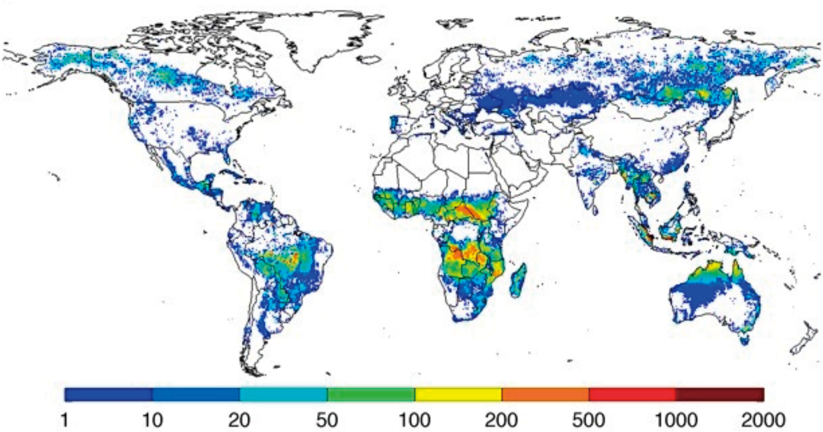


Figure 7. Annual carbon emissions (as g C/m^2/year), averaged over 1997–2009

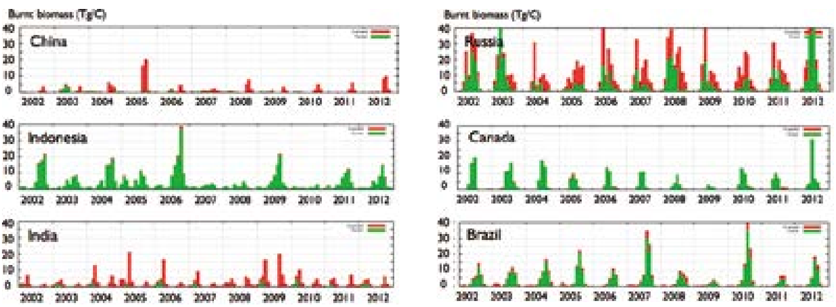


Fig. 8. Comparisons of burnt biomass (Tg/C)

them just look like green color. It means we cannot identify their species. So we consider the weather condition, temperature, rainfall and soil condition and so on, so then we could simulate the grows up of the vegetation.

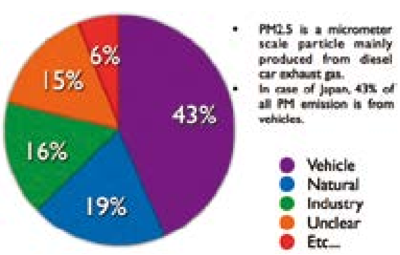


Fig. 9. The ratio of PM2.5 emission source in Japan

VISIT (Vegetation Integrated Simulator for Trace gases) is the kind of software to simulate the component the carbon in the deep or the stand or the root of the soil. Its objectives are 1) Atmosphere-Ecosystem biogeochemical inter-

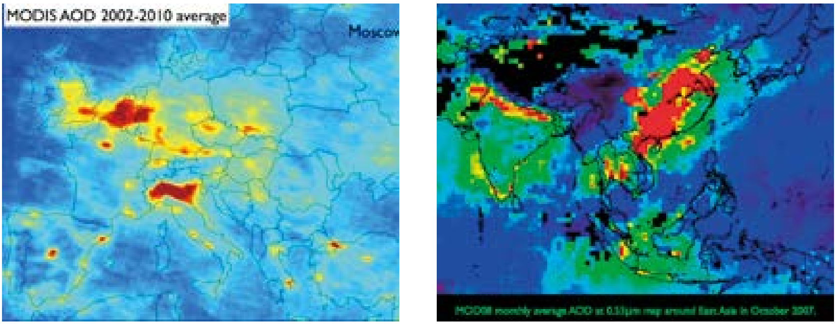


Fig. 10. Fractional depletion of radiance per unit path length

actions; 2) Especially, major greenhouse gases; 3) Assessment of climatic impacts and biotic feedbacks.

The Global fire data (GFED) shows in Figure 7, (NASA, 2009). Emissions estimates are carried out by combining burned area with a biogeochemical model (CASA) that enable fuel loads and combustion completeness for each monthly time step. Fuel loads are based on satellite derived information on vegetation characteristics and productivity to estimate carbon input, and carbon outputs through heterotrophic respiration and fires.

The Figure 8 shows the comparisons of burnt biomass (Tg/C) from 2002 to 2012 among several countries. Red color represents cropland and green color represents forest. We could find that in China, India and Russia have more cropland burning than other. The Russia has most amount of biomass burning, but it also has the biggest area in the world.

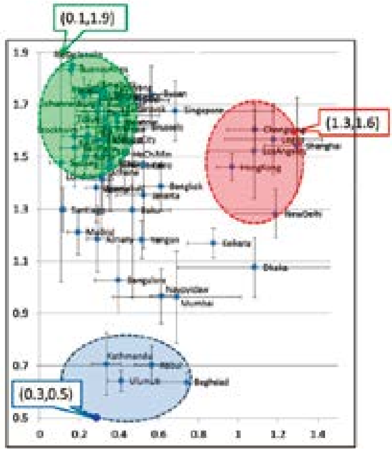


Fig. 11. Aerosol types in mega-cities

AIR POLLUTION

Particle matter (PM) is a complex mixture of solid and liquid particles, which remain suspended in the air. PM is one of the major pollutants that affect

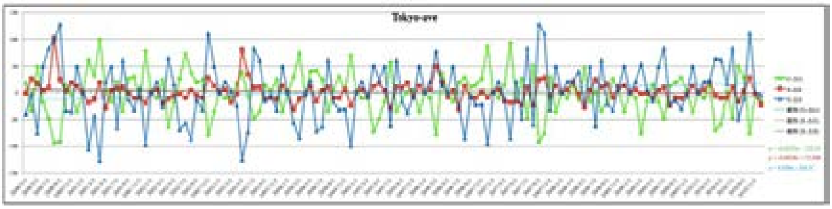


Fig. 12. Aerosol types in Tokyo

air quality in urban and even rural areas of the world. PM is mainly produced from diesel car exhaust gas. It remains in the inner part of lung. The ratio of PM2.5 emission source in Japan was shows in Figure 9.

"Aerosol Optical Thickness (AOD)" is the degree to which aerosols prevent the transmission of light by absorption or scattering of light. The aerosol optical depth or optical thickness (τ) is defined as the integrated extinction coefficient over a vertical column of unit cross section. Extinction coefficient is the fractional depletion of radiance per unit path length (also called attenuation especially in reference to radar frequencies) (Fig. 10).

Three types of aerosol types in mega-cities in Figure 11, where R: Polluted air with fires and exhaust gas; G: Clean air; B: Moderate air quality with ocean salt or desert sand (Fujikawa, 2012).

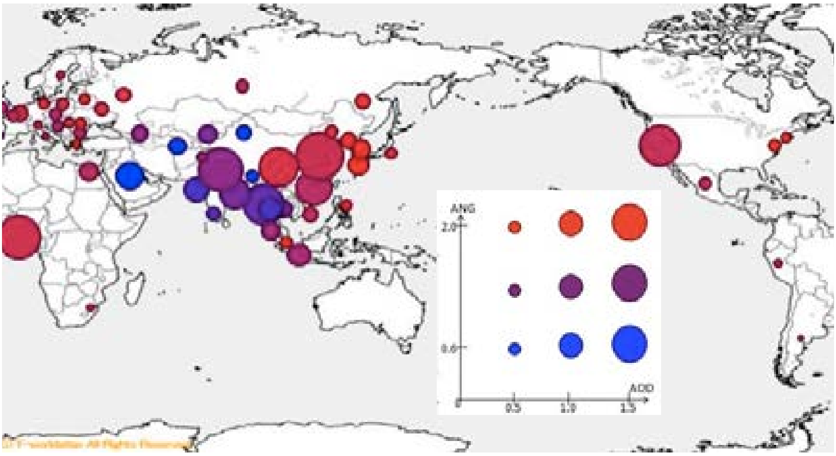


Fig. 13. ANG and AOD over global mega-cities

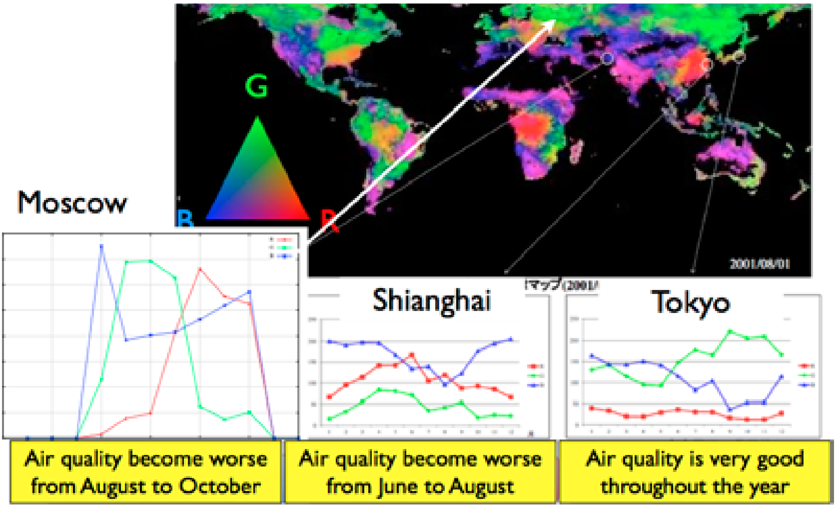


Fig. 14. Aerosol types in global scale map

Characterization of aerosol types in Tokyo from 2000 to 2012 (Fig. 12). R and G are in decreasing trend whereas B is increasing trend in the last 12 years of satellite measurements.

Characterization of aerosol types in global scale map (Fig. 14). R: Polluted air with fires and exhaust gas; G: Clean air; B: Moderate air quality with ocean salt or desert sand.

CONCLUDING REMARKS

Emissions from biomass burning in global scale from 2002 to 2012 are estimated. Seasonal variations between our model and GFED database are very similar. Atmospheric optical depth (AOD) and angstrom coefficient (ANG) reveal the characteristics of atmosphere and concentration in Global mega cities. More cross-validation points are indispensable to guarantee the reliability of the satellite based estimation model. More studies are extended to Russian cities supplemented by a ground-based measurement.

I would like to finish my presentation and really hope to have a research collaboration with Moscow State University especially CH_4 emission studies and air pollution studies in Moscow and the other Russian cities.

OUR SUPPORTERS

- Dr. Yoshiki Yamagata, Dr. Hasi Bagan, Dr. Akihiko Kto (NIES, Japan)
- Prof. Sachiko Hayashida, Dr. Akiko Ono (Nara Womens' University, Japan)
- Prof. Takashi Hirano, Prof. Mitsuru Osaki (Hokkaido University, Japan)
- Dr. Kazuyuki Yagi, Dr. Tamon Fumoto, Dr. Kazunori Minami (NIEAS, Japan)
- Prof. Hua Xu, Prof. Xiaoyuan Yan (CAS, China)
- Dr. Lam Dao Nguyen (VAST, Vietnam), Mr. Vu Tien Dien (FIPI, Vietnam)
- Dr. Louis Gonzalez (Lille University, France)
- Prof. Lal Samarakoon, Dr. Manzul Hazarika (AIT, Thailand)
- Dr. Kyaw San Oo (Peace research center, Myanmar)
- Dr. Orbita Roswintiarti (LAPAN, Indonesia), Dr. Rizatus Shofiyati (ICARLD, Indonesia)

M.V. Slipenchuk
Department of Nature Management, Faculty of Geography,
Lomonosov Moscow State University

Modern methods of research of Lake Baikal

THE INTERNATIONAL RESEARCH EXPEDITION “MIRS AT LAKE BAIKAL”

The International Research Expedition *Mirs at Lake Baikal* (2008–2010) became a unique achievement of Russian science of global importance. Deep Water Manned Submersibles *Mir-1* and *Mir-2* conducted research at Lake Baikal (Fig. 1). The research encompassed all areas of the lake. Over the three years, the submersibles made 178 dives with participation of 215 hydronauts from 12 countries (Fig. 2) [6].

The main aim of the expedition was the performance of the obligation of the Russian Federation towards the world community to maintain the ecosystem of Lake Baikal as a UNESCO World Natural Heritage site and create the necessary conditions for the sustainable development of the Baikal region.

Figure 1. Deep Water Manned Submersible Mir

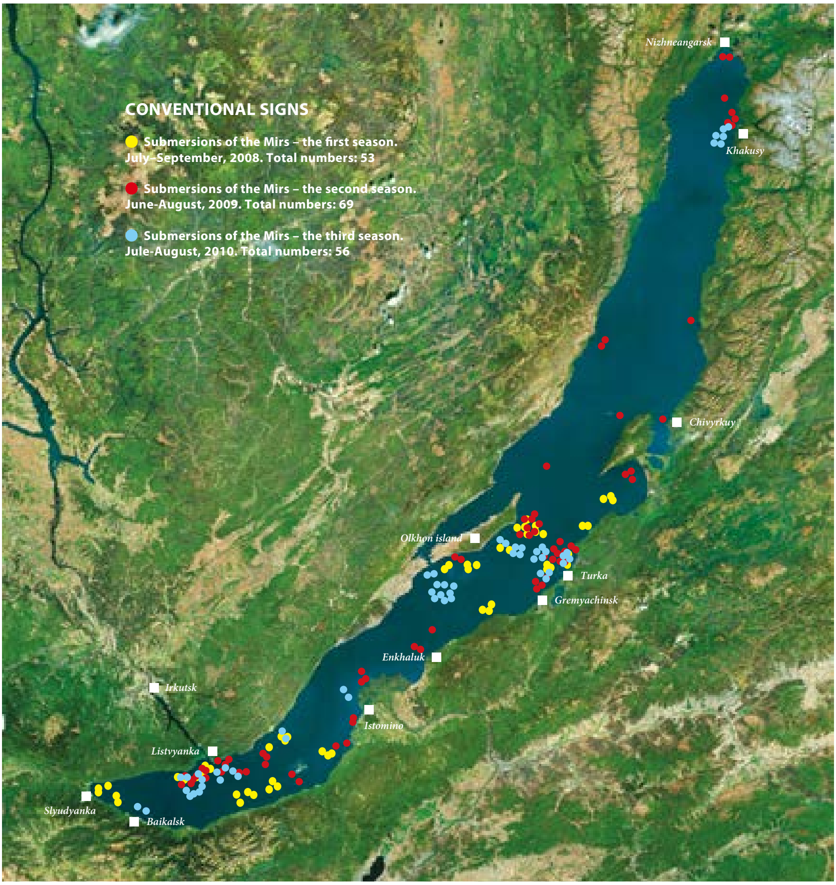


Figure 2. Map of dives during Expedition Mirs at Lake Baikal (2008–2010)

For the first time ever, the expedition enabled the discovery of combined solutions to the following critical tasks:

- obtaining new fundamental data in the research of Lake Baikal natural world and geology;
- international promotion of the achievements of Russian science in the creation and maintenance of manned deep water submersibles and hydrospace studies;
- creation of favourable conditions for the improvement of the investment climate in the Baikal region and addressing social challenges on the basis of the sustainable development principles;

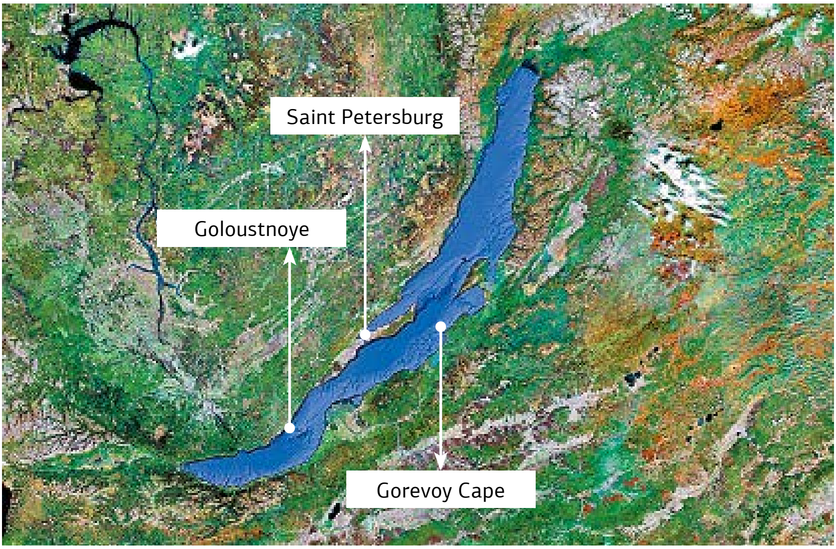


Figure 3. Areas of gas hydrates research at Lake Baikal

- attracting the attention of the world community to scientific, environmental and social problems of the Baikal region.

The most important scientific results of the expedition included the following.

Discovery of massive gas hydrate deposits at the bottom of the lake in layers of up to 0.8 m:

It is a fundamental discovery which has utmost importance for the world science. The search method of gas hydrate deposits by methane anomalies in water detected by a sensor installed on *Mir* Deep Water Manned Submersibles was tested (Fig. 3). The experiments carried out related to hydrates formation and decomposition depending on the temperature and pressure of the aquatic environment which will allow creation of a theoretical model of the process. Sample collecting devices were designed in order to preserve the gas hydrates while lifted to the surface [1, 2].

Research of deep oil and gas ingresses at the bottom of the lake:

For the first time ever, kerogenic structures and oil seepage in the form of drops were detected in Lake Baikal with a certain regularity seeping from sedimentary rocks at depths from 600 to 800 m.

Typically, hydrocarbon seepage is accompanied by bacterial mats. Various types of bacteria using oil in the primary food chain were established. The anomalies in the contents of hydrocarbon gases in the water mass and in sediments were studied in detail [4].

Large scale geothermal research:

The location and size of hydrothermal fields were defined, the values of the hydrothermal gradient were measured and the activity of underwater mud volcanoes studied. For the first time ever, the data on the methane flow from sediment into the water and the oxygen flow from water into sediment was measured. Thermal activity has been linked to benthic habitat organisms. The measurements of temperature, velocity and dynamics of bottom currents were carried out.

Geological and paleogeomorphical research:

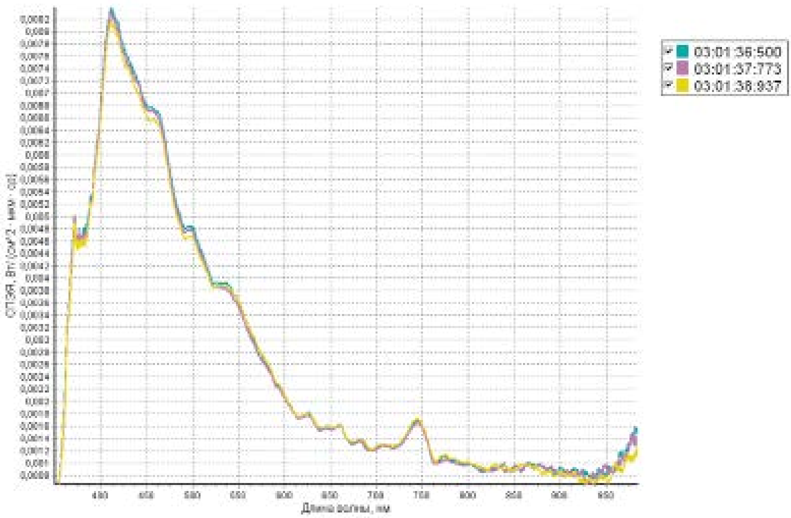
New data was obtained relating to the age of Baikal depression and the water level in the lake at different geological times. Four ancient submerged shorelines of Lake Baikal were recorded proving the variation of the water level in glacial times. The rift-forming fault on the western slope of the Baikal basin and the morphological characteristics of kinematics were studied [3].

The tectonic slopes with negative inclinations and the visual signs of the earthquake of August 27, 2008 on the submarine slopes of the lake were mapped for the first time. Hydrothermal fields with recently extinct geysers similar to the ocean floor “black smokers” were discovered.

Biological research:

Several dozen new endemic species were discovered. The animals found in the area of Gorevoi Utes were of particular interest as high density biomass was observed in the seepage areas of bitumen and oil strata and low-density carbon was detected in tropic chains. This unusual phenomenon allows us to assume the existence of living organisms on the basis of chemosynthesis discovered in Lake Baikal for the first time [7].

Within the area of hydrates seepage, previously unknown spherical forms with a diameter of 1–3 cm were discovered. The first analyses indicate that they contain a large number of microorganisms, primarily filamentous forms.



a

b

Figure 4. Spectrum image of homogenous surface of Baikal (*a*) and of the same surface after the methane emission (*b*)

A study of vertical distribution of plankton, behaviour and orientation in space of endemic species of amphipods and migrating Baikal fish was carried out.

Spectrometry of greenhouse gases with application of space station:

Among the scientific experiments, we must highlight the synchronous measuring of methane emissions resulting from the destruction of gas hydrate fields at the bottom of Lake Baikal. The measurements were performed using high-precision spectrophotometer aboard the space station *Soyuz* and on the water surface of the lake on July, 30 2010. These spectral observations, which were attended by cosmonaut Fedor Yurchikhin, specialists of space rocket complex *Energy*, Institute of Geography and the Institute for Problems in Mechanics of the Russian Academy of Sciences allow the provision of the quantitative estimate of the possible implications for global warming as a cause for increased amount of greenhouse gases emitted from gas hydrate within the shelf zone (Fig. 4) [5].

For the first time in Russia, a large-scale long-term research project aimed at ecosystem preservation of Lake Baikal, the UNESCO World Natural Heritage Site, was implemented within a framework of public-private partnership. The abilities of Russian science and its leading position in the field of underwater research were demonstrated. The organizational level of the expedition *Mirs at Lake Baikal* as well as its scientific and practical results are unprecedented. The expedition made a great contribution to the solution of global environmental issues and to the study, development and conservation of water resources of our planet.

INTERNATIONAL RESEARCH EXPEDITION "TRANS-EURASIAN FLIGHT: LEMAN–BAIKAL"

International Swiss-Russian Scientific and Research Expedition *Trans-Eurasian flight: Leman–Baikal* is a unique new project, during which comprehensive researches will be carried out using ultralight motorized trikes (ULM). This project is a logical continuation of the research expeditions *Mirs at Lake Baikal* (2008–2010) and *Mirs at Lake Leman* (2011).

Goals of the expedition:

- To create new methods and devices of the atmosphere and water surface sensing;
- To increase considerably knowledge about the impact of forest fires on the carbon cycle;
- To prepare proposals for the complex environmental protection measures along the route;
- To raise public awareness of environmental issues in Europe and Asia.

Main objectives of the project:

- To research of the parameters (pollution, hydro-physical and hydro-chemical data) using photo and video survey along the route, including the data of surface water mass of the lakes;
- To develop and improve the equipment complex of small aircraft, to create new methods and devices of the atmosphere and water surface sensing;
- To track and quantify the suspended solids and contaminants, carried by a stream, from their sources to the sites of deposition;
- To estimate stocks of suspended solids and their impact on the environment;
- To analyze the impact of forest fires on the carbon cycle in the summer.

It is planned that the expedition will be working in the Baikal region in 2013–2015. ULM will be based in Republic of Buryatia.

The first technical ULM flights took place July 4, 2013. From July 6 till August 10, 2013, researches took place according to the scientific program of the project at Lake Baikal and the Selenga River delta in Kabansky region (Fig. 5).

The previous results of the first season of the expedition:

- The technique of studying the surface of water bodies and land cover using equipment for multispectral remote sensing data set on ULMs has been worked off. In parallel with ULM, data of water of Lake Baikal and the Selenga delta was collected from the boat. This technique was used for the first time to study the degree of contamination of the unique objects of the Baikal natural territory and in the future this will allow to estimate the level

Figure 5. ULMs – participants of expedition

and composition of water pollution on the basis of aerospace survey, without the need for selection and analysis of samples.

- Samples of atmospheric air were taken for assessment of extent of technogenic pollution and for subsequent laboratory analysis and mapping of actual contamination.
- From the ULMs survey of rural settlements in Kabansky region of Buryatia was conducted for compiling cadastral plans. Researches of Kabansk irrigation system began to assess its impact on the pollution of Lake Baikal (jointly with Buryat State Agricultural Academy).
- A preliminary preparation was carried for the study of the reflectivity of the forests with the nanosecond radar (jointly with the Institute of Physical Materials Science).
- Survey was performed of the Kabansky reserve and Stepno-Dvoretsky reference forest area to assess the current state of their ecosystems.
- Data have been collected to create a digital terrain model (including settlements and forests), and landscape maps for research area in the Selenga Delta.
- Filtering ability of suspensions by aquatic vegetation is visually picked in the Selenga Delta.

Figure 6. Dark objects at the surface of Lake Baikal

- Visual studying of the coastal area of Lake Baikal was carried out in Kabansky region to identify illegal dumping and deforestation. As a result of the observations map of violations will be drawn up.

It is important to tell particularly about pictures which were taken during photographing the Selenga River from the air. The photos clearly show a number of dark objects right round, located on the same line. The diameter of each object is 7–8 meters; the distance between them is 15–20 meters. Explanation of this fact is not yet available. If these objects are of anthropogenic origin, it is a question of the unauthorized business activities, and it is the task of government to reveal and eliminate the violations. If the objects have a natural genesis, this is another interesting topic for future work of the expedition (Fig. 6).

The collected information will be processed in the Federal Polytechnic Institute of Lausanne, the Baikal Institute of Nature Management of the Russian Academy of Sciences, Department of Geography at Lomonosov Moscow State University with the support of the Fund for Protection of Lake Baikal.

The Baikal stage of the expedition “Trans-Eurasia flight: Leman–Baikal” is planned for three seasons — from 2013 till 2015. The next year the study will be continued at the coast of Lake Baikal, in the Selenga Delta, at Goose Lake (Buryatia) and Lake Hovsgol (Mongolia). It will also be evaluated the influence of the Selenginsky cellulose and board mill and the Gusinoozersky heat-electric generation plant on air and water pollution of the Baikal natural territory.

REFERENCES

1. Egorov A.V. Discovery and studies of gas hydrates on the bottom of Lake Baikal during Mirs on Baikal Expedition in 2008–2010. In: Planet Baikal. Collection of the reports from the UNESCO Conference "Baikal — the world treasure". – M., 2012. P. 130–143.
2. Egorov A.V., Nigmatulin R.I., Rozhkov A.N., Sagalevich A.M., Chernyayev E.S. On Transformations of Deepwater Methane Bubbles Into Hydrate Powder and Hydrate Foam // Oceanology, 2012, Vol. 52, No 2. P. 213–225 (in Russian).
3. Khlystov O.M., Khabuev A.V., Hauds L., De Batist M. Geological research of Lake Baikal using submersibles and 3D Mapping. In: Planet Baikal. Collection of the reports from the UNESCO Conference "Baikal — the world treasure". – M., 2012. P. 144–149.
4. Khlystov O.M., Zemskaya T.I., Sitnikova T.Y. Research areas unloading hydrocarbons of Lake Baikal using Deep Water Manned Submersibles. In: Baikal — the world treasure. – M. – Ulan-Oude, BSC SB RAS, 2012. P. 88–95 (in Russian).
5. Petrosyan G.A. Cosmos and Baikal. Three-level scientific experiment. In: Planet Baikal. Collection of the reports from the UNESCO Conference "Baikal — the world treasure". – M., 2012. P. 62–73.
6. Sagalevich A.M. 25th Anniversary of Mir Deep Water Manned Submersibles. In: Planet Baikal. Collection of the reports from the UNESCO Conference "Baikal — the world treasure". – M., 2012. P. 34–47.
7. Zemskaya T.I., Sitnikova T.Y., Klystov O.M. Key findings of the biota of Lake Baikal deep zone using Deep Water Manned Submersibles. In: Baikal — the world treasure. – M. – Ulan-Oude, BSC SB RAS, 2012. P. 72-81 (in Russian).

Makoto Shimamura
Department of Civil Engineering, the University of Tokyo

EADaS: a risk assessment methodology of natural hazards by topographic map reading

INTRODUCTION

Before talking about the main topic of my presentation, I would like to shortly introduce myself. I am now titled as Project Professor at the department of civil engineering at the University of Tokyo, but I have spent much longer period of time as a practitioner than as an academic professional. Actually, I worked more than thirty years as a railway civil engineer at the ex-Japanese National Railways from 1978 to 1987 and at East Japan Railway Company, one of the then privatized Japan Railway companies, from 1987 to 2012. Some examples of my past contributions to the railway industry are improvement of the observation and warning systems to safeguard train operation under various natural hazards including the seismic early warning system of Shinkansen, or the Japanese bullet trains, which functioned very effectively in the case of the great earthquake, which attacked the northern part of Japan in March 2011. From my background just I have mentioned, you would righteously imagine that my main interest is not pure academic research work, but more practical aspects of engineering. Speaking more precisely, I am more inclined to applying existing knowledge to the society as the tools to solve its actual problems rather than the realms of intellectual pursuits of obtaining new knowledge by carrying out research works.

THE CONCEPTUAL STRUCTURE OF EADAS

Among the ideas on which I am currently working and developing, today I would like to talk about a new methodology of risk assessment of

The framework of EADaS

		Agents (A)	
		$A_1 \sim A_{90}$	Total
Specific quality of environment (E)	$E_1 \sim E_{1483}$	$345{=}8_E F_A$	$\Sigma_E F_A$ for each **E**
	Total	$\Sigma_E F_A$ for each **A**	Sum

Prefix and suffix of a symbol (e.g. $_E F_A$) show the cause (E) and result (A), respectively.

		Agents (A)	
		$A_1 \sim A_{90}$	Total
Disaster modes (D)	$D_1 \sim D_{20}$	$345{=}8_{AH} C_D$	$\Sigma_{AH} C_D$ for each **D**
	Total	$\Sigma_{AH} C_D$ for each **A**	Sum
$_{EAH}0_D = \Sigma_E F_A \times \Sigma_{AH} C_D$		$\Sigma_{EAH} 0_D$ for each **A**	$\Sigma_{EAH} 0_D$

		Structures (2)	
		$2_1 P2_{135}$	Total
Disaster modes (D)	$D_1 \sim D_{20}$	Table $_D 1_2$	$\Sigma_D 1_2$ for each **D**
	Total	$\Sigma_D 1_S$ for each 2	Sum
$_{EAHD}0_S = \Sigma_{EAH} 0_D \times \Sigma_D 1_2$		$\Sigma_{EAHD} 0_2$ for each 2	$\Sigma_{EAHD} 0_2$

Fig. 1. The framework of EADaS

natural hazards based on topographic map reading and the related software to implement this methodology as actual practice of risk assessment. The methodology and its derivative software is collectively nicknamed as EADaS, as they work on the logical framework of utilization of the knowledge which is obtained by topographic map reading about environment (E), agent (A), disaster mode (D) and structure type (S) for predicting possible geomorphic disasters at arbitrary sites in Japan.

EADaS was originally designed to help railway engineers to optimize their decision-making in safeguarding train operation and planning of disaster prevention works for railway facilities, but it is as well applicable as a problem solving tool of engineering risk management of natural hazards in much broader contexts for the objectives as to:

1. Provide a holistic view of social infrastructure management,
2. Present a scalable framework of risk management practice and
3. Discuss the problem of choosing actions on the basis of numerical priority rating.

Geomorphologists know well that most natural disasters result in some changes in topography or landforms. This means that the disaster agents are largely identical to the geomorphic agents, and hence most of natural disasters can be taken as almost a synonym of geomorphic disasters or geomorphic processes, although there are some exceptions. The underlying geomorphological premises of EADaS can be stated as below:

1. Landforms are created and changed by topographic agents.
2. The present landform is the result of the accumulated past works of topographic agents.
3. Almost all disasters we experience are accompanied with changes of landforms.
4. Topographic maps are the most fundamental and inexpensive source of information about landforms.
5. Therefore, topographic map reading is the most crucial and scalable key to disaster risk assessment at the site.

And the logical framework of EADaS can be summarized as below:

1. Natural disasters result in geomorphic changes to varying degrees. Therefore, disaster agents (A) ≒ geomorphic agents.
2. Occurrence of geomorphic agents are controlled strongly by geomorphic setting and some others ≒ disaster environments (E). Some agents (e.g. flood, mass movement) will often occur simultaneously at a site, when their parent agents (e.g. typhoon) occur.
3. Geomorphic agents are varied in their risks: i.e. hazard risk (H).
4. Disaster modes (D) (e.g. destruction, covering) are dependent on the agents (A).
5. Damages of the structure (or facilities) (S) depend on the D's.
6. The evaluation of the relationships between E, A, H, D and S will give the collective risk (P) of all possible disasters at the target site.

In short, EADaS is a so-called expert system based on the geomorphologic information obtained from map reading, which enables systematic and numerical rating of the potential risk of all possible natural disasters at the site. It is important to emphasize that though numerical rating is a unique characteristics of EADaS, it is not its face value but its easiness of amendment in risk communication by using it that we appreciate it.

Frequencies of various geomorphic agents occurring at a site are controlled strongly by the geomorphic setting or disaster environments (E). Disaster environments include many factors other than geomorphic setting. They are geology, vegetation, disaster prevention facilities, etc. However, EADaS so far has worked exclusively within the horizon of

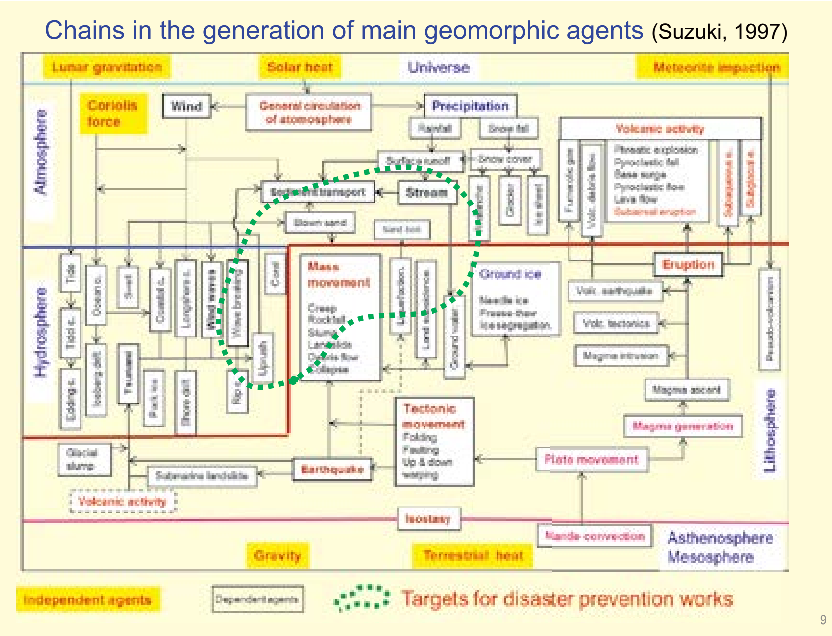


Fig. 2. Chains in the generation of main geomorphic agents (Suzuki, 1997)

natural conditions, neglecting the effects of the disaster prevention facilities such as check dam, bank, retaining wall, and so on.

THE FRAMEWORK OF EADAS

Figure 1 demonstrates the above-mentioned logic of EADaS. Table *EFA* is of the most important, or main engine of EADaS, and shows the relationship between frequency of *An* and each element of the environment at a target site *En* . Prefix and suffix of a symbol (e.g. *EFA*) show the cause (*E*) and result (*A*), respectively. Table *AHCD* shows the relationship between the agent (*A*) with specific hazard factor (*H*) and the disaster mode (*D*).

In building an expert system like EADaS, it is important to remind that various kinds of geomorphic agents will occur at a site separately, but often simultaneously, as shown here in Figure 2 particularly at the time when the big-scale parent agent, such as an earthquake or typhoon attacks the site.

Next, concerning the disaster agents or geomorphic agents, I believe that all geomorphic agents are linking to form chains in their

Division of choices for an element of environment
(= Questions in EADaS)

Example: Question C2: Division of the elevation or depth of the site.

C2	Elevation or Depth （*H*, m）	For manual, refer to Fig. C2 & Fig.C5	Next question
Purpose	Examination of the effect of coastal agents	Definition and/or Significance	
No.	Choice of *H* (m) （Choose 1item）	Main disasters due to coastal agents	
1	C1 = 2 and *H* ≧10	No disasters except salt breeze	Goal
2	C1 = 3, 4 or 5 and *H* ≧40	No disasters except salt breeze	Goal
3	40 > *H* ≧ 10	Maximum height of tsunami in Japan	C3
4	10 > *H* ≧ 5	Maximum height of high waves	C3
5	5 > *H* ≧ 3	Makimum height of flood tide	C3
6	3 ＞ *H* ≧ 1	erosion and deposition in shore	C3
7	1 ＞ *H* ≧ 0	daily minor change in shore landform	C3
8	land lower than sea level （0 ≧ *H*）	inundation (flood outside the levee), flood tide,	C3
9	0 ＞ *H* ≧ - 5	seasonal change in coastal landform due to beach drifting	C3
10	-5 ＞ *H* ≧ -10	change in submarine landform due to storm waves	C3
11	-10 ＞ *H* ≧ -40	Almost no disasters	C3
12	-40 ＞ *H*	No disasters, excepting the cuting of submarine cable	C3
13	Unknown		C3

C1 is the question for the distance from the nearest coastline to the target site.
'Goal' means that "Go to the next major classification of environment".
'Unknown' means that the user of EADaS has no data and/or knowledge for the question!
(If 'unknown' is more than 10% of all questions required, the data is untrustworthy!) 13

Fig. 3. Division of choices for an element of environment

generation like this. The disaster prevention works are the actions to cut and/or weaken these chains, but the targets for the works are restricted to these agents surrounded by a green dotted line. However, EADaS is concerned with the 90 kinds of agents, all of which occur somewhere in Japan and in almost every year or some decades.

Table *DRS* is not yet included in the software under the present situation. This is because it is very difficult to evaluate the uncertainties of so many facilities of 135 kinds, e.g. bridge, house, bank, cable line, atomic power station, etc. But *DRS* will be included in the software in near future. This total score is called the potential risk of disaster by each agent (*ΣEAHPD*) under the present disaster environments, so that to obtain this score is the main objective of EADaS.

DATA ANALYSIS AND SCORING PROCEDURES

Next, I will explain how to score the individual variables of EADaS briefly. First of all, the disaster environments (*E*) are classified into 18 major groups, and they are divided into total 225 elements like

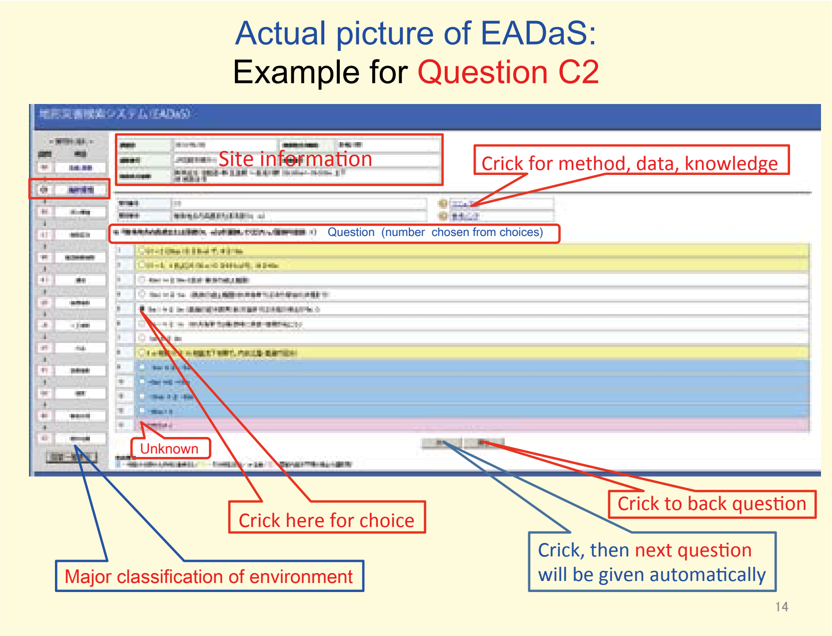


Fig. 4. Actual picture of EADaS

this. This means that 225 questions are prepared by EADaS and their answers will be chosen from these choices. However, the user does not necessarily have to answer the all questions, as explained later.

Figure 3 is an example for the question (C2) and choices for an element of environment. If you choose one item, then the next question will be automatically given by EADaS. The "Goal" means that the evaluation of this group of environment is complete, so that go to next environment. The "Unknown" means that users cannot choose any choices owing to no data such as a good geologic map and no knowledge for the concept of question. Note the result including so many unknown is untrustworthy.

Figure 4 is an actual picture of the same question as C2. In case of the JR Omigawa station, for example, first, question for the kinds of landform (*L*), choose the choice 2: Terraces, then next question T1 will be given, so choose 1: marine terrace, then for T3: choose marine erosion terrace, for T7, choose terrace scarp, T9, choose the effect on the lower land, and so on. Thus, the user does not necessarily have to answer all questions and the task is not so troublesome.

Disaster modes (D)			C_D	Examples of the agents causing the disaster mode (mainly for railway)
Space-blocking	Decrease in visibility	D_1	1	dense fog, heavy rainfall and snowfall, tornado, splash, lightning, etc.
	Scattering of materials	D_2	1	strong wind, tornado, blizzard, splash, etc.
	Vibration of facilities	D_3	1	strong wind, tornado, blizzard, earthquake, etc.
	Poisonous gas	D_4	1	volcanic activity, deficiency of oxygen, big fire, etc.
Covering	Settling of rock body	D_5	5	lava flow, pyroclatic flow, large-scale rock slump and landslide, etc.
	Deposition of huge rock blocks	D_6	4	rock fall, rock slump, landslide, debris flow, tsunami, etc.
	Deposition of sediment	D_7	3	strong wind, river flood, flood tide, tsunami, pyrocaltic fall, etc.
	Deposition of drift materials	D_8	3	strong wind, river flood, flood tide, tsunami, etc.
	Covering with water	D_9	2	river flood, flood tide, high waves, splash, tsunami, etc.
	Covering with snow	D_{10}	2	heavy snowfall, thick snow, avalanche, snow flow, blizzard, etc.
	Icing and freezing	D_{11}	1	low temperature
	Salt damage	D_{12}	1	strong wind, salt breeze, flood tide, tsunami, etc.
Destruction	Ground failure	D_{13}	5	erosion, slope failure by mass movement, volcanic acivity, earthquake, etc.
	Facility destruction	D_{14}	5	*ditto*
	Destruction of moving equipment	D_{15}	2	due to almost all of disaster agents
	Destruction of vegetation	D_{16}	3	*ditto*
Lowering of function	Decrease in strength of ground	D_{17}	2	weathering, deformation, remarkable change in ground water, etc.
	Decrease in strength of facility	D_{18}	2	weathering, deformation
	Abnormal growing of vegetation	D_{19}	1	destruction of ecological environment
	Abnormal breeding of animals	D_{20}	1	insects, undergound animals, birds, etc.

Fig. 5. Classification of disaster mode (*D*) and their risks (*CD*, score: 1 ~ 5)

	Time for restoration (*t*)	Examples of disasters due to agents
5	some months (or abandon of the facility)	Destruction of bridge, tunnel, high-level railway and basement due to large-scale tsunami, flood, slope failure, erosion, etc.
4	about one month	Destruction of cut-slope due to slope failure, Covering of facilities due to debris-flow.
3	some days	Destruction of embankment, Covering of facilites due to minor flood, high tide, etc.
2	about one day	Covering of facilites due to rockfall, thick snow-cover.
1	some hours	Closing the clearance limit due to strong wind, rainfall, snowfall, smog, etc.
0	no disasters occur	minor flood for high-level railway, high voltage cable, etc.

Fig. 6. Classification of the risk of disaster mode (*CD*)

As we do not have sufficient data to make it possible to analyze the *EFA* statistically for all combinations, the *EFA* for each *E–A* combination is graded into five levels based on the past events and our knowl-

Fig. 7. Natural disasters result in landform changes in the vicinity of JR Omigawa station

edge. Needless to say, these evaluations may include some errors. However, since EADaS examined a great number of *EFA*, I believe that this way of evaluation meaningful from the macroscopic pint of view.

The disaster agents are different in their risks of primary cause, so that all agents are weighted using these ten parameters defined by UNESCO. Concerning these ten parameters, the agents are graded into five levels with different scores and taking the risks of primary cause (*H*) into consideration, all agents are graded in ten classes, i.e. (*HCA*), as shown in this column. Difference in *HCA* from score 1 (e.g. creep) to score 10 (e.g. bedrock slump) may be logarithmic in their risks.

Next, disaster mode (*D*) is classified into 20 groups as shown in Figure 5.

Their risks (*CD*) are graded into six levels according to the criteria shown in Figure 6, assuming that *CD* is proportional to the time for restoration (*t*), for example, the time for stoppage of railway because *t* will be proportional both to the feature of total damage of facility and to the cost for restoration.

Next, Frequencies of disaster modes induced by each agent (*AFD*) are divided into four grades for each disaster mode. Notice that one agent often results in some kinds of disaster modes. Thus, taking *HCA* into consideration, the potential risk of disaster mode *AHPD* is defined as the following formula:

Site No.	JR-636-29.4k-01	Site name	Omigawa st.	Name of checker	Suzuki, T.	Date of EADaS	20070620
Past event	Rock fall, slump	Structure	Natural slope	Affiliation	Chuo Univ.	Date of field survey	20070616

Disaster Agents (A_1~A_{25})				$_HC_A$	$\Sigma_{EAH}P_D$	Threshold
Climatic agents	air temperature	high air temperature	A_1	1	12	20
		low air temperature	A_2	1	0	24
	wind	strong wind	A_3	3	54	90
		tornado	A_4	4	25	–
		sand drift	A_5	3	0	200
		salt breeze	A_6	1	60	40
	rainfall	heavy rainfall	A_7	4	132	100
	snow	heavy snowfall	A_8	2	0	65
		thick snow	A_9	1	0	35
		avalanche	A_{10}	5	0	300
		snow flow	A_{11}	4	0	160
		blizzard	A_{12}	3	0	75
	others	lightning	A_{13}	1	12	24
		hailstorm	A_{14}	2	24	16
		dense fog	A_{15}	1	1	3
Coastal agents	waves	splash	A_{16}	2	264	160
		high waves	A_{17}	4	0	350
		flood tide	A_{18}	3	0	280
		tsunami	A_{19}	7	1161	500
	coastal erosion	beach erosion	A_{20}	3	0	200
		rocky coast erosion	A_{21}	3	0	300
	coastal deposition	beach deposition	A_{22}	3	0	150
		beach drifting	A_{23}	1	0	100
		prevailing direction of beach drifting	A_{24}	1	0	10
		drift timber etc.	A_{25}	2	0	200
Fluvial agents	surface flow	sheet erosion	A_{26}	1	0	50
		gully erosion	A_{27}	2	0	90
	rapid increase of river water	in discharge	A_{28}	3	0	300
		in water leve	A_{29}	3	0	500
	fluvial erosion	valley head erosion	A_{30}	2	0	400
	bedrock erosion	down cutting	A_{31}	3	0	500
		lateral cutting	A_{32}	3	0	500
	sediment erosion	down cutting	A_{33}	3	0	300
		lateral cutting	A_{34}	3	0	400
	deposition	sedimentation	A_{35}	3	0	400
		flood	A_{36}	5	0	800
		inundation	A_{37}	4	0	500
		drift timber	A_{38}	3	0	400
Mass movement	creep	creep	A_{39}	1	0	300
	rockfall	fall off type	A_{40}	5	1470	500
		separation type	A_{41}	6	1804	600
	slump	soil slump	A_{42}	8	2346	700
		bedrock slump	A_{43}	10	2655	1500
	landslide	rapid landslide	A_{44}	10	2537	1700
		slow landslide	A_{45}	4	792	1000
	debris flow	debris flow	A_{46}	7	0	1500
		sand flow	A_{47}	5	0	1000

Disaster Agents (A_{48}~A_{90})				$_HC_A$	$\Sigma_{EAH}P_D$	Threshold
Subsurface agents	ground water	change in the level	A_{48}	2	0	140
		water spring	A_{49}	2	112	120
		piping	A_{50}	2	0	100
		mud effusion	A_{51}	2	0	6
		liquefaction	A_{52}	6	0	300
		sand boil	A_{53}	3	0	50
	subsidence	sinking, collapse	A_{54}	5	0	–
		land subsidence	A_{55}	1	0	60
		settlement	A_{56}	2	0	200
Volcanic agents	explosion	volcanic gas	A_{57}	4	0	180
		phreatic explosion	A_{58}	8	0	1000
		magmato-phreatic	A_{59}	9	0	1000
	pyroclastic fall	base surge	A_{60}	9	0	1000
		ballistic fall	A_{61}	6	0	250
		ash fall	A_{62}	4	95	150
		scoria fall	A_{63}	4	95	150
		pumice fall	A_{64}	4	95	150
	pyroclastic flow	lithic flow	A_{65}	8	0	300
		scoria flow	A_{66}	8	0	300
		pumice flow	A_{67}	8	0	300
	lava effusion	thin lava flow	A_{68}	6	0	220
		thick lava flow	A_{69}	5	0	190
		dome lava	A_{70}	5	0	190
		crypto doming	A_{71}	5	0	190
	volcanic debris flow	explosion type	A_{72}	10	0	–
		snow & ice melt type	A_{73}	6	0	450
		crater overflow type	A_{74}	6	0	–
		metamorphosed type	A_{75}	7	0	–
		earthquake type	A_{76}	9	0	–
		heavy rain type	A_{77}	7	0	90
	incidental phenomena	geothermal change	A_{78}	1	0	60
		air shock	A_{79}	2	0	50
		volcanic earthquake	A_{80}	4	0	200
		volcanic deformation	A_{81}	3	0	150
		volcanic tsunami	A_{82}	7	0	600
Tectonic agents	earthquake risk	minimum	A_{83}	1	114	–
		small	A_{84}	2	676	–
		intermediate	A_{85}	6	1920	–
		large	A_{86}	8	2438	–
		maximum	A_{87}	9	2419	–
	crustal movement	active faulting	A_{88}	9	266	–
		active folding	A_{89}	3	119	–
		rapid uplift & subsidence	A_{90}	2	91	–
Total of all agent (A_1~A_{90})					21789	Risk rank
Total of all external agents (A_1 ~ A_{56})					13461	13
Total of all volcanic agents (A_{57} ~ A_{82})					285	A/Q
Total of all tectonic agents (A_{83} ~ A_{90})					8043	100%

Fig. 8. An example of EADaS output

AHPD = AFD * HCA * CD

where,

AFD = Frequency of each disaster mode (*D*) for each agent (*A*),

HCA = Class of agent (*A*) classified by the total scores (*ΣHRA*) of the risk of primary cause or hazard factor (*H*),

CD = Class of the risk of disaster mode.

Based on the all afore-mentioned considerations, the total potential risk of each agent at a target site, is defined as:

ΣEAHPD = ΣEFA * ΣAHCD

where

ΣEFA = Total scores of the frequency of each agent (*A*) for all elements of disaster environment (*E*),

ΣAHCD = Total scores of all disaster mode class (*D*) for each agent (*A*) with the hazard factor (*H*). The scores of *ΣEAHPD* for all agents are output for each agent separately as the product of EADaS.

AN EXAMPLE OF EADAS RESULTS

Figure 8 is an example of the output for all agents evaluated for the JR Omigawa railway station, shown in Figure 7. Using this output after the deletion of the agents including '0 score', we can check the plausibility of the output from the viewpoint of our common knowledge in geomorphology.

CONCLUSION

EADaS is continuously being developed and improved in order to make it a practical risk assessment tool of natural hazards for decision makers in various fields. Among the various items of development and improvement, there are such topics actively discussed and manipulated as:

1. Completion of the 'Table DRC'.
2. Verification of the assessment results by actual disaster data.
3. Scaling and adjustment of parameters.
4. "Thresholds" of decision-making.
5. Use of expert judgment elicitation as an alternative measure of verification by actual disaster data.

REFERENCES

1. Suzuki, T. and M. Shimamura. (2013). EADaS: A reference system for predicting possible geomorphic disasters in Japan. In: Abstract volume of the 8th International conference on Geomorphology, 495.
2. Suzuki, T. (1997). Topographic map reading for civil engineers Vol.1. Kokin-shoin, Tokyo (in Japanese).

E.I. Golubeva, T.O. Korol, N.N. Mogosova, A.A. Potapov, A.A. Sayanov, V.A. Toporina, T.A. Vorobyova
Department of Nature Management, Faculty of Geography, Lomonosov Moscow State University

Landscape planning and environmental safety of urban space

INTRODUCTION

Facing current tendencies of urban expansion and sprawl the prior interest of landscape planning has been focused on environmental safety of urban area.

In order to lay out urban areas we aim to bring designed area into accord with the requirements to be eco-friendly, efficient and aesthetically beautiful.

Thus we have to remember the area is ecologically safe in the case of simultaneous protection of cultural and historical, natural, aesthetic features and introduction of innovations.

METHODOLOGY AND STUDY AREA

We are able to mark out following trends in landscape planning of urban areas (Fig. 1).

RESULTS

Urban environment is highly polluted as lots production facilities, transport etc. release pollutants into the air and water. These harmful substances tend to accumulate in organic tissues and soil.

1. ENVIRONMENTAL SAFETY AND RISK REDUCING

Physical pollution. As an example of large-scale studies of physical pollution we mention the experience of electromagnetic fields monitoring. Electromagnetic field of radio frequency (EmF RF), generated by

Fig. 1. Key trends in landscape planning of urban areas

systems of wireless communication and broadcasting, is one of the most volatile and not enough studied impact factors of the environment [8].

Effects of this physical environment factor is rapidly increasing in urban areas as new wireless technologies and data transmission in cellular communications systems, local wireless network (Wi-Fi devices) etc. are actively developing and implementing into everyday population life. Furthermore, according to various researchers, diseases caused by EmF RF vary from psycho-neurological (e.g., the so-called electromagnetic hypersensitivity) to DNA molecules damaging and cancer (including cell phone users), that stresses environmental impact of EmF RF [4, 5].

Staff of the Department created a framework for fieldworks [11] within researchers studied the spatial inhomogeneity of EmF RF. Integrating a wide range of existing methods of experimental physics and environmental simulation this framework was established in order to provide electromagnetic safety and reliability of telecommunication systems [10].

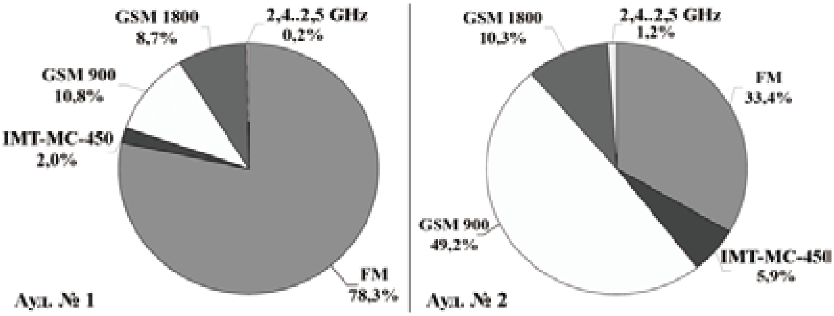


Fig. 2. Cumulative radio-frequency bands contribution to the structure of electromagnetic pollution; *to the left* – room window-oriented on FM radio broadcasting centre

Practical testing of wideband frequency-selective measurements methods was carried out in high-rise apartments. Measuring resulted in rich data base of the relative numbers of cumulative radio-frequency signals (FM, GSM 900 and 1800 MHz and others). Moreover, researches showed window opening spatial orientation on FM radio broadcasting centre significantly contributed in electromagnetic pollution (Fig. 2).

Application of wideband frequency non-selective measurements joint with GIS technologies provides detection of the very complex spatial structure of EmF RF, including areas with maximum values of the electromagnetic field strength (Fig. 3).

In such a way, the search findings on electromagnetic safety of residential areas led by the methods of objective control of radiofrequency electromagnetic fields, including GIS technologies, provides arrival at decision making and classification of urban areas according to the criterion of electromagnetic safety, and certainly improving of data visualization [11].

Chemical pollution. Environmental quality monitoring includes ambient parameters observation and data recording. The monitoring procedure was elaborated in Moscow Department of Natural Resources Management and Environmental Protection. The main purpose was to get reliable on-line information on environmental situation. Moscow State Budgetary Environmental Institution “Mosecomonitoring” was responsible for development and implement of this system [16].

Environmental monitoring in city of Moscow includes the system of basic stations [15] accounted for (Fig. 4):

- *Atmospheric air monitoring* is conducted by 39 automatic stations of air pollution control, which operate day and night gathering data on more than 20 parameters. Automatic stations are situated in all functional areas of Moscow (residential areas, industrial areas etc.); they are supplied with modern gas analyzers. The research showed there was steady trend in average annual concentration of nitrogen dioxide of about 49–44 mkg/m^3 (Fig. 5).
- *Water quality monitoring* is carried out on 60 control posts. In that we monitor the water quality of the Moscow river basin. The system records data on more than 27 parameters every month. Besides 3 automatic stations of waters pollution quality will be designed in the nearest future.

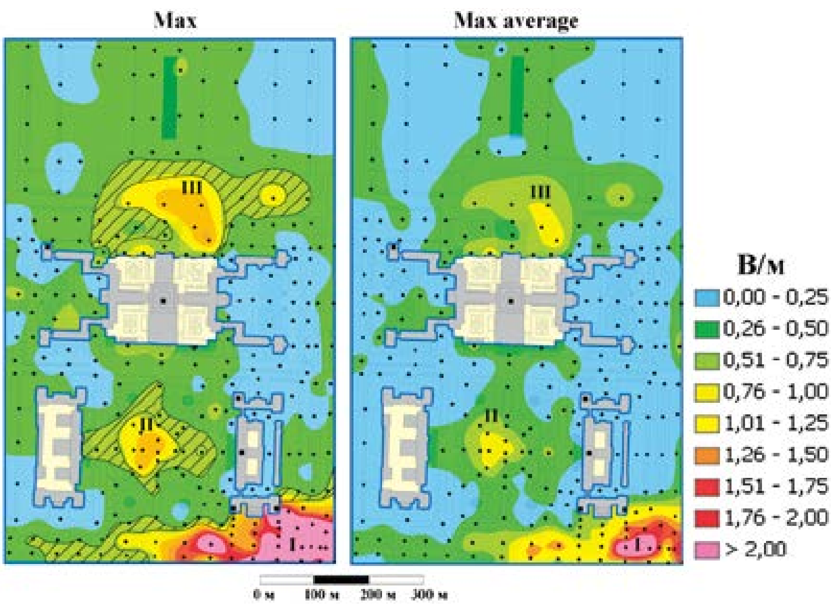


Fig. 3. Spatial distribution of electromagnetic field strength (V/m, GHz) on the area adjacent to buildings of Lomonosov Moscow State University. The figure demonstrates results taken in measurement option *Max* (to the left) and *Max average* (to the right). Base stations of mobile phones are pointed by black dots. Figures **I**, **II** and **III** mark maximum intensity of electromagnetic field strength [9]

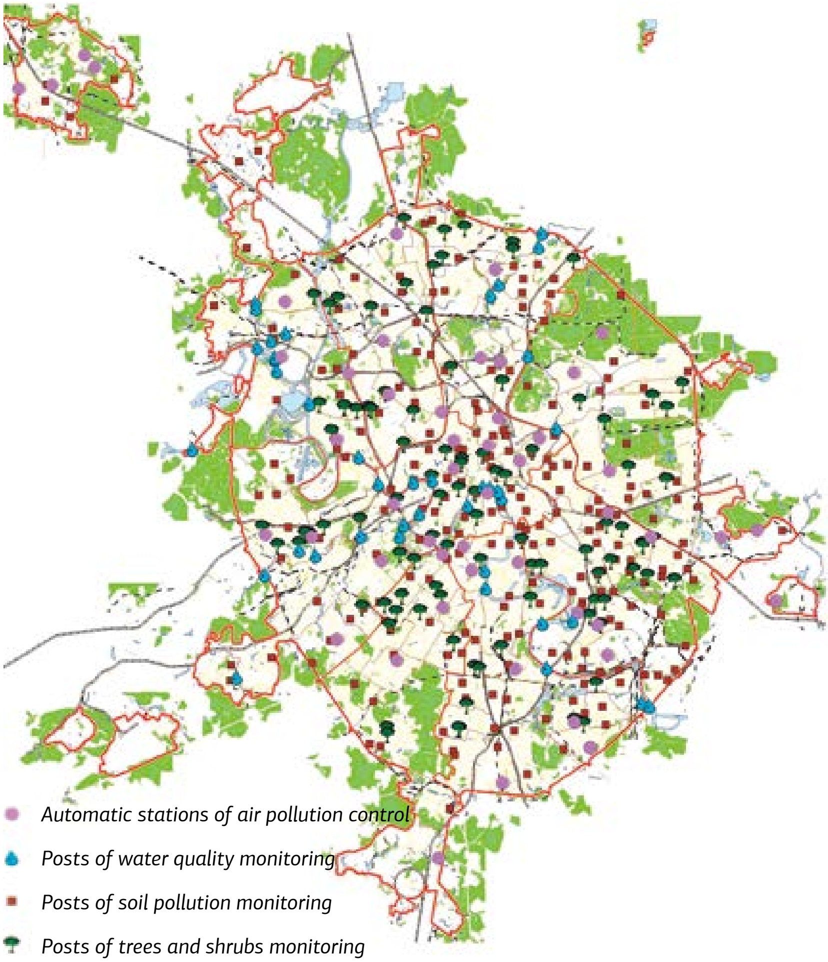


Fig. 4. Basic stations of environmental monitoring in Moscow [13]

- *Soil monitoring* is taken on 253 major posts of control. There are more than 20 parameters of interest.
- *Trees and shrubs monitoring* includes 494 stations of observation where dendrology, chemical and geological researches are conducted in the course of year. Posts of monitoring are distributed widely in the area of Moscow and they cover various types of planted trees and shrubs (green plantations, urban ecosystems, protected areas) (Fig. 6).

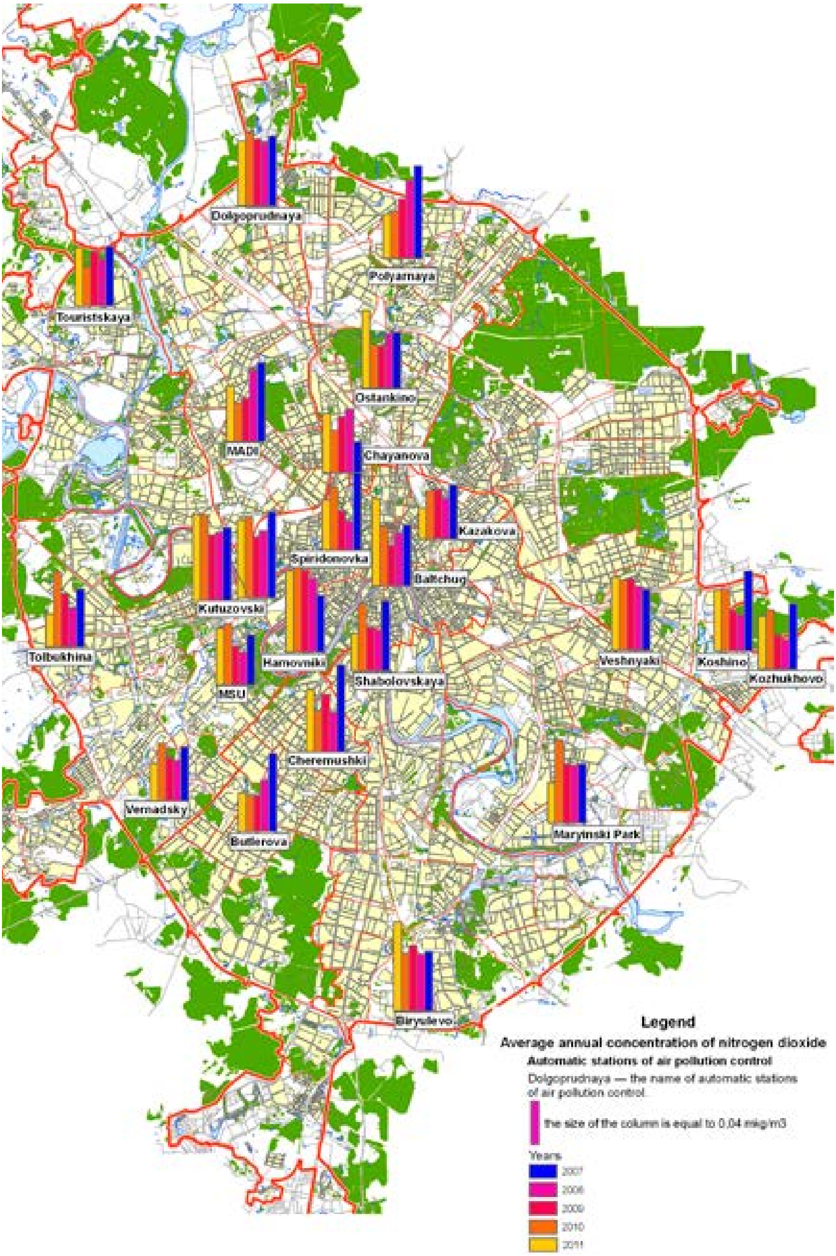


Fig. 5. Average annual concentration (mkg/m^3) of nitrogen dioxide (N2O) from 2007 to 2011 (based on the data of automatic stations of air pollution control) [6]

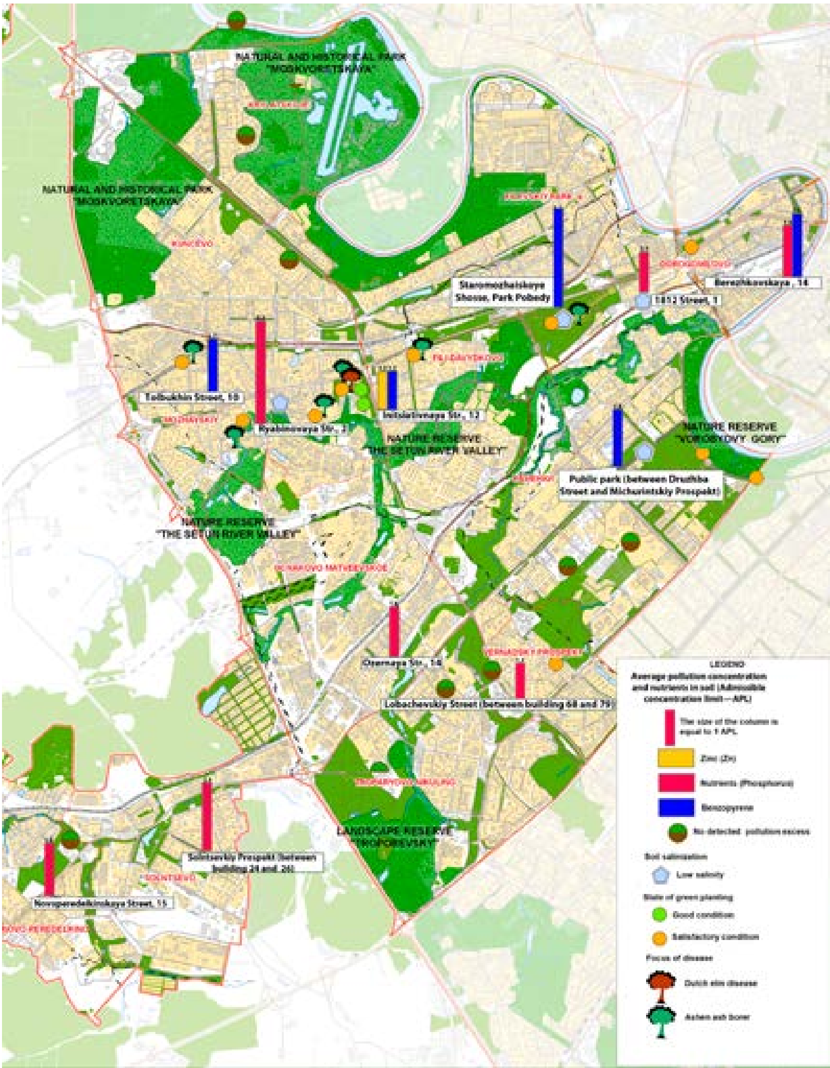


Fig. 6. Stations and posts of soil, trees and shrubs monitoring situated in Western Administrative Area of Moscow [6]

- *Hazardous geological processes monitoring* includes 170 cracks monitoring, 14 constant sites of landslide processes observation, and more than 200 sites of karst-suffosion processes describing.

- *Noise monitoring* is expected to be carried by 3 automatic stations of noise control (in the nearest future).

The problem of risk assessment and forecasting is in the focus of attention of city management and decision making. Moscow Environmental Map was created so as to integrate successfully monitoring data and actual maps of Moscow city. This GIS product presents appropriate information environmental situation in Moscow.

The research introduces the details of this Map. It combines a few thematic maps demonstrating environmental situation or human impacts. Each of thematic maps consists of layers presenting features of natural landscapes, green and blue areas in city, and pollution of water, air, soil, also facilities, and industrial enterprises correspondingly. In that Environmental Map enables us to scrutinize urban environment, e.g. it provides finding out patterns of negative effects of human activity [15].

A systematic approach to monitoring and analysis of various indicators of urban pollution favors to environmental risk management and forecasting so as to humans avoid or only significantly reduce adverse impacts.

2. OPTIMIZING THE STRUCTURE AND FUNCTIONS OF URBAN AREAS

Facing urban sprawl city managers keep their mind fixed on practical tasks:

- landscape planning of urban areas under change of functionality purpose;
- conservation programs for natural and cultural heritage;
- recreational zones of specific interest: protection of nature and human health;
- advanced planning of settlements.

Landscape planning of urban areas under change of functionality purpose. Nowadays urban planning involves deep natural landscapes transformation and design of urban landscapes of specific favorable properties.

Landscape planning is useful methodology for regional policy and spatial planning [4] since:

AREAL FEATURE	Parks, protected areas	Percentage of the total area		
			50	
LINEAR OR TRANSIT FEATURE	River-beds, flood-lands, valley of the watercourse		*50*	30
	Green corridors of transport infrastructure		*10*	
	Protecting forest plantations		*40*	
POINT FEATURE	Public parks, green areas		15	
BUFFER AREA	Sanitary-hygienic zone		15	

Fig. 7. Design project of open green spaces in district of Maryino (Moscow) (Graduate work by Vasilieva S., 2010) [2]

- it emphasizes the importance of nature protected areas (including open green areas, block green belts), and outstanding cultural (or authentic) dominants (monuments) in urban landscape;
- it provides restoration and protection of degraded river landscapes, city parks, badlands, abandoned and waste lands so as to enhance landscape diversity and environmental sustainability;
- it further promotes system of urban vegetation and planted areas of specific purpose (shelter belts);
- it contributes to establishing of buffer zones between urban land and surrounding landscapes [13].

In connection with the study of practical tasks we mention here the successful realization of landscape ideas. The matter concerns design of open green spaces in district of Maryino (Moscow) (Fig. 7). Previously there were aeration fields, besides the refinery was near to this land. Studied area has undergone land reclamation in order to design green spaces. Hard work was required of landscape specialists in this course [2], as a result Maryino is one of the "greenest" districts of Moscow.

Sites of cultural and natural heritage which has appeared in rapidly developing city seem to find themselves in a difficult situation. On the one hand, if such a site is available the city's touristic attraction increases. In this way many noble manors has become multicultural centers and function as museums and concert halls (e.g. Kuskovo, Kuzminki, Tsaritsyno in Moscow).

On the other hand, some of these sites are much pressed in as more high-rise buildings have been raised, thus losing their relish (Church of St. Simeon Stylites on Povarskaya street).

In addition, we recall distinctly that many cultural sites all along the urban planning of the 20th century have been destroyed due to the specific ideology, but then reconstructed, becoming remake (the Cathedral of Christ the Savior in Moscow).

Natural and cultural heritage protection is strongly affected by economic, political and social processes in the country [14]. In Russia, many of the legal heritage regulations and cultural policy are of pretentious nature. Political and legal instability, social fallout, economic questions have influenced negatively the heritage protection, e.g. cut or overgrown parks and gardens, the ruins of the historic monuments and landscapes as well as non-authentic facilities being raised. We are facing visual pollution of cultural landscape [7, 14].

Recreational zones of specific interest: protection of nature and human health. City managers face the challenge to optimize recreational land use in order to meet the requirements of sustainable development.

Thereat, we are concerned with the problem of search and application of recreational loads regulation [3]. The approach described here was used in Architectural and Natural Landscape Museum and Reserve Kolomenskoye:

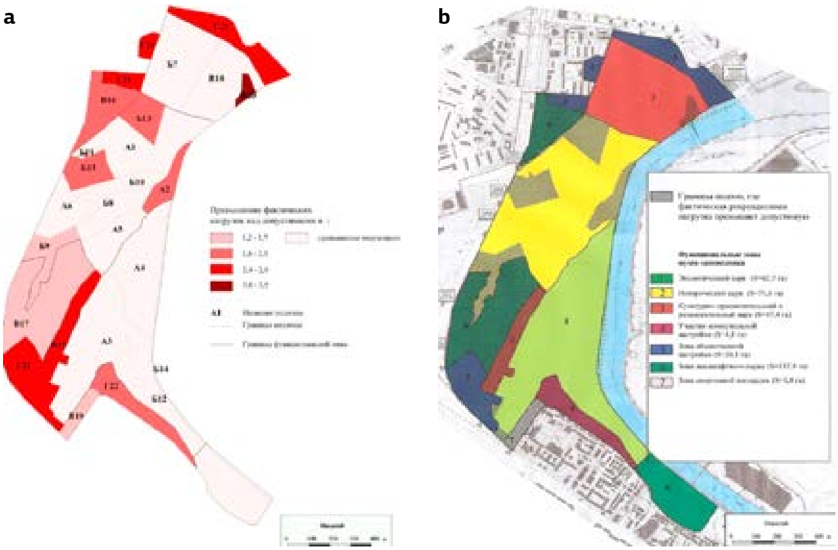


Fig. 8. Architectural and Natural Landscape Museum and Reserve Kolomenskoye: the schemes of actual recreational load (*a* – to the left) and functional zoning (*b* – to the right) (Graduate work by Sirko A., 2010) [3]

1) recreational load is characteristic that demonstrates recreational impact on landscape and integrates indices as the rest activity, the number of tourists and the duration of stay per unit area [1]. For nearly decade the attendance of the reserve increased by almost 20%. The research showed the recreational load significantly exceeds that of permissible on half of key areas (11 out of 22). The scheme of actual recreational load had arisen from calculations carried out for Museum-Reserve (Fig. 8 a).

2) According to recreational and city planning activities the area of Kolomenskoye has undergone functional zoning. For each zone permissible load, showing the daily attendance was calculated (Fig. 8 b).

Improvement of the planning structure, including optimization of new recreational zones and places of public entertainment, will supply sustainable and aesthetically attractive landscapes. To a certain extent, the project "Teply Stan forest park" is the example of recreational land use within the framework of nature and human health protection (Fig. 9).

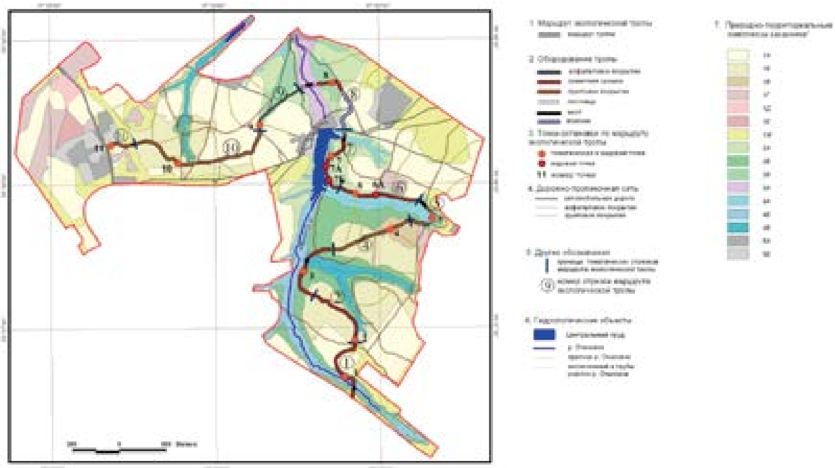
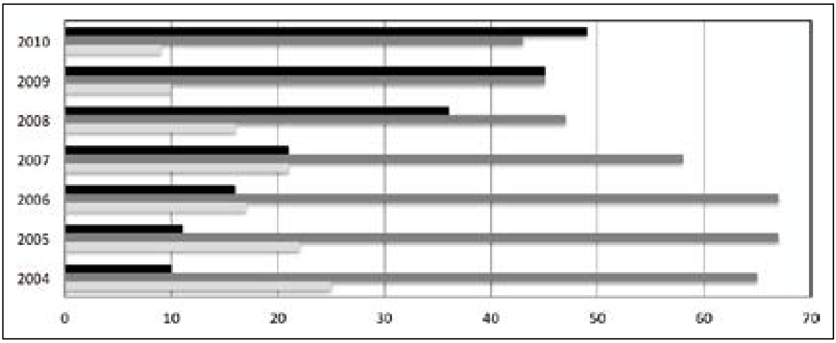


Fig. 9. Ecological path in landscape protected area “Teply Stan” (Graduate work by Kharchenko A., 2010)

Economy-class cottage property “Anyutiny glazki” (Istra District, Moscow region)

Business-class cottage property “Vysokiy bereg” (Istra District, Moscow region)

Premium-class cottage property “Deauville” (Odintsovo District, Moscow region)



■ Economy-class ■ Business-class ■ Premium-class

Fig. 10. Distribution of cottage settlements from 2004 to 2010 [13]. Types of cottage property is shown above (a); percentage of total number is below (b)

Advanced planning of settlements. Urban sprawl covers more and more suburban areas. Development of cottage settlement in Moscow region as a recently formed housing should meet the requirement to be environmental safe.

There are few types of cottage settlements (Fig. 10 a, b). Each type has its own architectural and economic characteristics, but settlements in common do not meet requirements to be authentical and environmental safe [10].

As a result we are able to apply methodology of landscape planning for cottage settlement projects. It consists of four parts: concept design stage, project design, architecture design and planning decision. Landscape planning tools are implemented on all levels of design and based on the environmental approach.

CONCLUSION

Thus after carrying out a description and analysis, we arrived at the methodology of landscape planning embraces a wide range of challenges of different nature: urban development, reconstruction of zones of different functional purpose, ensuring the environmental safety, meeting the aesthetic attractiveness and complying with an economic efficiency.

As a whole, it can be defined as the process of designing of a comfortable environment for living in the city so that it fulfills following conditions: negative human effects are reduced; local surroundings (both natural and cultural) are protected. Instruments of landscape planning can greatly diminish the negative influence of the city and various aspects of human activity on the environment by introducing innovative technologies into all spheres of the city life. This may include the implement of a monitoring system, including environmental, that secures the life and health safety for the population. Protection of natural and cultural heritage of urban areas as well as suburbs contributes significantly in monitoring system.

Landscape and ecological planning can become a universal instrument of spatial development and elaboration of a new economic projects and environmental programs in Russian regions.

REFERENCES

1. Doncheva A.V., Kazakov L.K., Kalutskov V.N., Chizhova V.P. Landscape sustainability and man induced impact // Recreational land use and nature conservation. – Tartu, 1981. P. 90–94. (in Russian).
2. Golubeva E.I., Korol T.O. Urban ecosystems as resource of city development. Proceedings of XI International conference “Public administration: Russian Federation in a present-day world”. – M.: Faculty of public administration, 2013. (in press, in Russian).
3. Golubeva E.I., Korol T.O., Sirko A.Yu. Landscape planning for recreational load mitigation: study for architectural and natural landscape museum and reserve Kolomenskoye. Proceedings of VI International conference “Tourism and recreation: fundamental and practical studies”. – SPb., 2011. P. 359–368. (in Russian).
4. Golubeva E.I., Korol T.O., Toporina V.A., Tulskaya N.I. Landscape planning for land use improving // Environmental management: theoretical and practical studies, and educational process / Ed. Slipenchuck M.V. – M.: Faculty of Geography, Lomonosov MSU, 2012. P. 161–167. (in Russian).
5. Marc-Vergnes J.-P. Electromagnetic hypersensitivity: the opinion of an observer neurologist // Comptes Rendus Physique. 2010. № 9–10. P. 564–575. (in English).
6. Sage C., Carpenter D.O. Public health implications of wireless technologies // Pathophysiology. 2009. № 16. P. 233–246. (in English).
7. Mogosova N.N. Geoecological component in contemporary urban policy. Environmental management: tradition and innovation. International scientific and practical conference. – M.: Moscow University Publishing House, 2013. (in Russian).
8. Polyakova M.A. Protection of cultural heritage in Russia. – M.: Drofa, 2005. 271 p. (in Russian).
9. Potapov A.A. Environmental physical characteristics spatial variations as an ecologically relevant factor: Monograph. – Moscow: MAKS Press, 2011. 176 p. (in Russian).

10. Potapov A.A. Methodological principles for radio frequency electromagnetic fields ecological monitoring // Environmental management: theoretical and practical studies, and educational process / Eds. Slipenchuck M.V. – M: Faculty of Geography, Lomonosov MSU, 2012. P. 140–146 (in Russian).
11. Potapov A.A. Physical and engineering fundamentals of radiomonitoring complexes development: Volume II: Radiotechnique terrain-based models development and environmental radiophysical characteristics exploration with geospatial technology implication / Eds. Sysoev N.N. Moscow: MAKS Press, 2012. 350 p. (in Russian).
12. Sayanov A.A. Green infrastructure of cottage settlements. EFLA Regional Congress Green Infrastructure: from global to local. International conference proceedings. – SPb., Uppsala, 2012. P. 113. (in Russian).
13. Sayanov A.A. The concept of landscape and environmental design of cottage settlements. 2013. Ecology of urban areas. № 4. (in press, in Russian).
14. Smolitskaya T.A., T.A., Korol T.O., Golubeva E.I. Urban landscape: traditions and current development trends / Eds. Smolitskaya T.A. – M.: Publishing house "LIBROKOM", 2012. 272 p. (in Russian).
15. Toporina V.A. GIS technologies for heritage sites inventory. Proceedings of II International conference "Natural and cultural heritage: interdisciplinary researches, protection and use". – SPb.: Herzen State Pedagogical University, 2013. P. 251–254. (in Russian).
16. Vorobyova T.A., Mogosova N.N. GIS application for ecological monitoring in urban areas. Proceedings of XV International conference InterCarto-InterGIS "Sustainable Development of Territories: GIS theory and practical experience". – Moscow, 2010. P. 45–48. (in Russian).
17. Zakharova P.V., Mogosova N.N. Geographic Information technologies for environmental monitoring in Moscow. Proceedings of VII International Conference "Remote Sensing–the Synergy of High Technologies". – Moscow, 2013. (in press, in Russian).

A.A. Pakina, Yu.L. Mazurov
Department of Nature Management, Faculty of Geography,
Lomonosov Moscow State University

Education for sustainable nature management: traditions and innovations

INTRODUCTION

Education is recognized today as a leading element of a movement towards sustainable development (SD). According to UN documents, education is the decisive factor for SD and further civilization progress. During the last years, from 2005, the vast majority of countries around the world have been actively involved in the UN's Decade of Education for Sustainable Development (ESD), announced for 2005–2014 years by the suggestion of the Japan. ESD decade reflects the specifics of individual countries, historical features of their educational systems, national policy priorities and other factors. The national education system in Russia was among the first in the world, responding to the UN initiative to promote ESD in the practice of teaching, learning and training.

The first Russian projects in the area of ESD were initiated in the late twentieth century. The first Russian Department of Nature Management was established at the Faculty of Geography of the Lomonosov Moscow State University in 1987. Background of the modern system of integrated environmental education at the Department — classical geographical knowledge with strong ecological component. Russian achievements in shaping the scientific principles of ESD, as well as their involvement into a practice of education, are based on numerous and widely recognized national scientific and educational traditions of the past, substantially similar to the ideas of ESD. One of such traditions is a successful experience of an ecological (environmental) education in Russia, the implementation of which began with the World Conference on Environmental Education (Tbilisi, Georgia) in 1977 [3]. These traditions formed the framework of a new educational concept, implemented at the Department.

Education for sustainable nature management is an indispensable element for achieving sustainable development. Education at the Department of Nature Management (MSU) is actually based on: 1) traditions of ecological (environmental) education of the Russian high school; and 2) innovations in a world educational process as a means to implement best international practices for SD achievement in modern Russian high education institutions [2]. Our experience is strongly demanded in Belarus, Ukraine, Moldova, Armenia, Kazakhstan, Kyrgyzstan and other CIS countries with whom we have strong mutually beneficial contacts.

SCIENTIFIC RESEARCHES AS A BASE OF EDUCATION

Education for sustainable nature management is based on traditional understanding of Nature Management (NM) as a field of interdisciplinary study and complex practical activities. System of Nature Management includes two main sub-systems: Nature Use and Nature Protection. General structure of NM is shown in Figure 1.

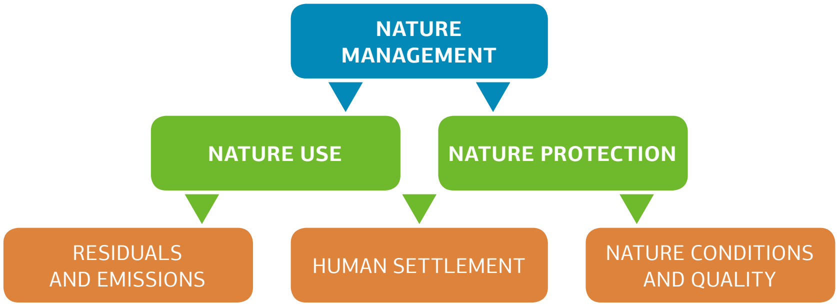


Fig. 1. General structure of nature management

We face many challenges within a highly competitive world, and a response to these challenges is a key task of the educational process at the Department. According to the new educational standards, accepted in 2011, the Department develops program on “Ecology and

Nature Management" for Bachelor level (4 years) and Master level (2 years). There is also education for post-graduate students for specialties "Economic, social, political and recreational geography" and "Geo-ecology".

The system of education at the Department includes both a study of theoretical aspects of and applied researches in a field of nature management. Trying to make an education interdisciplinary and complex, we develop a wide range of studies and researches in following fields:

- mapping of natural and human phenomena;
- remote sensing and field methods;
- environmental monitoring;
- economic aspects of environmental management, and many others, providing knowledge for decision making in a field of nature management.

Among research topics of the Department:

- regional features of environmental quality and problems;
- geo-ecological monitoring and impact areas;
- quality of waters and management of marine systems;
- instrumental methods of physical contamination in urban environment;
- GIS technologies and mapping of environment conditions in urban areas;
- environmental economics;
- cultural and natural heritage' conservation and use;
- recreation planning and eco-tourism;
- landscape planning and design.

Results of researches are widely involved in the learning process. Some examples are presented below. The Figure 2 demonstrates the geographical distribution of the effects of natural hazards on cultural monuments in Russia's regions.

Multi-years project on ecological monitoring of the cultural heritage of Russia's regions was leaded in 1998–2010 by Yu. Mazurov. Extensive data on the impact of natural hazards and anthropogenic risk factors on cultural heritage was submitted to the annual State Report "On a state of the environment in the Russian Federation" (part III "Impact of environmental factors on a state of cultural heritage") [6].

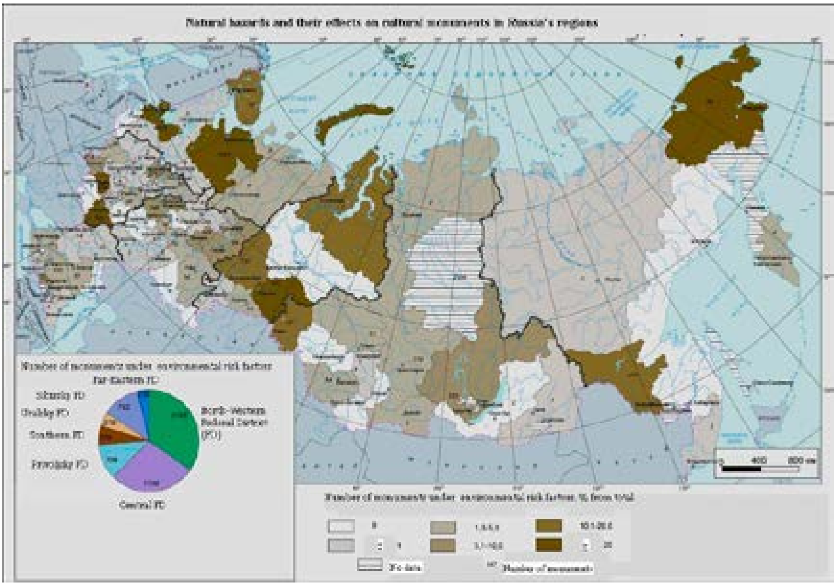


Fig. 2. Natural hazards and their effects on cultural monuments in Russia's regions [6]

Researches on current state of the Russian Arctic's natural heritage were also undertaken at the Taimyr Peninsula — the northernmost peninsula of the continental land masses not only in Eurasia, but in the world. Russian-Dutch ecological expedition (2002–2008) "Conservation ecosystems of the Russian Arctic" was organized in cooperation with Institute "Alterra" (Wageningen University and Research Center, The Netherlands), D.S. Likhachev Russian Research Institute for Cultural and Natural Heritage (Moscow, Russia) and the Great Arctic Reserve (Dudinka, Russia) (Fig. 3).

The coast of the Taimyr peninsula and its wetlands are the summer habitats of hundreds of thousands water birds from different regions of the world. One of them — Brent goose (*Branta bernicla*) — a main subject of the expedition's researches. About 80% of its population spend a winter in Western Europe and a summer — in Taimyr peninsula. Along with assessment of natural conditions of the habitats, participants of the expedition they studied the state of the natural landscape in the face of climate change, including the condition of the snow cover and the depth of permafrost's thawing (Fig. 4). There was also a significant part of researches, devoted to development of ecotourism as one of the most effective forms of sustainable use of the pristine nature of the area.

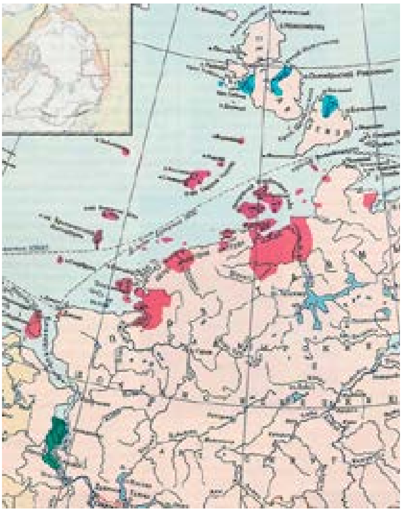


Fig. 3. Clusters of the Great Arctic Reserve at the Taimyr peninsula [4]

Researches on Arctic landscapes' actual conditions under impact of economic activities are the main interest of many members of the Department. Among the projects, developed at the Department, studies of the peculiarities of current nature management at the Kola Peninsula, in the Republic of Komi and the Arkhangelsk region; study of a shifting border of the northern forests under climate changes; planning and management issues of specially protected natural areas at the Novaya Zemlya, etc.

Along with this, analysis of environmental conditions at the cities is one more important direction of researches at the Department of Environmental Management is. Different issues in this field are examined with modern instrumental methods of measuring a physical contamination, remote sensing methods and GIS technologies. Innovative approaches are complemented by traditional for geographi-

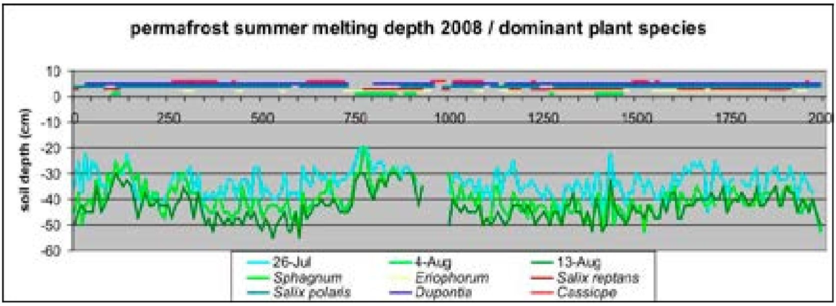


Fig. 4. Depth of permafrost melting and dominant plant species [5] at the Cape Vostochny, Taimyr peninsula (2008)

Fig. 5. Typical landscape of the northwestern Taimyr: polygonal tundra (a view from helicopter; photo by P. Glazov).

cal faculty methods of mapping geographical phenomena — both natural and social. The most important feature of these researches is that their results are used in educational programs. Students of the Department have a possibility to participate in these researches and to use the data in their own projects.

FIELD TRAINING

Probably, the most important part of education at the Faculty of Geography of the Lomonosov Moscow State University is a summer field training. This type of educational forms is included into the curriculum of the Department of Nature Management along with lectures and seminars. Summer field trainings (or practices) are organized on the bases of the Faculty's field stations. 1st year students have their complex geographical field study (9 weeks duration) at the Satino field station, located in Kaluga region, close to the border of Moscow region. 2nd year students receive a practical knowledge on the field stations in several areas of Russia and abroad. Students enrolled in our department, have a practical training in three regions, different both in natural conditions, and in type of human impact on environment: Krasnovidovo station at the Moscow region, Crimea peninsula and Kola Peninsula (Murmansk region of Russia).

The main objectives for these 3 stages of a field practice (Fig. 6):

1. study of a surface water quality on the example of the Mozhaiskoye reservoir and field methods of such researches (supervisor — Dr. D. Badyukov);
2. study of a land use and industrial impact at the Crimea peninsula, including the assessment of the recreational potential of the tourist areas and socio-ecological aspects of urbanization (supervisor — Dr. T. Vorobieva);
3. study of the impact of industries on a fragile environment of the Arctic, including changes in the various components of nature under influence of modern technologies of extraction and processing of mineral resources (in particular, apatite-nepheline and copper-nickel ores) (supervisor — Prof. A. Evseev).

In addition to the field stations of the Faculty, the students have an opportunity to get their field training in scientific institutions and different companies after 3rd year of education. Wide range of professional contacts which are normally used for this option includes:

1. Ministry of natural resources and ecology of Russian Federation, regional ministries and administrations;
2. production companies in different regions of Russia and abroad (exploring companies in Western Siberia, Baikal area, Arctic regions, agricultural companies, areas of tourism and recreation development, etc.)
3. specially protected natural areas (*zapovedniks* (nature reserves), national parks, World Heritage Sites) and organizations in nature protection;
4. scientific and research institutions in different cities of Russia and CIS (Ukraine, Kazakhstan): Institute of urban ecology, Institute of cultural and natural heritage by name D. Likhachev, Institue of transport economy and policy (Moscow), Baikal Institute of Nature Management and Limnology Institute of Siberian branch of Russian Academy of Science (Baikal region) and many others.

Fig. 6. Field work of students of 2nd year of education of the Department of Nature Management at the Mozhaiskoye reservoir. Sampling of water and measuring the level of chemical contamination. Photos from the department archive.

Such approach to the organization of field practices and their inclusion in the educational process provide a high quality of students' projects. Many of the students graduated from our Department with a bachelor degree, continue their education on a master programs — both at MSU and other universities in Russia and abroad. Some of them continue their education in a graduate school.

The main advantage of successful students' projects — their complex character, reflecting interdisciplinary education. The bachelor project of our student B. Turlybekova from the Republic of Kazakhstan can be presented here as an example of such project. The title of the project — "Environmental and economic aspects of renewable energy use: case of the Rudny city" (supervisor Dr. A. Pakina). Data for this project were collected by the student during her field practice at the city Rudny (Kazakhstan) and then analyzed at the Department.

In general, the project includes the following parts:

1. study of modern policy of the Republic of Kazakhstan in a field of energy efficiency;
2. analysis of current environmental situation and the impact-factors at the research area;
3. study of economic characteristics of the local productions with a special attention to its main component — a thermal power station;

4. accounting of environmental pollution damage;
5. evaluation of environmental and economic efficiency of renewable energy as an alternative to traditional energy sources.

An important part of the project is devoted to assessing the impact of thermal power plant on the residential areas of the Rudny city and evaluating of environmental damage. For this purpose the student analyzed conditions of air pollution and their distribution at the research area, taking into account the wind rose. The research was undertaken at the summer seasons of 2011 and 2012. Then the level of emissions was compared with permitted level (MPC). Total environmental damage was estimated, and its value significantly exceeded actual payments of the company. Taking into account these calculations a conclusion on efficiency of wind turbines' use was made. It was shown in the project that the wind energy plant contributes to reducing environmental damage and air pollution, including emissions of greenhouse gases [7]. It also leads to replacing nonrenewable resource (coal) by a renewable one — energy of wind.

NEW DIRECTIONS IN EDUCATION FOR SUSTAINABLE FUTURE

Traditional forms of education are supplemented by innovative form, one of which is a remote (distance) education. The Department implements 2 programs: "Ecology and environmental management" and "Aesthetics and design of landscape". Materials of these programs are available in online mode at the web-site http://de.msu.ru/ [8]. Education programs are aimed to improve the skills of professionals working in respective fields, and are available for the Russian citizens living in every regions of Russia — from Kaliningrad to Vladivostok, as well as for neighboring countries (Belarus, Kazakhstan). Graduates are provided by a certificate of completion the training at MSU.

The program "Ecology and environmental management" includes, among others, the following topics:

- Introduction to nature management and sustainable development;
- Environment and natural resources;
- Environmental management and audit;

- The legal basis for the protection of the environment;
- Economics and environmental management;
- Remote sensing methods and GIS technology;
- Industrial ecology and life safety.

The program "Aesthetics and design the landscape" includes following topics:

- Landscape design and basis of landscape planning and design;
- Methods of spatial representation in landscape design;
- Economic basis and management;
- Design of city sites, parks, and natural and cultural systems;
- The aesthetics of landscape and video-ecology and others.

UNESCO World Conference on Education for Sustainable Development, held in 2009 in Bonn, was the central event of the UN Decade of Education for Sustainable Development. The main idea of the Declaration is the call to act. The document identified two main levels of the corresponding actions: 1) level of policy-making in the states-members of the United Nations and UNESCO, and 2) level of practical actions. The conference is of great significance for Russia due to stimulation it to a more effective improvement of the national education model taking into account the positive world innovations and achievements. The basis for this development is an active cooperation of Russia with other countries. In the development of the theory and practice of ESD Russian specialists are in constant collaboration with partners from the leading countries in the development and promotion of ESD in the world (UK, Sweden, Germany, Netherlands, Japan, USA, etc.). One of the last experiences of such cooperation — a common Russian-Swedish project on ESD, implemented in 2008–2013.

The above project was initiated by the Russian Ministry of Nature Resources, expressed interest for co-operating with Sweden on issues related to Education for Sustainable Development. The Swedish Agency on Environmental Protection supported this idea, and the project on ESD was launched in September 2008. The Lomonosov Moscow State University together with the Russian Academy of Public Administration under the President of the Russian Federation and three Swedish universities: of cities Lund, Uppsala and Luleo were involved in the project, aiming to support ESD in Russia.

The overall objective of the project was to exchange experiences gained on education for sustainable development and elaborate design and testing of new subjects and educational methods needed for complementary education for state officials in Russia in the field of sustainable environmental management [1]. Totally 9 joint Russian-Swedish ESD seminars for state officials and policy makers of the Russian Federation were organized during the 1st and 2nd phases of the project, which was launched in September 2008. The programs of the seminars were elaborated by Swedish and Russian specialists — universities' professors, and a very high value of this type of training was noted by both Russian and Swedish sides. The seminars were organized in institutions at different cities of Russia: Moscow, Vladimir, Voronezh, Syktyvkar, Ukhta. After the completion of the project its results have been appreciated by Swedish and Russian sides and a need to continue a cooperation was underlined. Exchange of experience in this area and the introduction of global best practices in the learning process is one of the main goals of the Department.

REFERENCES

1. Alekseeva N., Kasimov N., Mazurov Yu., Osterlund S.-E., Pakina A., Plepys A. Sustainable development in the context of education: Swedish realities and Russian potential // Geography, Environment, Sustainability. 2011. № 1. P. 86–103.
2. Education for sustainable development at the Russian high school: scientific principles and development strategy. Ed. Kasimov N.S. – M.: Faculty of Geography, 2008 (in Russian). 232 p.
3. Kasimov N.S., Glazovsky N.F., Mazurov Yu.L., Tikunov V.S. Geography and education for sustainable development // Vestnik of the Moscow University. Series 5. Geography. 2005. № 1. P. 38–49 (in Russian).
4. Pristine wilderness of the Taimyr peninsula. 2005 report. Ed. B. Ebbinge and Yu. Mazurov. M: Heritage Institute. 2006. 180 p.
5. Raad J.A. de, Mazurov Yu.L. and Ebbinge B.S. Pristine wilderness of the Taimyr peninsula. 2008 expedition to the Pyasina Delta, Taimyr peninsula, Russian Federation. Alterra Report 2109. Wageningen, 2011. 138 p.

6. State Report “On the state and protection of the environment of the Russian Federation in 2008”. Moscow, State center of environmental programs, 2009. P. 141–167 (in Russian).
7. Pakina A.A., Turlybekova B.T. Rudnenskaya Thermal Power Plant (Republic of Kazakhstan): Ecological and Economic Aspects of Its Transition to Wind Power Engineering. In: Ecology of Urban Areas, № 4, 2013. P. 42–46.
8. Center of distance education of the Moscow State University: [electronic resource]. URL: http://de.msu.ru (reference date: 12.11.2013).

Ryosuke Shibasaki
Center for Spatial Information Science, the University of Tokyo

Mobile "Big Data"

Good afternoon everyone, I'm Ryosuke Shibasaki, actually I'm working for the research center of spatial information of science, the University of Tokyo. The title of my talk, in short, is some sort of the mobile big data, probably big data could be, for example, called "Bolshoi" data. And actually professor Matous have a very very interesting talk about the mobile phone and also its impact on people communication. And actually we also handle a number of, or in other words, millions of people data from the mobile phones.

But actually, what we are focusing on is a changing of location of those million people. Actually our target is to monitor, analyze and if possible, model those people through the changes of location data. So, in that sense this is very geospatial or geographical study.

In 1967 zoologist Desmond Morris published this paper. Actually he handles the human being or people as a just simply another species of animal. This book became so popular and very very interesting. But nowadays, we can see the other types of new apes.

That is ape with a mobile phone.

Actually this ape or human being actually is now prevailing all over the world because we see now more than 6 billion handsets.

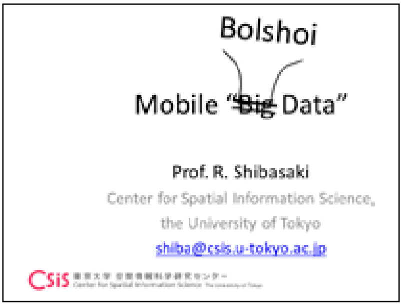


Fig. 1. Mobile big data

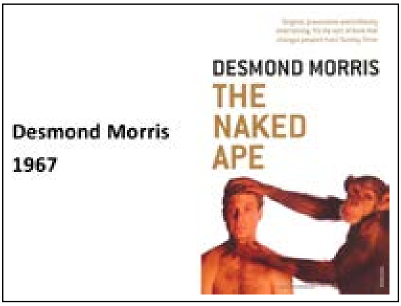


Fig. 2. Naked Ape

Fig. 3. Mobile Phone Ape

Anyway around 6 billion people actually using the mobile phone for communication, sending messages or data.

And also actually, the mobile phone areas completely covers almost all the populated areas, so I believe that the mobile phone can be a device creating or establishing a kind of new frontier of the observation of the people or human being and also some sort of impacts on the earth.

And through the mobile phone and also at the same time, through the observation or monitoring human activities, we can see or observe how those people creates the problems like traffic jams and air pollution, water pollution, also some sort of the crimes, anyway something like this. Probably, that just shows the importance of the monitoring people through the mobile phone.

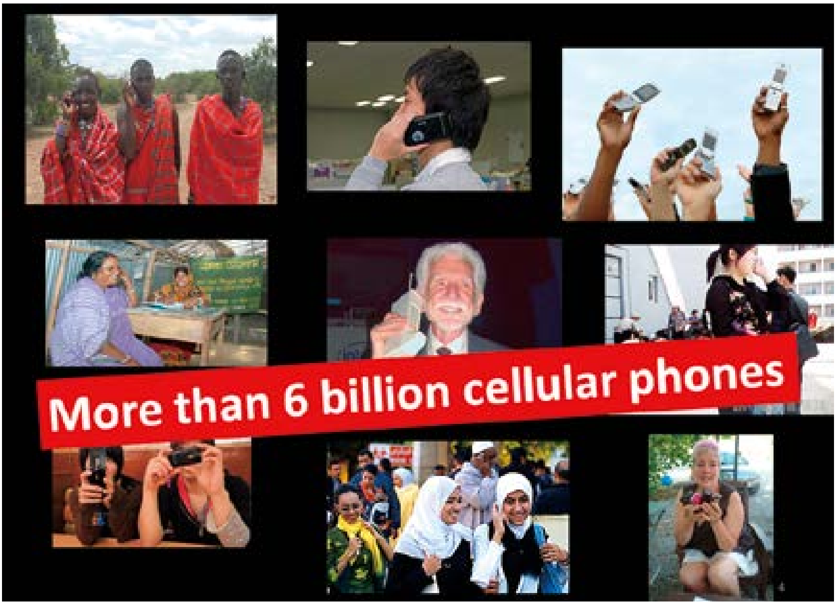


Fig.4. Six billion handsets of mobile phones

Fig. 5. Geographic area covered by mobile phone services

And actually from the mobile phone we can obtain the location of the individual handsets through the several different methods. The first one, the most straightforward one, is GPS. Some of the mobile phone, typically smart phones have GPS receivers. By receiving the satellite signals we can monitor the location of those handsets on the real time basis. But more importantly, actually every handset communicates with cell towers. By using transaction or communication data between the handsets and also cell towers, we can have a kind of approximate location of individual handsets or 6 billion handsets in theory or technically.

This is real GPS log data obtained through the mobile phone. Actually these data include 1 million almost 1 million people in Japan for the past 2 years, because they click “I agree” when they start the navigation service using the mobile phone. Ok, so anyway let’s see how we can see… (he started to run movie). Since we are focusing on Tokyo, actually this movie may include around two hundred thousand or three hundred thousand people from the very early in the morning. Actually Tokyo is very strongly supported by the dense subway

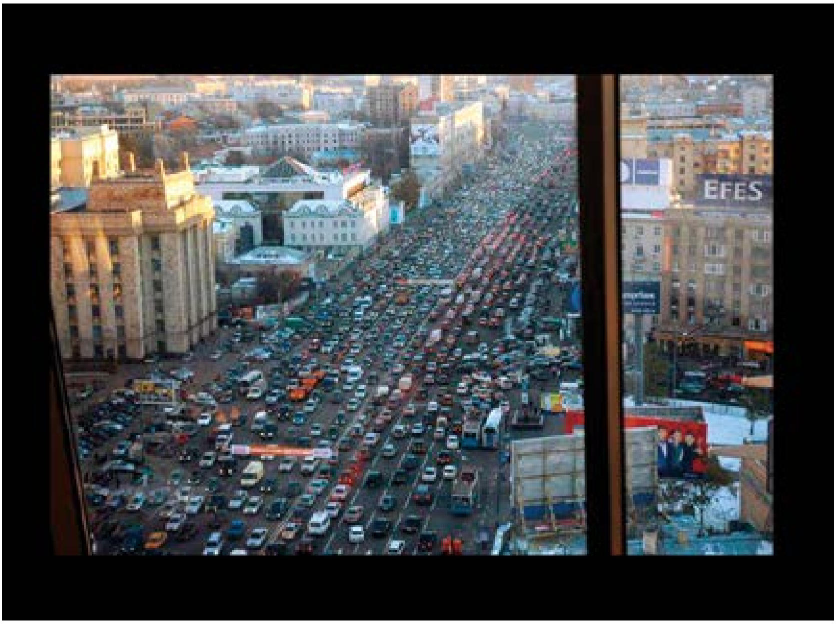


Fig. 6 & Fig. 7. Traffic jams in Moscow

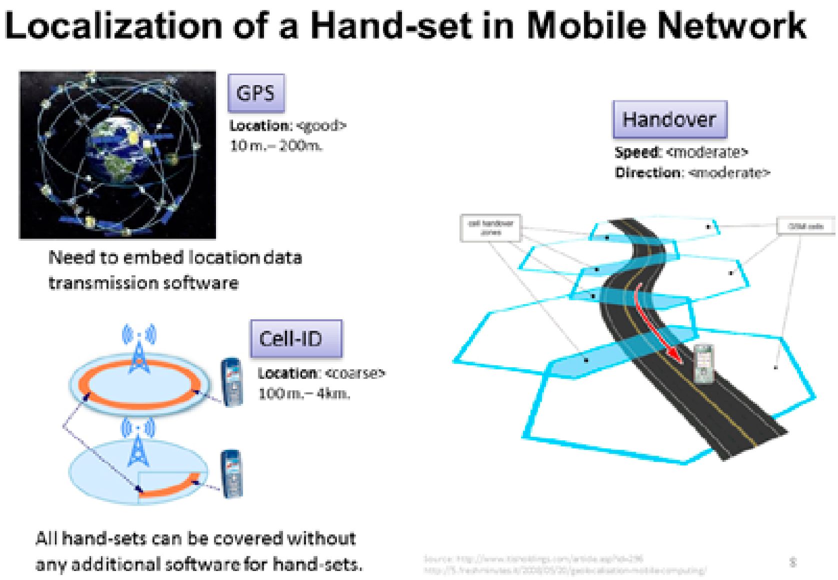


Fig. 8. Localization with mobile phone systems

network like Moscow and around 9 am morning rush is almost over but instead, you may see the other light spot, it is a Tokyo Disney Land attracting many people. And very unfortunately on that day, we have a very big earthquake at 2:46. When the earthquake struck, all the railways stopped. Although the Tokyo had almost no direct physical damages, the railway system stopped and everyone have to walk, sometimes more than 10 or 20 km. So, you can see that people were marching for home and it continued until very late at night or even the early morning of the next day. And this location data is acquired for providing the navigation service. That means those location data is acquired on the real time basis. So if such kind of data is available for the governmental officers responsible for disaster risk management, actually, they could monitor the people movement on the real time basis.

Through such kind of movies you can understand how we could monitor the overview of the people movement but actually those data is identified by some kind of anonymized ID (ID's have nothing to do with the personal attribute of those specific users). But nevertheless

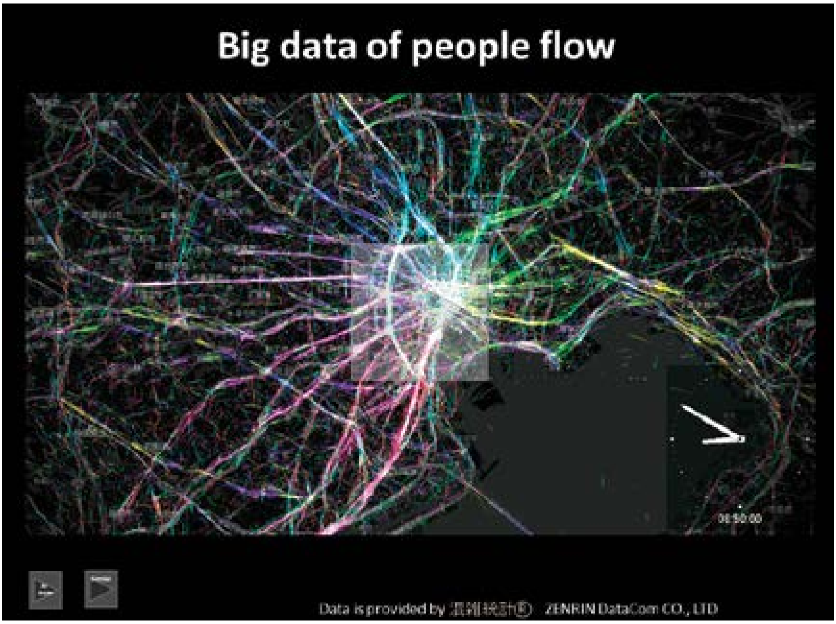


Fig. 9. People flow in Tokyo after the earthquake, Mar.11, 2011

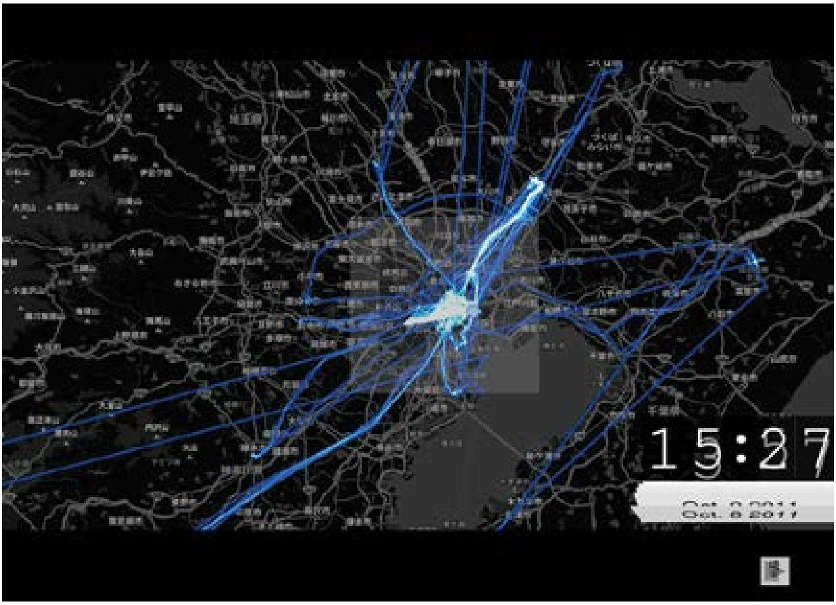


Fig. 10. GPS trajectory of a person

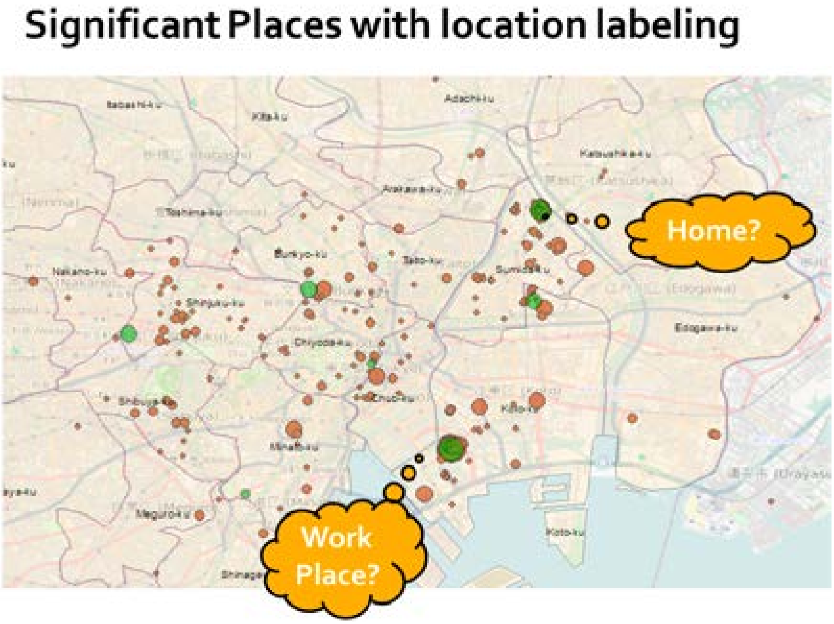


Fig. 11. Labeling GPS trajectory

with such kind of consistent ID, we can monitor the movement of a single person for, let's say, one or two years. This is again a kind of movie of that specific person trajectory for the 6 month. And by associating with location and also the time, probably you can have an idea on where he or she lives and where he or she works. Actually, he has three working places and with many chances of overseas business trips from Narita, Tokyo International Airport. Yes as you imagine, this is my trajectory. But anyway, by looking at such kind of GPS without knowing about his personal attribute, we can make some sort of guess about his lifestyle, working style and also even approximate location of the homes.

And this is not mine, but anyway these kinds of the cluster of GPS points probably that correspond to the stay point of this specific person, this may be a kind of home location, this could be the workplace. Associating location with time, we can say staying at night suggests residential places or home location. And through such kind of analysis we can put the label to the home location of almost all of the GPS

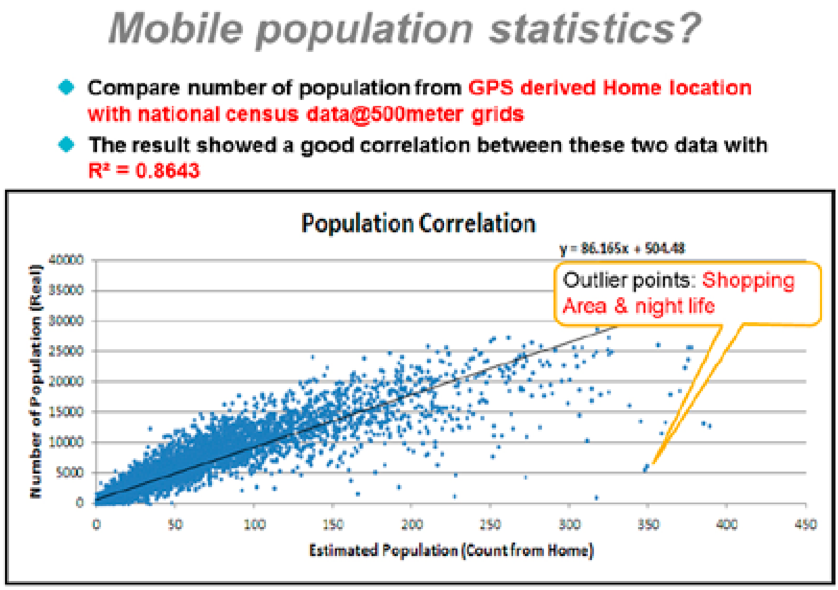


Fig. 12. Estimating night time population with mobile phone GPS data

trajectories. So then after that, actually, we can aggregate the number of GPS users who may live in some specific areas.

So then, we can have a kind of mobile population statistics of some specific areas. Then, again, we can compare that mobile phone population statistics with the real national census. According to that it has very good correlation. Actually through the other questionnaire survey we can check bias of those mobile phone users in terms of sex and also of age groups. Amazingly the bias is not so big at all. From this regression analysis, by multiplying 86 or so to the mobile phone population statistics we can have relatively good estimates of the real numbers, real night time populations. But at the same time, you may see several outliers. When we checked those outliers we found that those outliers is for some kind of night towns with many drinking places, restaurants, open very late at night or even early in the morning. So probably the people working there have completely reverse patterns of the, let's say, home-staying at night and also the business at daytime.

And also by aggregating such kind of GPS numbers, we can see the changes of population density of individual grids. And also individual

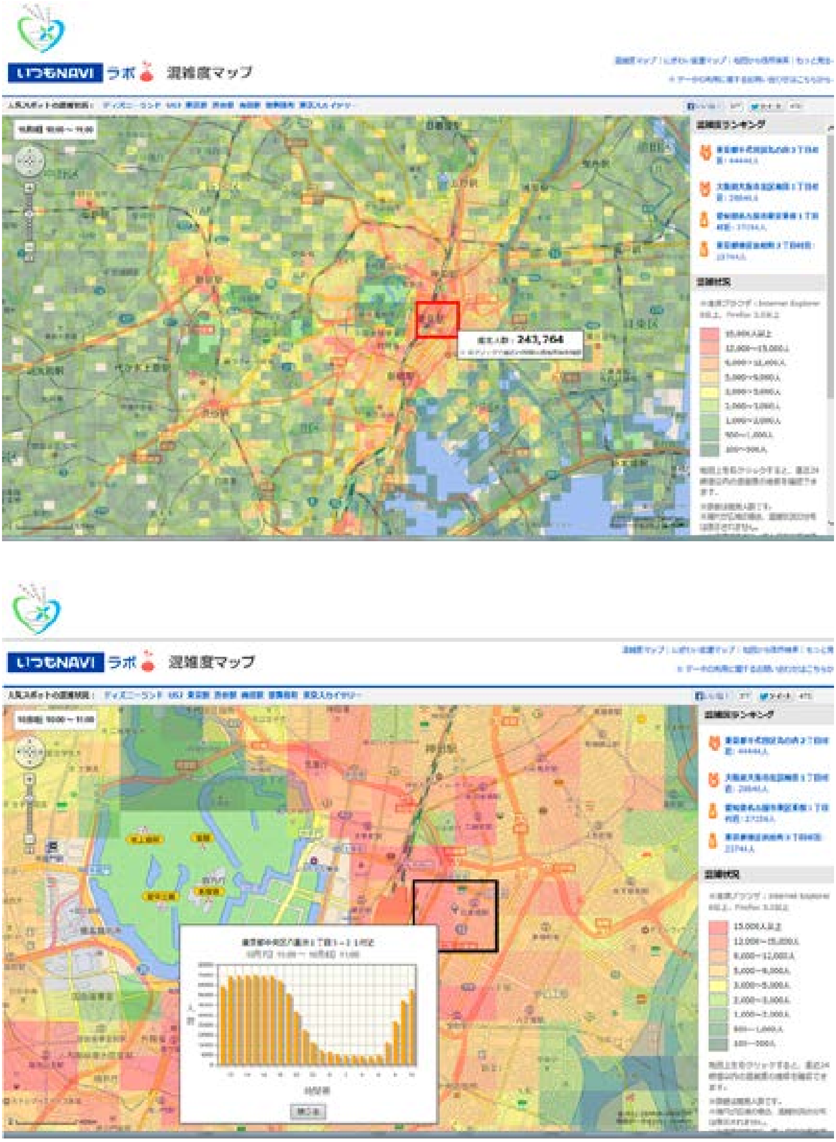


Fig.13 & Fig. 14 Monitoring changes of people distribution

grids have a changing pattern of that specific day. So the when we look at, when we examine such kind of changing patterns, we can identify some sort of the anomalies or kind of abnormal situation or phenomena.

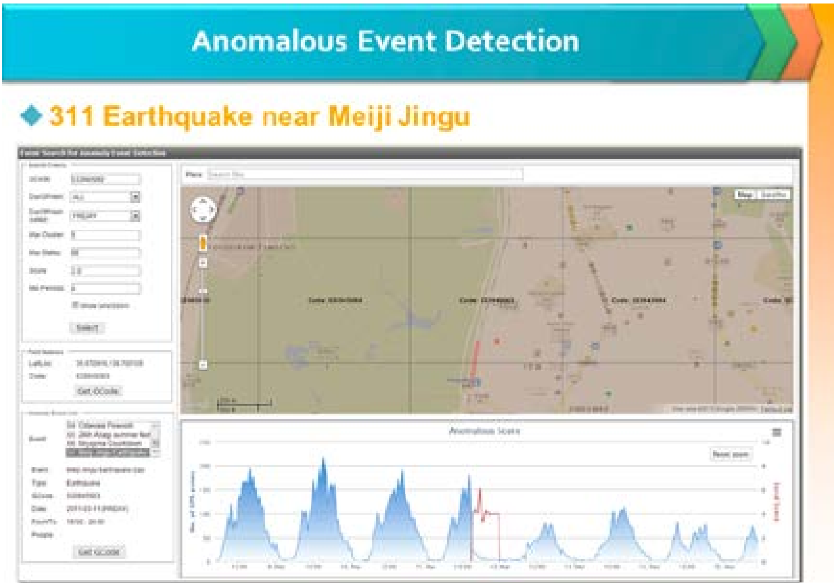


Fig. 15. Anomalous event detection

Actually this is the one example of such kinds of anomaly detected by examining the change of the population density. This place is called Meiji Jingu shrine and one of the people attraction of Tokyo. And every day it attracts so many people but the day of the earthquake, after the earthquake occurred, people have left here. And this is a kind of an anomaly detected through this kind of analysis.

And also at the same time, you may see this river. Actually here during the summer vacation, we have very big firework festivals so then that is the very sudden increase of the populations around here.

And to achieve the better accuracy in estimating reality from GPS data, for example, at first, we can just count the number of GPS point passing through the specific points like stations of railways.

So then we may combine with automated gate for the railways as you can see the Moscow subway entrance. The gates provide people counting data and we may combine such kind of data to determine kind of scaling factor for GPS data.

And such kind of process could be called the data assimilation. And with this data assimilation of the moving objects, the residual

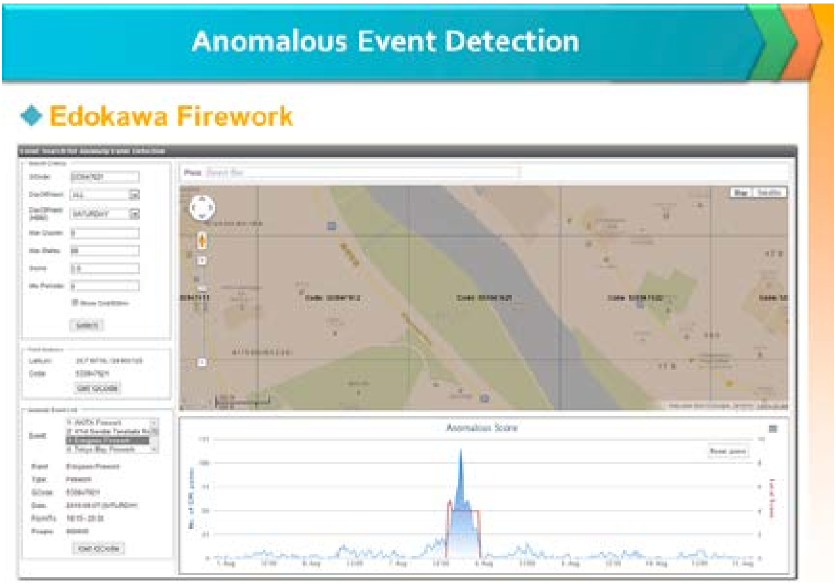


Fig.16. Anomalous event detection

or the errors could be reduce rather drastically. And actually in handling such kind of data, actually including 9 billion records just for 1 year, we have modified the open source software called Hadoop. And also on the Hadoop, there is another kind of open source software, that is called Hive for supporting the data retrieval or data query . By modifying such kind of open source software, just by running 10 or 20 ordinary PC, we can handle such kind of data. By using this kind of system, for example, if you conduct some ordinary query by the data base management system, it may take more than 20 hours. But for the same data processing, this system can complete the same task within 1 minute. Without this kind of system, we cannot let the students graduate by submitting Master thesis in time.

This is a final slide, a proposal of further collaboration between the Moscow State University and the University of Tokyo. The first one actually is on mobile phone data. Explore the possibility of using such kind of mobile phone data here in Moscow. At first we may start monitoring the people movement and then such kind of data will support studies on air pollution or urban development or traffic

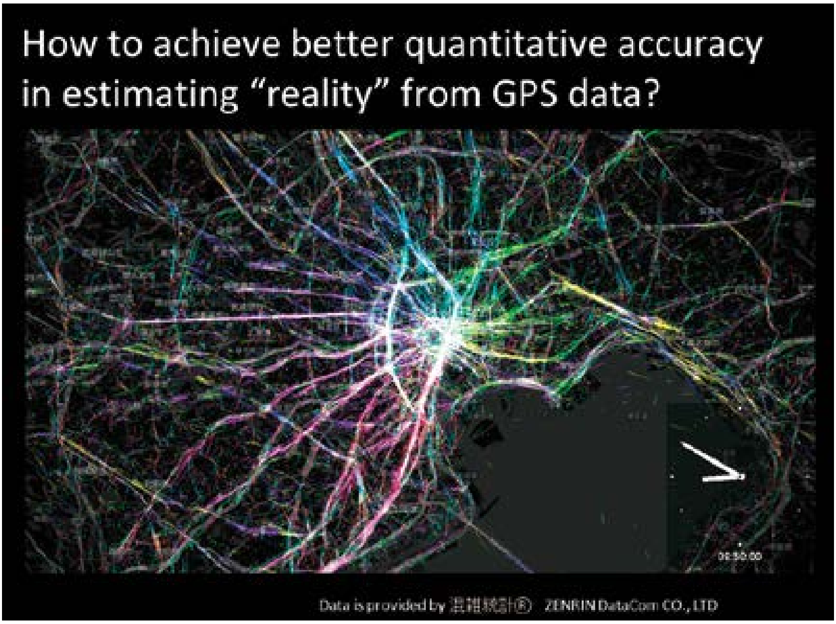


Fig. 17. How to better estimate people flow?

jams and so forth. And mobile phone could be extended even for the data correction. And also the data management system for handling such kind of data could be transplanted to supporting necessary data processing, because that is open source. And probably such kind of system could be combined with Geo-portal because in conducting such kind of analysis we want to have background information, typically, street maps, land use data and also some sorts of the land covers or distribution of the restaurant or shops etc.

Fig. 18. Combination of people counting sensors with GPS trajectories

And in addition, I invite you to join G-space. Actually this is a kind of experimental international educational program focusing on the use of the GPS, satellite observation with the combination of the mobile phone

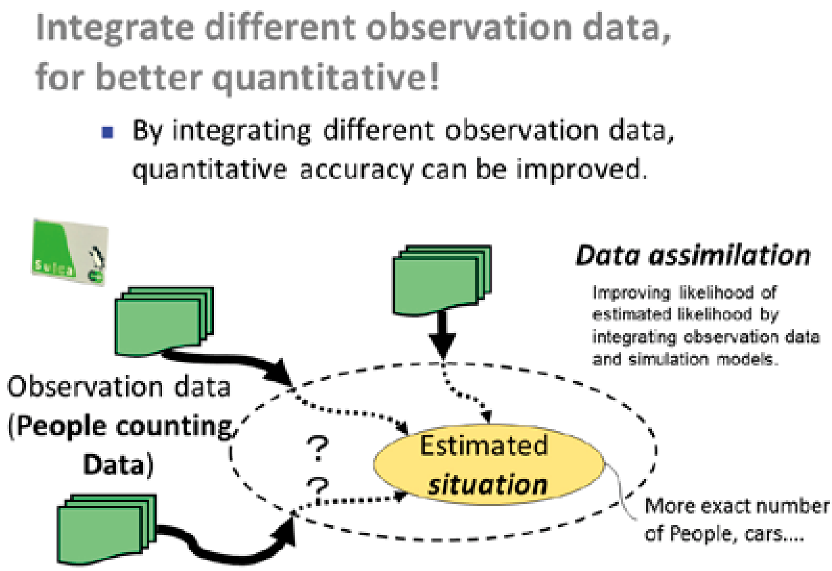


Fig. 19. Data assimilation for better estimation of people flow

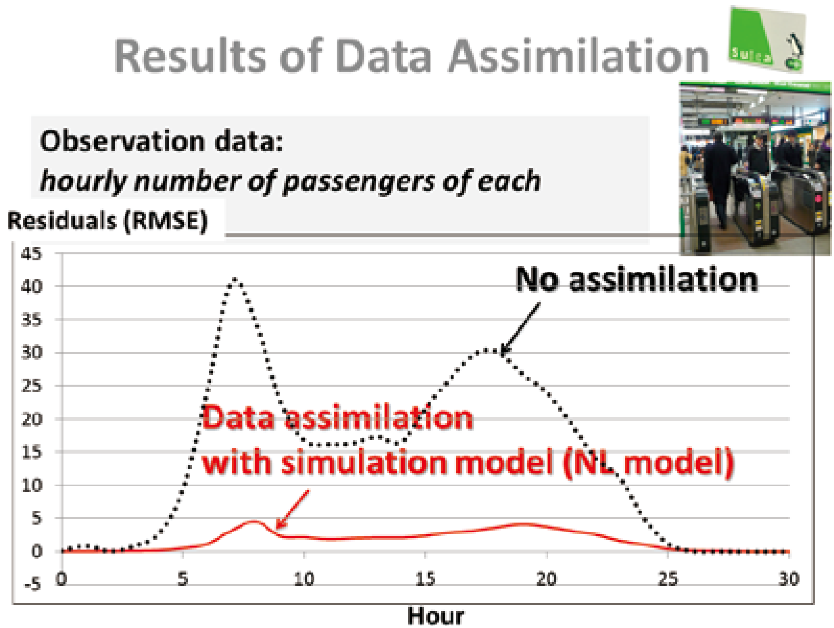


Fig. 20. Data assimilation results

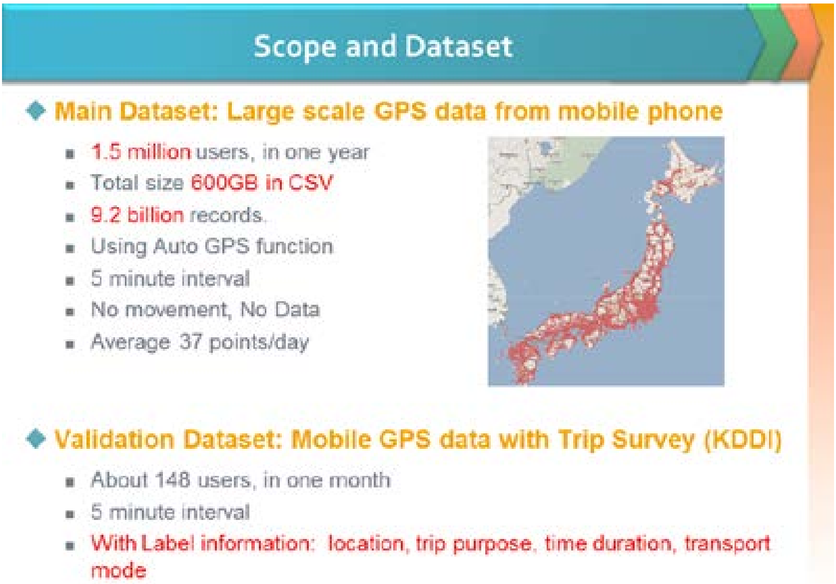


Fig. 21. Size of GPS trajectory data

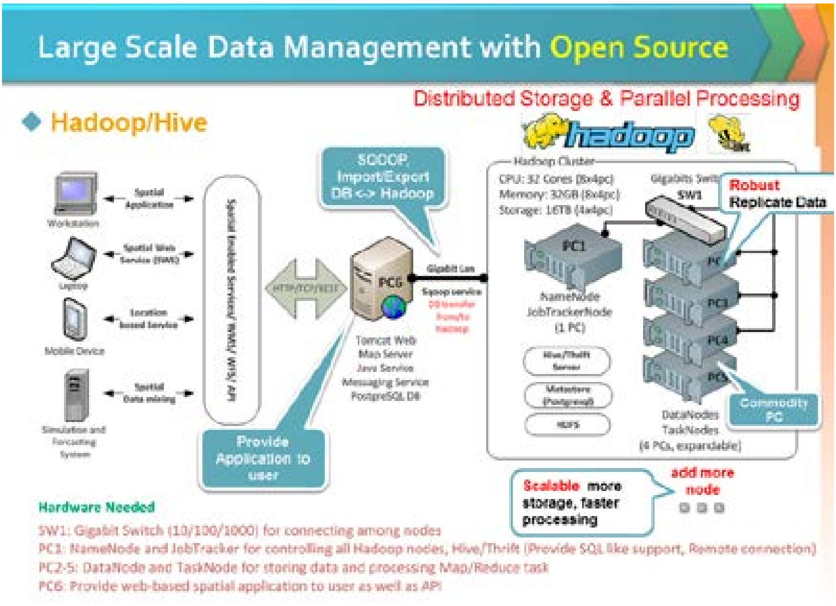


Fig. 22. Handling GPS trajectory data with Hadoop and Hive

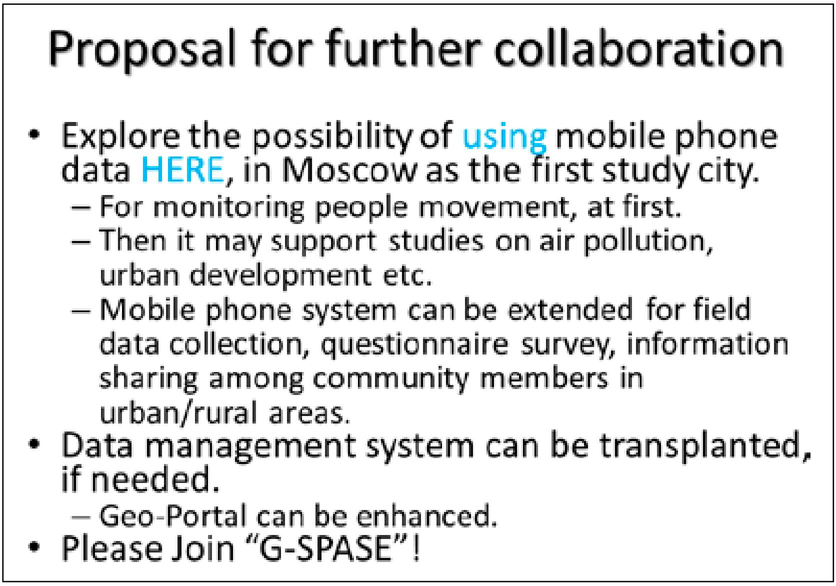


Fig. 23. Proposal for further collaboration

Fig. 24. G-SPASE project: International education program

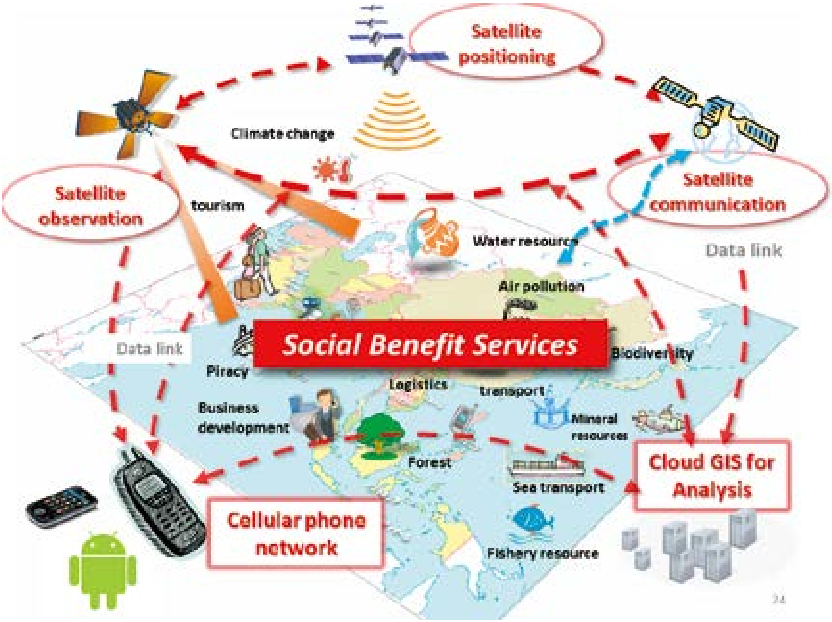


Fig. 25. Space infrastructure and mobile phone data for societal benefit services

data. And actually we are running this program by three Japanese universities and also several other Asian countries.

This program is based an idea that space infrastructure enables innovative societal benefit service by combining with ICT, typically, GIS and mobile phone systems.

I strongly believe that could be a very good starting platform for the collaboration in education. Thank you very much.

T.Yu. Zengina
Department of Nature Management, Faculty of Geography, Lomonosov Moscow State University

Remote sensing methods for research and educational programs of the Department of Nature Management

Remote sensing methods long ago have become a part of active use, both in research and in the education programs of our Department.

Remote sensing data are currently widely used by all world scientific community to solve the numerous and varied problems in the field of both natural and socio-economic objects and phenomena, as well as to solve the problems of environmental management, sustainable development of society and the environment. Of course, the method of remote sensing is widely used by staff of all Departments of the Geographical Faculty, and by our Department of Environmental Management as well.

However, analyzing the experience of the Department in this scientific field, we must begin with the works of the founder of our Department and its permanent head over many years — Andrei Petrovich Kapitsa (Fig. 1).

Lake Vostok. In his scientific activity A.P. Kapitsa always paid a great attention to the innovative methods of research. His activity style of scientific work — was a bold new ideas, often do not fit the generally accepted dogmas. It is interesting that in some cases, namely new research methods that are based on innovative technologies only years later confirmed the correctness of his scientific assumptions. So it was with a scientific hypothesis of the existence of the subglacial Lake Vostok in Antarctica, which has been put for-

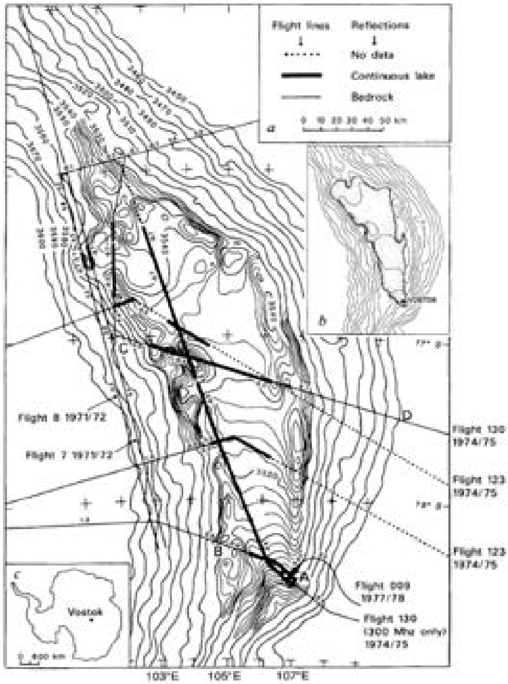


FIG. 1 Surface topography. ERS-1 waveform product (WAP) altimeter maps of the Vostok region. The improved altimetry comes from two 168-day repeat cycles of satellite orbits. The WAP analysis[4] gave 600,000 mean surface elevations over circles of 3 km diameter. Repeated and overlapping measurements gave an r.m.s. deviation of 20 cm and a maximum relative error in contours of 50 cm for the first time. This can now be extended over all inland ice north of 82° S. *a*, Contours over and near the lake boundary at 2-m intervals, with 10-m contours over steeper slopes. Figures along flightlines show bedrock elevations in kilometres above or below (–) sea level. Unpublished data now included come from flight 009 of 1977/78 and spot soundings every 2.4 km along the south-to-north flight 130 of 1974/75, which was not covered by continuous profiling (Fig. 3a). *b*, Shaded area shows the extent of the sub-ice lake, based on 2-m contouring but with 10-m contours over the entire area. This shows the low surface slope over the lake compared with the surrounding surface topography. *c*, Location of Vostok station.

Fig. 1. Surface topography: ERS-1 waveform product altimeter maps of Vostok region [3]

ward by A.P. Kapitsa back in the late 1950-s, and was later confirmed thanks to remote sensing methods appeared only in a few decades.

Relying on the theoretical developments of the most outstanding Russian oceanologist Nikolai Nikolaevich Zubov, A.P. Kapitsa in 1958 for the first time in his Ph.D. thesis suggested the possibility of the existence of water lenses in the central areas of the Antarctic ice sheet. In his 1961 monograph “The dynamics and morphology of the ice sheet of the central sector of East Antarctica" he specifically pointed the area (between the stations "Vostok" and "Komsomolskaya") where under the ice can be a powerful lens of water. Later, as a member of the three Soviet Antarctic expeditions in 1959–1964 A.P. Kapitsa conducted seismic soundings and defined a power of the ice cover as 3,700 m thick. He also established that there were some very explicit boundary, which presumably interpreted him as a border between ice and water.

The factual proof of scientific hypothesis of A.P. Kapitsa were obtained only in 1994 in joint complex works of Russian and British scientists (glaciologists G. de Q. Robin and G. Osvald, Skott Polar Research Institute) on the interpretation of seismic measurements, radioecho-sounding data from the aircraft and space-based measurements from ERS-1 satellite [3].

Remote sensing satellite ERS-1, produced by the European Space Agency was designed for the implementation of high-precision measurements in monitoring the Earth's surface and its atmosphere. It had on board the Radar Altimeter, which provides accurate measurements not only the level of the sea, but also the different characteristics of the ice cover. The program of the flight included 2 special stages, focused on the study of ice sheets and their characteristics.

The results of its work have made the final confirmation of the existence of the lake, known now as Vostok, and specified its parameters and contours (Fig. 1). This caused an enormous resonance in world science, and was recognized as one of the most significant geographical achievements in the 20th century. Investigations of the unique phenomenon of Lake Vostok continuing to this day, one of the goals is to study it unique ecosystem and its preservation.

As the discoverer of Lake Vostok A.P. Kapitsa was invited to participate in the development of NASA to study Jupiter's ice "Europe", where by analogy with the Earth, there may be sub glacial lakes with manifestations of life.

The discovery of Lake Vostok — was the result of the collective efforts of many scientists in the world, launched during the International Geophysical Year. It is significant geographical discovery made by means of geophysical methods, and confirmed by remote sensing methods (satellite observations). Thus, remote sensing techniques were included in the list of methods actively used at our Department.

Space geography: polygon studies. A major project based on the use of Remote sensing methods and techniques, which involved members of our Department, was the work carried out in the USSR in the late 1980s and early 1990s. It was devoted to creating Remote Sensing Geographic Information System (GIS) based of technical capabilities of satellites and designed to study natural resources.

In those years the great hopes in such studies were associated with synchronized observations and measurements that were carried out simultaneously from outer space, aircrafts, and on Earth. Ground surveys are usually conducted in special sub-satellite polygons. Their effective functioning requires not only special technical equipment, but also the development of appropriate methods of ground and airborne researches.

Investigations were carried out under the management and with the participation of the Office of Space Systems of the USSR State Committee for Hydrometeorology, under the guidance of Prof. Yu.G. Simonov and with active participation of the staff of our Department.

As a result of this work the previous operational research experience in the sub-satellite test polygons has been generalized. Also methods of obtaining ground data and satellite TV images processing were developed. Also within this work the principles of placing polygons within country taking into account geographical peculiarities of area and the specifics of the economic development of the territory has been developed. The results were published in a monograph in 1988 [5].

For the development of the principles of placing sub-satellite polygons within this project natural-management zoning of the USSR based on the interpretation of multispectral satellite images was conducted. The result was a series of different scale maps of natural-management zoning of the country. So, on the basis of "Meteor" satellite images was produced the map plotted to a scale of 1:8 000 000, which included 35 map units. Images from orbital station "Salyut" were used to produce the map plotted to a scale of 1:4 000 000 (180 map units), "Landsat" satellite images became the basis for the map plotted to a scale of 1:1 000 000 (~630 map units). The maps of natural-management zoning of the USSR were the basis for the further development and improvement of GIS, designed to study natural resources. They were used for the determination of the specificity of operation programs and operation mode of the regional GIS, for identifying the objects and tasks of monitoring, as well as to detect potential consumers of information.

It should be noted that even presently after years these maps are in demand by many experts in different scientific fields somehow related to the solving of problems in ecology and environmental management.

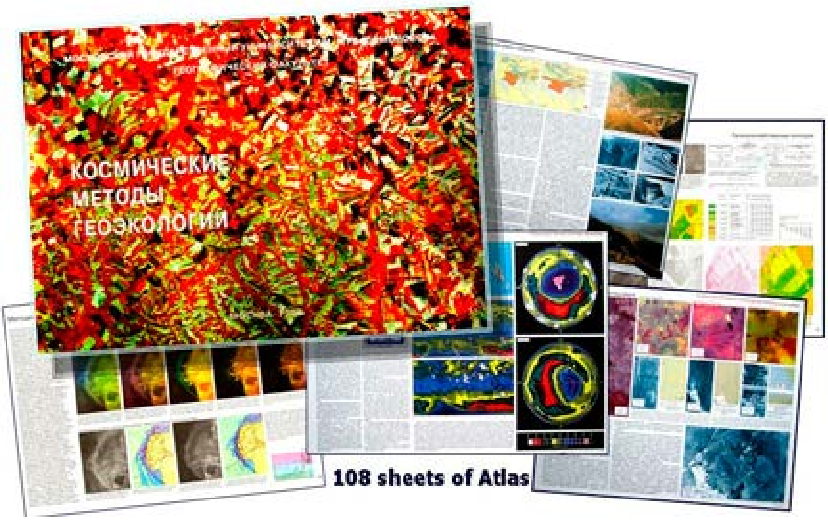


Fig. 2. The atlas of satellite images "Space Methods in Geoecology" [6]

The atlas of satellite images "Space Methods in Geoecology" (Fig. 2), edited by V.I.Kravtsova, employee of Department of Cartography and Geoinformation, was the largest project brought together staff from different departments of our Faculty.

The atlas is devoted to the application of space techniques for solving geo-environmental problems. It generalizes the experience and achievements on space methods application in geoecology up to the middle 1990's, shows the ways of satellite images use in geoecological monitoring and for solution of ecological and environmental management problems [6].

A significant contribution to the development of the atlas was made by members of our Department, which provided the creation of more than 10 sheets of atlas and were responsible for editing the part, devoted to the use of space images in studying mining areas.

Remote Sensing Methods for landscape-indicator studies, for thematic and GIS-mapping. The range of scientific studies carried out at the Department has always been extremely wide and is associated with the development, both theoretical background and practical aspects of environmental management. Therefore, among thematic areas of scientific activity, many were related with the study of the territorial organization of environmental management, landscape studies, environmental mapping, development of criteria for assessment of the ecosystems in the technogenic impact areas, environmental-economic evaluation of land and other natural resources, landscape planning, etc. Many of them were carried out with the use of Remote Sensing techniques.

Thus, the number of projects was implemented in the Kola Peninsula in the impact zone of Severonikel copper-nickel factory (town of Monchegorsk) together with the Department of Cartography and Geoinformation Moscow State University and the Scott Polar Research Institute (SPRI) of the University of Cambridge. Project was supported by a Regional Academic Partnership Programme (REAP), financed by Department for International development (DFID) and administrated by the British Council. During project implementation the methodology for diagnostics of ecosystem disturbance on the basis of interdisciplinary field research and remote sensing analysis was developed, the features of spectral reflectance of northern vegetation were investigated, the phytocenotic and geochemical criteria of ecosystem changes under industrial impact, and satellite image interpretation methods for mapping the consequences of industrial impact were developed [1].

Little bit later, the same team of specialists participated in project BENEFITS between Norwegian Institute for Nature Research, four Russian partner institutes at the Russian Academy of Science and Moscow State University, and Cambridge University. The project was dedicated to the study of structure and dynamics of the tundra-taiga interface in Russia [4]. The overall project aim was to develop a long-lasting scientific and educational collaboration network between Norwegian and Russian institutions with focus on young scientist and graduated student activities linked to topics related to processes controlling changes in the boreal-arctic transition zone in Northern Norway and Russia. Fieldwork of the summer 2008 and 2009 took place in Kola Peninsula, and in 2010 in Kola and Taimyr. Researchers collected and analyzed ground and remote sensed data for further analyses of the status in the forest-tundra transition zone. The studies also included a choice of transects, test areas, geo-botanical description, multi-channel digital terrestrial vegetation spectrometry, satellite image interpretation, soil description, the collection of samples for geochemical analyzes, measuring the depth of thawing of soil, taking core samples to determine the age structure of forest stands and regrowth in ecotone. The results of these studies were presented at the conference and were published [4].

The part of the PPS Arctic and BENEFITS projects was the research dedicated to the study of remote sensing methods for phytomass estimation and mapping of tundra vegetation. Mapping of above-ground phytomass provides a baseline for monitoring climate-induced changes, especially in the northern regions. It is important for practical applications, such as assessing quality of pastures and defining reindeer migration routes. The main purpose of this study was to develop a methodology for mapping lichen phytomass of mountain and lowland tundra ecosystems using multi-spectral high-resolution satellite imagery in a case study on the Kola Peninsula [4]. Investigations have successfully demonstrated the potential for deriving the above-ground tundra phytomass maps from very-high resolution satellite imagery. Although it was found that definite relationships between spectral and phytomass characteristics were derived only for lichen tundra. There were many uncertainties in subsequent upscaling from the ground data to the satellite image-derived map of the lichen tundra phytomass.

Currently investigations on the Kola Peninsula are continued. The studying of terrestrial spectral images of geosystems of the Kola Peninsula to assess the possibilities of mapping the spatial structure and dynamics, using the newest equipment recently appeared on the Faculty (Spectrometer Skye Instruments Spectro Sense2+ and giper-spektro-radiometrom ASD FieldSpec 3 Hi-res), are allowing the study of the spectral images of plants, minerals and rocks (Fig. 3). The databases of ground spectral measurements of northern vegetation and other natural objects are created to further ensure the interpretation of satellite images.

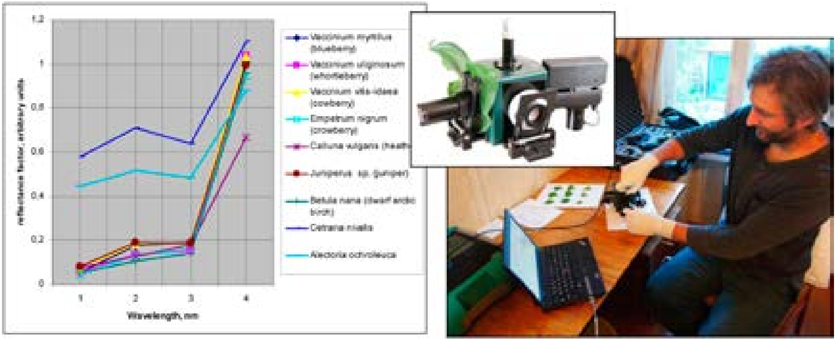
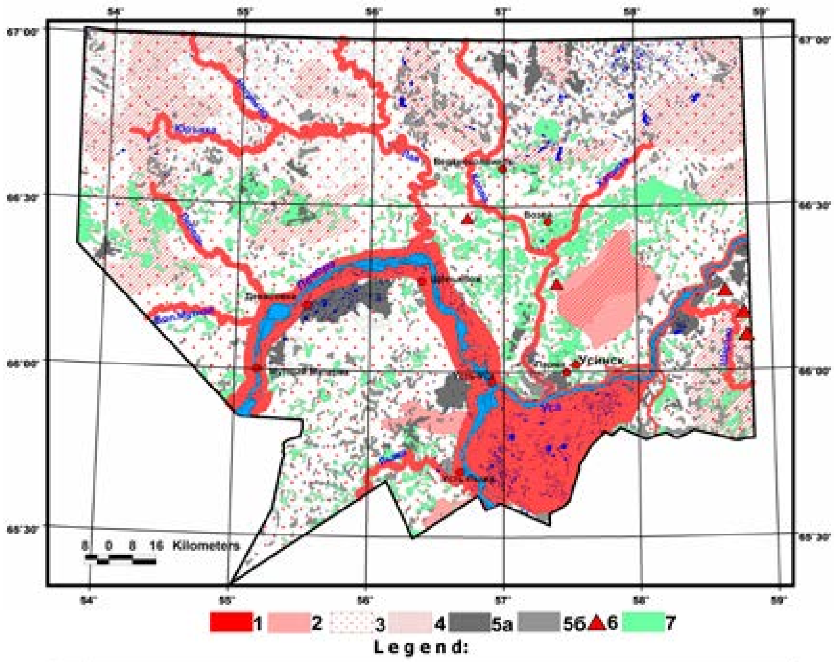


Fig. 3. Reflectance coefficients for typical tundra plant species. The Portable spectrometric laboratory [2].

The studies and the results obtained by ground-based spectrometric measurements can go on to develop geoportal technology and space analysis of hyperspectral images. Resulting analytical materials will form the basis of the structure and functioning of the on-line database of spectral measurements which is planned to place on the Geoportal MSU.

Identifying and mapping of environmental management restrictions (case of Komi Republic). Another region where members of the department for many years are conducting research is the Komi Republic — the district of Bolshezemelskaya Tundra — a part of the Timano-Pechorskaya Oil and Gas province. For a number of model areas of this territory with the help of Remote Sensing Methods were carried out such studies as: estimation of the degree of land disturbance, mapping of the landscapes and ecological frameworks, refinement and mapping of the boundaries of permafrost subzones within Bolshezemelskaya Tundra on the base of landscape-indicator studies [9], the research on identifying and mapping of environmental management restrictions and etc.

For example the Usinsk administrative region of the Republic of Komi was chosen as a model area for testing methods for determining and mapping of the environmental management restrictions [8]. A preliminary medium or large-scale mapping of the territories designed to the development can become an effective measure to im-



№	The main environmental management restrictions
1	Legislative environmental management restrictions within the partial nature reserves, spawning protection belts along rivers, valley and flood-landscapes of large rivers, forest protective belts along roads
2	Environmental (ecological) management restrictions within unfragmented large woodlands of extreme northern taiga subzone
3	Environmental (ecological) and nature-resource management restrictions within tundra landscapes of northern and southern forest-tundra subzones and forest landscapes of forest-tundra and northern taiga subzone
4	Environmental (ecological) management restrictions within the main watershed areas
5	Environmental (ecological) and potentially-possible engineering-geological (geotechnical) management restrictions within: a)large bog and forest landscapes b)small bogs and boggy areas
6	Legislative environmental management restrictions within swamp partial nature reserves and geological monuments of nature
7	No environmental management restrictions within the tundra landscapes of extreme northern taiga subzone

Fig. 4. Environmental management restrictions in the Usinsk administrative region, Komi Republic [8]

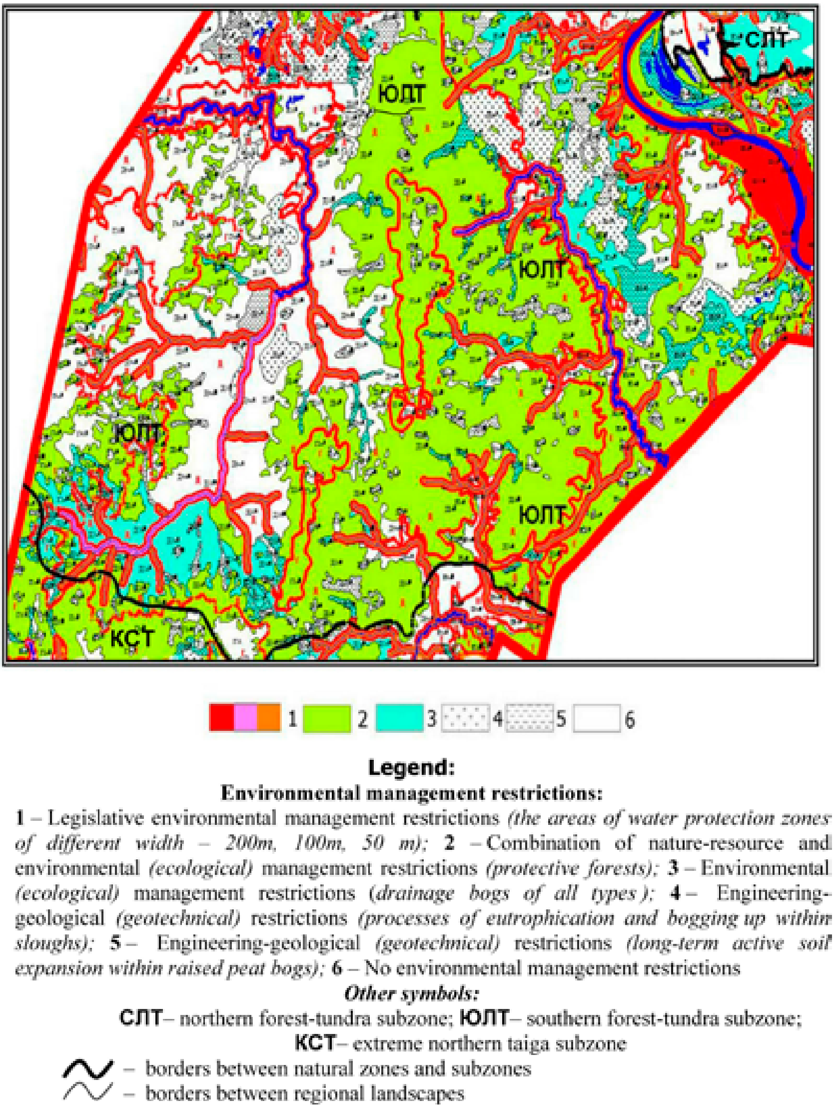


Fig. 5. The restrictions on environmental management for proposed to industrial development subsoil licensed field (the fragment) [8]

plement the environmental management restrictions on the administrative and legislative level. The area of land used for industrial infrastructure must be clearly defined and then tightly controlled.

Performing territorial planning at pre-investment stage is necessary to clearly define the limits of natural resources management and environmental management restrictions. Priority for industrial infrastructure location should be given to areas with no restrictions.

A mapping of the restrictions for nature management was based on the identification and mapping of ecological framework, for each element of which restrictions for nature management were defined. Ecological framework mapping was based on Remote Sensing Methods and GIS-technologies. The map of ecological framework gave an opportunity to create the appropriate map "The restrictions on environmental management" (Fig. 4), the analysis of which revealed areas with several kinds of restrictions on environmental management and the territories having virtually no restrictions. The following groups of possible restrictions were taken under consideration: legislative, environmental (ecological), engineering-geological (geotechnical), and nature-resource restrictions. The medium-scale and large-scale mapping was conducted.

The large-scale mapping of the restrictions on environmental management in the Usinsk administrative region was performed by the example of concrete proposed to industrial development and subsoil licensed plot of land (Fig. 5). Mapping was based on the landscape approach, differentiated for natural sub-zones, and within them — at the level of stows.

Mapping of the restrictions for nature management creates the preconditions for optimal regional planning at the level of the administrative district.

Spectrometry of greenhouse gases using space research (case of Lake Baikal). In recent years a number of interesting researches related to use of Remote sensing techniques have been carried out in the Baikal Natural Territory.

During International Scientific Research Expedition "Mirs on Baikal" in 2010 were conducted three-level synchronous measurements of emissions of methane from "provinces" of gas hydrate formations at the bottom of Lake Baikal. These observations will help to quantify the possible effects of global warming that can result of increasing the amount of greenhouse gases released into the air with the destruction of shelf gas hydrates.

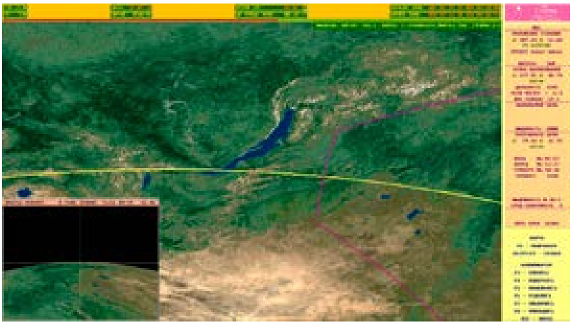



Fig. 6. The flight route of the spacecraft on the southern tip of Lake Baikal.
Disintegration of solid piece of gas hydrate, rising by manipulator of "Mir" [7]

During the expedition simultaneously scanning (from space and on the surface of the water) of methane emissions from the bottom of Lake Baikal was conducted. The measurements from space were performed with a high-precision spectrometers aboard the space station "Soyuz". To ensure full synchronization of surveys, it was necessary to combine on a vertical in one line and at the same time in the desired point tree objects: International Space Station "Soyuz" on the orbit, ship "Metropolis" on the surface of the lake and the manned submersibles' dive "Mir", which break off and handed to the surface the pieces of gas hydrates (Fig. 6). A similar experiment was performed for the first time.

The experiment provided valuable spectrometric data about Lake Baikal — not only on methane, but also general spectrometric data. Now, these data are used by scientists and researchers as the standard for monitoring ecological status of Lake Baikal.

Local monitoring using ultralight aviation (case of Baikal Natural Territory). The new direction of research in the Baikal natural territory is the developing methods of local monitoring using ultralight motorized trikes (ULM) "Tanarg 912S" with the equipment for obtaining multispectral remote sensing data.

These studies are conducted jointly by scientists of the Baikal Institute of Nature Management of the Siberian Branch of the Russian Academy of Sciences, the Faculty of Geography of the Lomonosov Moscow State University, Limnological Institute and the Federal

Polytechnic School in Lausanne (Switzerland), Russian Geographical Society, etc.

The first season of the International Swiss-Russian research expedition "Trans-Eurasia flight: Leman–Baikal" took place in summer 2013. The scientific program included the technique of studying the atmosphere and the water surface bodies using equipment for multispectral remote sensing data set on ULMs. The equipment included numerous devices: high-resolution spectrometer, a scanning aerosol lidar, a spectrometer and aerosol sampler, radar, video and photo camera, etc. In parallel with ULM collecting data more than 100 samples of water were taken from the boat in Lake Baikal and the Selenga delta. This technique in the future will allow to estimate the level and composition of water pollution on the basis of survey, without the need for sampling and analysis of samples.

Future expeditions will include research on the study of the reflectivity capacity of the forest environment using a nanosecond radar (with the Institute of Physical Materials), the study from the air the historical and sacred objects on the territory of Buryatia — datsans, suburgans, etc.

Remote Sensing methods for educational programs. For years of education at our Department students master a number of disciplines, which are somehow focused on the use of remote sensing products. These courses specifically devoted to the processing and interpretation of the images as well as a number of courses devoted to GIS-technologies use, cartographic study and GIS-mapping in ecology and environmental management. As a result, students master the visual interpretation methods as well as the related programs software packages for computer (digital) image interpretation and for data processing and spectral analysis of remote sensing products.

One of the most important stage of this study is the mastering of modern methods of field interpretation of aerospace images during expeditionary practice at the Kola peninsular in Hibiny (Murmansk Region). In field conditions students are trained to select the most typical key sites for their further detailed description and gridding. This stage is necessary for the subsequent creation of training samples and conducting the automated classification of objects within the study area using GIS-software technologies. In this way, students study not only the traditional practice of using maps and aerospace images, but also get acquainted with the methods of modern means and methods of recording the results of field work, their further office processing using GIS-technologies and interpretation to optimize the environmental situation and environmental management practices.

Members of the Department participated in the creation of a number of textbooks and teaching aids on Remote Sensing and applying aerospace images in studying of technogenic impact in mining and industrial regions, in studying cities and urbanized areas, mastering of Remote sensing and GIS-theory, practice of digital image processing and GIS-mapping.

Within the project British Degrees in Russia (BRIDGE — British education in Russia) in 2007 was released a textbook "Remote sensing methods for assessing ecosystems (summer field school)". It is devoted to mastering the intensive field remote sensing technologies and methodology of diagnosis and comprehensive assessment of the state of ecosystems in the areas of human impacts. As a polygon for research within training program of field school was chosen the central part of the Kola Peninsula, located in the impact zone of Severonikel copper-nickel smelter.

Great prospects for the students training in remote sensing techniques have been opened thanks to the project "Geoportal MSU". Geoportal MSU was put into operation in 2011 according to a government contract, providing by Russian Research and Development Center SCANEX (SCANEX R&D Center). It focused primarily on students and staff of MSU — to provide educational and research problems, access to remote sensing data. Mapping interface is based on technology ScanEx GeoMixer.

Geoportal MSU is a geo-information complex, which includes the hardware and software parts, and maintain databases on the basis of satellite images and maps. This is an innovative system of access to spatial data from remote sensing satellites of the Earth from space. Geoportal MSU contains raster and vector geospatial data of different scale, georeferenced mosaic coatings based on satellite images.

As part of the project “Geoportal MSU” there is an opportunity to place an order for free satellite imagery for scientific research, educational and contractual purposes. The staff and students of Moscow State University has a unique opportunity to order a free archive data FORMOSAT-2, SPOT 2/4/5, IRS-C1/D1, Radarsat-1, IKONOS, etc.

The structure of Geoportal includes a geo-portal space information receiving station, the operative part of Geoportal and workplaces with specialized software for processing of satellite imagery presented by Geoportal, and then adding on the Geoportal as the results of the analysis. Connection of Geoportal to space data receiving station allows to synchronize catalogs of recent images, get in near real-time new information and display it on the Geoportal.

REFERENCES:

1. Ecology of the North: Remote Sensing of Ecosystem Disturbance (Case Study of Kola Peninsula). Edited by A.P. Kapitsa and W.G. Rees. – Moscow: Scientific World, 2003. – 248 p.
2. Golubeva E.I., Plyushkyavichyute Y.A., Rees W.G., Tutubalina O.V. Remote Sensing Methods for Phytomass Estimation and Mapping of Tundra Vegetation. Socially Scientific Magazine “Geography, Environment, Sustainability”. № 03 (V. 03) 2010. P. 4–13.
3. Kapitsa A.P., Ridley J.K., Robin G.de Q., Siegert M.J., Zotikov I.A. A Large Deep Freshwater Lake beneath the Ice of Central Antarctica. Letters of Nature. Vol. 381, 20 June, 1996. P. 684–686.
4. Proceedings of the final workshop of Norway-Russia cooperation project BENEFITS. Moscow, 24–27 February, 2011. Edited by O.V. Tutubalina and E.I. Golubeva. – Moscow.: Faculty of Geography, M.V. Lomonosov Moscow State University, 2011. – 71 p.
5. Space Geography: Polygon Studies. Edited by Yu.G. Simonov. – Moscow: M.V. Lomonosov Moscow State University, 1988. – 128 p.
6. Space Methods in Geoecology (Atlas of satellite images). Edited by V.I. Kravtsova. – Moscow. 1998. – 108 p.
7. The official portal of the Lake Baikal Protection Fund [electronic resource]. Available at: http://baikalfund.ru/index.wbp

8. Zengina T.Yu., Osadtchaya G.G. The Experience in Identifying and Mapping of Environmental Management Restrictions for the European North-East of Russia // Environmental Management: Theory, Practice, Education / Edited by M.V. Slipenchuk. – Moscow: Faculty of Geography, M.V. Lomonosov Moscow State University, 2012. P. 194–205.
9. Zengina T.Yu., Osadtchaya G.G., Koroleva A.M. Use of medium-scale topographical maps and remote sensing data for geocryological zoning of Bolshezemelskaya Tundra // Geocryological mapping: problems and perspectives: Proceedings of the international conference (5–6 June, 2013, Moscow, Russia). – Moscow: Peoples' Friendship University of Russia. P. 46–50.

Daiki Hiramatsu, Kiichiro Hatoyama
Department of Civil Engineering, the University of Tokyo

Meeting abstract of the presentation at the 1st Russian–Japanese Collaboration Seminar for Sustainable Development entitled:

A study on management measures of tsunami evacuation by car in Kuroshio Town, Kochi Prefecture

INTRODUCTION

In the Great East Japan Earthquake (11th March, 2011), the rate of those who used cars to evacuate was 57%. Although there were many people who were saved from tsunami by car, to evacuate by car in improper manner is dangerous. Actually, 575 people in Miyagi Prefecture and 102 people in Iwate Prefecture died in cars in 3.11 case.

To begin with, the Government basically prohibited people from evacuating by car before the Great East Japan Earthquake. On the other hand, there were certainly many people who evacuated by car for their lives in not only 2011 Tohoku earthquake but also 1993 Hokkaido earthquake (北海道南西沖地震) and 2003 Hokkaido earthquake (十勝沖地震). From these kinds of reasons the Government partially permitted people to evacuate by car now, and local governments are making concrete plans of effective and proper car evacuation.

ON-SITE INVESTIGATION AND INTERVIEW

The subject of our research is Kuroshio Town, Kochi Prefecture (Fig. 1). The estimated tsunami height is 34 meters at some areas in the town, and about 11,000 townspeople live in the tsunami prone area. Additionally, the rate of aging (over 65 y. o.) is 37.2%.

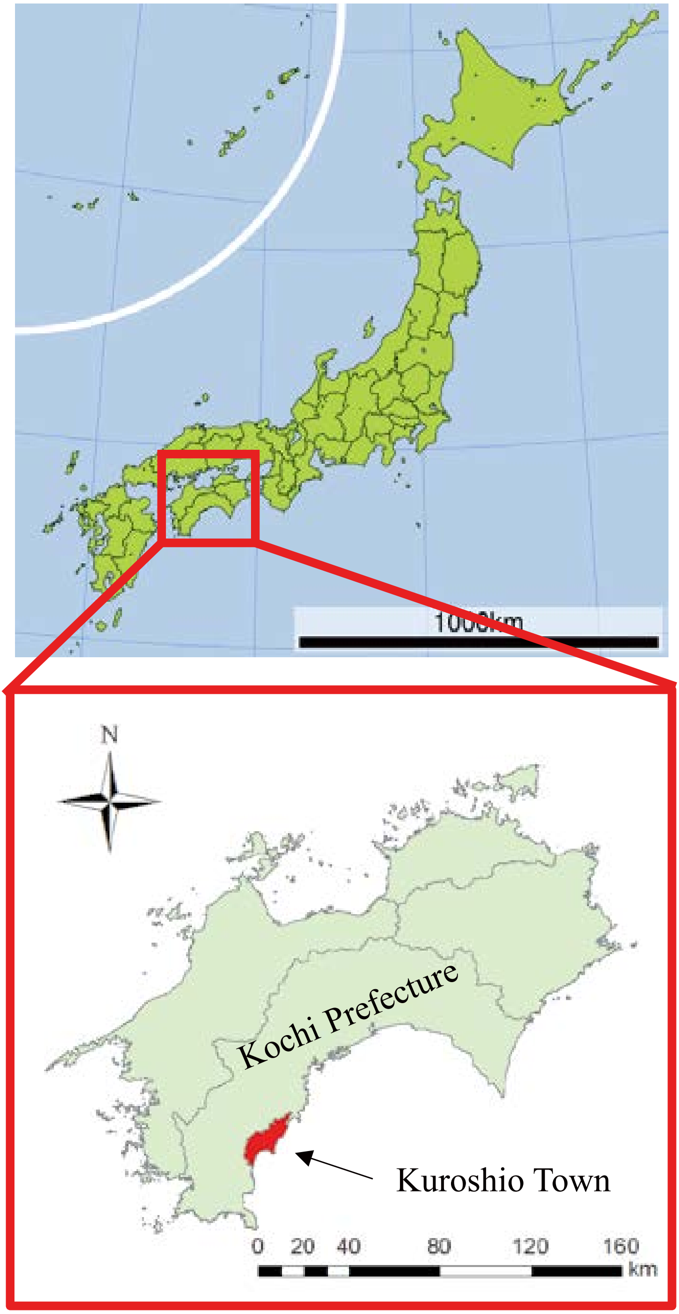


Fig. 1. The geographical location of Kuroshio Town

Fig. 2. District A

Fig. 3. District B

In September and October (2013) we did the on-site investigation and interview at two districts of the town to make problems about car evacuation clear.

There are two main problems of District A (Fig. 2). The first one is that community roads are narrow and close to roads. The second one is that many visitors (such as surfers) might be the cause trouble in evacuating.

There are also two problems of District B (Fig. 3). The first one is that shoulders of the road toward the shelter is narrow, and the second one is that there is no space to park cars in evacuating.

CONCLUSION

By the on-site investigation and interview, comprehension of the distinguishing features of districts is important and needed when making plans of car evacuation. In District A the reinforcement of walls and the guidance for visitors are significant. On the other hand, refuge-road widening and the securement of parking space are essential in District B. From now on, the special consideration to visitors might be the key point for other local governments which have sightseeing areas.

REFERENCES

1. 内閣府防災対策推進検討会議 (2012), 津波避難対策検討ワーキンググループ第5回会合資料.

All figures are clippings from the poster we used in the presentation at the 1st Russian–Japanese Collaboration Seminar for Sustainable Environment.

Kyoko Matsui, Makoto Shimamura

Department of Civil Engineering, the University of Tokyo

Meeting abstract of the presentation at the 1st Russian–Japanese Collaboration Seminar for Sustainable Development entitled:

Integrated management of tornado warning policies

INTRODUCTION

In these days as global warming gets harder and harder, it is said that severe weather events occur more and more frequently. There were unprecedented heavy rains also in Japan, and tornadoes are paid higher attention in this last few years (Fig. 1). Now it is necessary to invest not only in hardware like banks or shelters but also software; prediction technology, warning system.

BACKGROUND

25 Dec 2005, railway carriages of JR Uetsu line in Yamagata prefecture (Fig. 2) were turned over by a gust of wind, whose estimated maximum velocity is 34 m/s, and it killed 33 people. After

Fig.1. Map of tornado in Japan 1961 (*from Japan Meteorology Agency*)

Fig.2. Map of Shonai area, Yamagata prefecture (*a green circle is 20km distant, which is a valid range of one radar, from JR radar*)

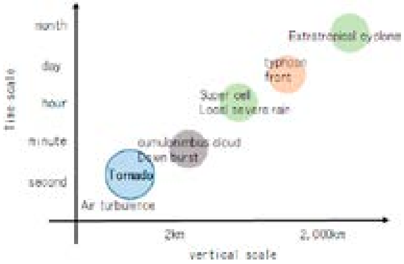


Fig. 3. Scales of meteorological phenomena

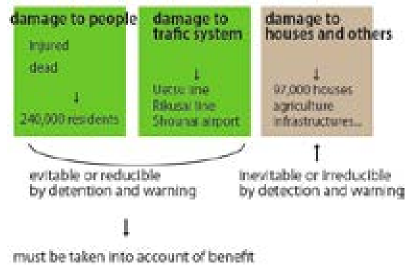


Fig.5. Defensive area of Doppler radar in Shonai

this accident, JR installed a Doppler radar and started cooperating with Meteorological Research Institute to develop a system for detection of tornadoes. Unfortunately, however, this system is so far assumed to be utilized only for JR lines. Then it is necessary to estimate its social benefit under hypothetical situation in order to show its usefulness.

Observation with very high resolution is indispensable for tornado detection because tornadoes are very small scale events in terms of meteorology (Fig. 3). So small and many Doppler radars are suitable for tornado detection.

REVIEW OF WARNING SYSTEM

Today Japan has a tornado warning system whose name is "Tatsumaki NOWCAST", which is based on coarse network of weather radar by JMA and tells state of weather likely for severe weather. So it gives 10km-square mesh alarm, but its prediction comes true only 5–10%, on the other hand, it misses 30–40% of the actual tornadoes (Fig. 4). This system just coincides with "outlook" step by

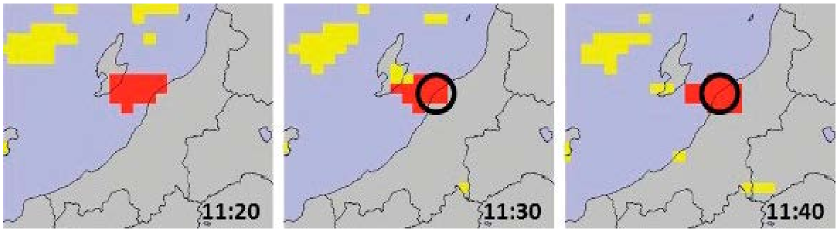


Fig. 4. Successful case of Tatsumaki NOWCAST, 6th Aug 2012, in Nigata prefecture

NWS, in America, and lacks “watch” step, which is more detailed observation.

This unreliable nature of current warning system is unsuitable for residents and traffic business in terms of their evacuation psychology as well as finance.

STEP 1. EVALUATION OF THE SYSTEM

As far as today’s tornado detection technology is concerned, lead time of possible warning with this type of system must be short, for example, around 16 minutes in America. Because of its nature, this system can be utilized only for evacuation of people and safe halt of transportation, not for protection of buildings (Fig. 5).

STEP 2. SUGGESTION FOR WARNING

Now Shonai has Doppler radar and MRI is developing its prediction, however, warning system for the whole region is not planned. In order to put the prediction into real use, reflecting which factor of warning information is critical for mitigating damages is necessary; lead time, estimation of tornado’s speed, direction, intensity, which is most important for evacuation among these factors? And WHO need WHICH factor?

All figures are clippings from the poster we used in the presentation at the 1st Russian–Japanese Collaboration Seminar for Sustainable Environment.

Masashi Minamide, Toshio Koike
Department of Civil Engineering, the University of Tokyo

Meeting abstract of the presentation at the 1st Russian–Japanese Collaboration Seminar for Sustainable Development entitled:

Research on the seasonal prediction of extreme precipitation events in Pakistan, focusing on the anomaly of global circulation

INTRODUCTION

In Asian region, there is monsoon caused by the contrast of temperature between the atmosphere over land and over ocean. Especially, Asian Summer Monsoon is a good source of water supply. Its precipitation is crucial for agriculture, industry, and also daily lives. Asian Summer Monsoon region is shown in Fig. 1, which shows the amount of climatologic precipitation from June to September. Since Pakistan locates in the west edge of Asian Summer Monsoon Region, the amount of precipitation there is severely influenced by the variability of monsoon activity. In some dry years such as in 1991 or 2002, Pakistan suffered from strong drought, causing great economic and life losses, while, in wet years such as 1994 or 2003, flood came to Pakistan, washing away whole cities. In order to reduce the damage of these water hazards, seasonal prediction is greatly effective, but due to the complicated mechanism of monsoon, it is still very challenging problem. The purpose of this research is to reveal the mechanisms of heavy rainfall and drought, which is indispensable for the improvement of prediction.

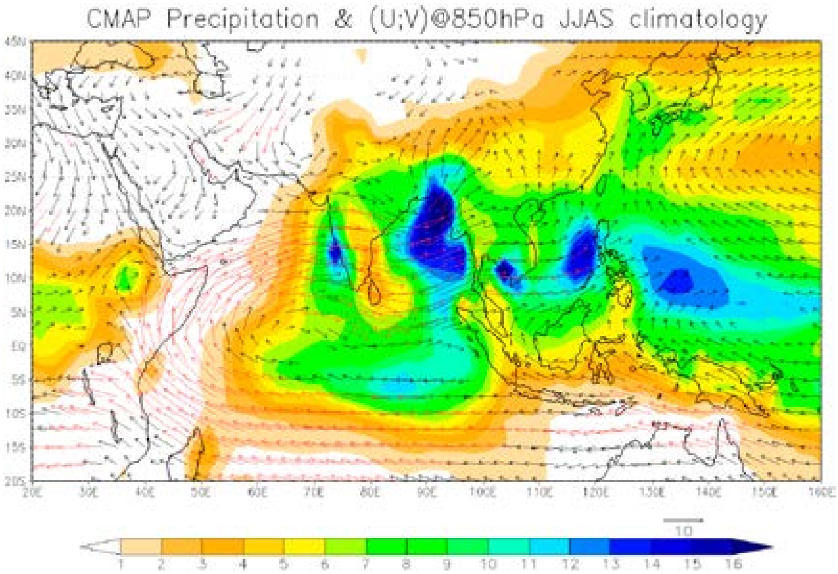


Fig 1. Climatology of the amount of precipitation [mm/day] (shaded) and horizontal wind [m/s] (vector)

METHODOLOGY

The satellite observation data provided by National Oceanic & Atmospheric Administration (NOAA), and the reanalysis data (JRA25) provided by Japan Meteorological Agency, are utilized for this research. Firstly, statistic approach such as EOF analysis was conducted in order to extract the dominant abnormal pattern of atmospheric conditions. The relationship between those atmospheric circulation

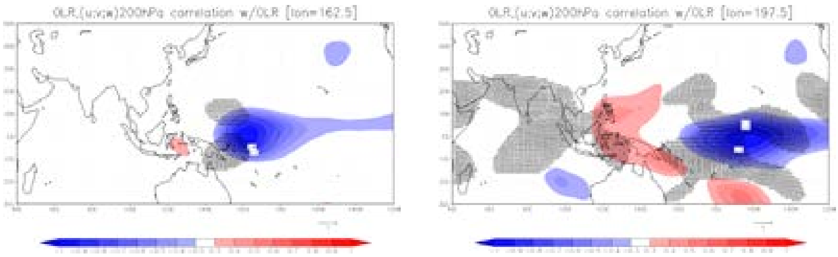


Fig. 2. Correlation with OLR (shaded), horizontal wind in the upper troposphere (vector) & vertical wind (contour), and meridionally (5S-5N) averaged OLR at (upper) 162.5 E, (lower) 197.5 E

pattern and intra-seasonal oscillation was also checked. Finally, numerical experiments will confirm a causality of heavy rainfall and drought, using Weather Research and Forecasting Model (WRF).

RESULTS

The result of EOF analysis showed that the strength of local Hadley-like Circulation pattern, which is composed of updraft in the equator region and downdraft in the mid-latitude region, has a strong impact on the precipitation activity over Pakistan. With the Hadley Circulation Index by (Abraham & James, 1996), which uses mass stream function the strength and the temporal change of Hadley Circulation was examined.

$$\text{(I)Mass Stream Function: } \Psi = \frac{2\pi a \cos\varphi}{g}\int_0^p \bar{v}\, dp$$

$$\text{(ii)HCIIndex} = \max_p \Psi$$

The strongest power spectrum in wavelet spectral analysis was seen in the range of 20–40 days period (not shown), which indicated that this circulation is greatly influenced by the Madden-Julian Oscillation (MJO) (Saith and Slingo, 2006; Susmitha et al, 2009; etc). MJO is an oscillation in which huge convection area propagates eastward from Indian Ocean to Pacific Ocean around equator. The difference in the influence of MJO on the atmospheric general circulation was examined by the correlation analysis between atmospheric conditions and outgoing longwave radiation in each longitude (Fig. 2). Depends on the location of convection area, the range of influence of MJO is absolutely different. Currently, numerical experiments with Regional Climate Models is designed with artificially changed Sea Surface Temperature (SST), in order to reveal the mechanisms which can cause heavy rainfall / drought.

SUMMERY AND FUTURE RESEARCH

We examine the strong influence of the local Hadley Circulation over the Arabian Sea on the monsoonal precipitation activity in Pakistan. The frequency analysis showed that the intra-seasonal variability of the local Hadley Circulation is induced dominantly by the Madden-Julian Oscillation (MJO). In addition, the correlation analysis of the atmospheric conditions with OLR in MJO days indicated that there could exist some kind of tele-connection of MJO in the Pacific Ocean affecting on Arabic region. Further ideal experiments is needed to clarify the impact of convection in specific region.

REFERENCES

1. Abraham, O., & James, Y. (1996). Observed interannual variability in the Hadley circulation and its connection to ENSO. Journal of Climate, 9 (11), 2751–2767.
2. Saith, N., & Slingo, J. (2006). The role of the Madden-Julian Oscillation in the El Nino and Indian drought of 2002. International Journal of Climatology, 26 (10), 1361–1378.
3. Susmitha, J., Sahai, A. K., & Goswami, B. N. (2009). Eastward propagating MJO during boreal summer and Indian monsoon droughts. Climate Dynamics, 32 (7–8), 1139–1153.

All figures are clippings from the poster we used in the presentation at the 1st Russian–Japanese Collaboration Seminar for Sustainable Environment.

Naotsugu Nakamura
Department of Civil Engineering, the University of Tokyo

Meeting abstract of the presentation at the 1st Russian–Japanese Collaboration Seminar for Sustainable Development entitled:

Overseas expansion of Japanese companies: from business and infrastructure's perspectives

BACKGROUND AND OBJECTIVE

Japanese infrastructure companies want to enter overseas infrastructure market, especially in developing countries. There are two main reasons behind Japanese companies' movement. First, infrastructure markets in developing countries are growing. McKinsey Global Institute (2013) pointed out that the world needs to invest $57 trillion to infrastructure between 2013 and 2030 (Fig. 1). Developing countries are eager to invest and improve infrastructure in their countries, but they don't have much experience on the field of infrastructure investment and improvement and much money to do so. On the other hand, Japanese domestic infrastructure market is shrinking. Infrastructure stocks in Japan are relatively high because Japanese government has put priority on infrastructure investment under the Liberal Democratic Party of Japan after the end of the World War II. Thus, there are not many margins to invest more infrastructures. Also, by the decrease of Japanese population, the demand to infrastructure is decreasing.

According to the survey by the Ministry of Economy, Trade and Industry of Japan, Japanese companies don't take much share in overseas infrastructure markets, compared with other European and American, Chinese infrastructure companies. As mentioned above, infrastructure markets in developing countries are expanding and

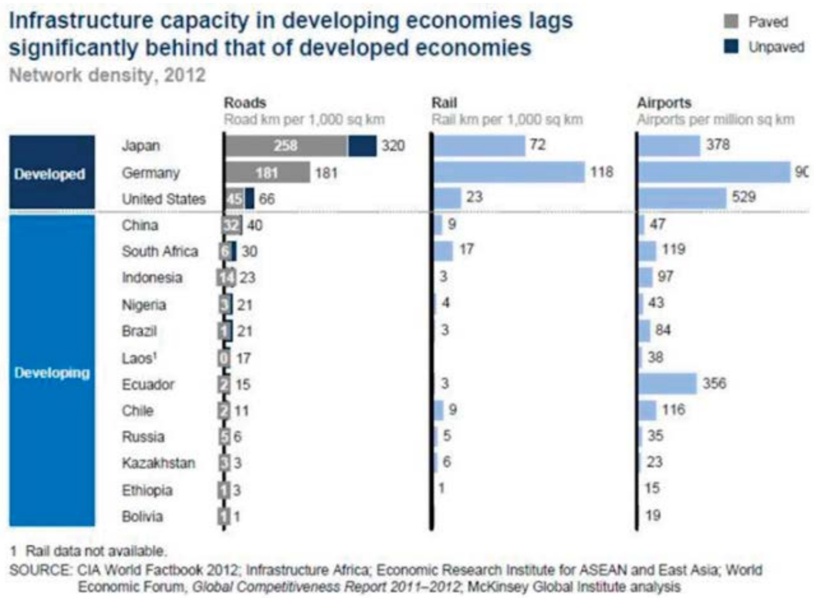


Fig. 1. Infrastructure capacity in developing economies lags significantly behind that of developed economies. *From: McKinsey Global Institute (2013)*

there are lots of demand to high quality and efficient infrastructures such as roads, rails, and energy facilities. It means a lot to research why Japanese infrastructure companies can't acquire many profits in overseas infrastructure markets and compare Japanese companies with successful other countries' companies in order to draw out some useful lessons.

Main objectives in this research are "There are many obstacles when Japanese companies enter overseas markets such as language, cultural differences. How these obstacles can be reduced?" and "How Japanese companies can expand overseas sales efficiently and effectively?"

METHODOLOGY

Literature reviews on Japanese companies have been progressed. In order to find useful information, targets of companies are not limited within infrastructure companies. I include not only infrastructure, construction and engineering companies but other companies such as car manufacturing and consumer product manufacturing companies. Now I am researching from the characteristics of Japanese companies. Thus, literature reviews are more related with academic fields such as management and business administration than civil engineering.

Second, I plan to do interviews with people in some Japanese companies to know decision-making processes and strategies to expand sales in overseas markets.

CASE STUDY: KOKUYO

I've already done a research on KOKUYO, a stationery company in Japan. KOKUYO is the largest stationery company in Japan, but it doesn't take a good position in overseas stationery markets and acquire many profits. Although being big in Japan, KOKUYO's sales in overseas markets are still very low. The net sales KOKUYO earned from overseas markets in 2012 accounted for only 5% of total net sales. KOKUYO is similar with Japanese infrastructure companies which don't make many profits in overseas markets. KOKUYO recognizes these opposing sale results between domestic and overseas markets and started an overseas expansion strategy from 2011. In that year KOKUYO decided two key movements in China and in India.

In addition, I conducted comparative study between KOKUYO and other Japanese companies, Yakult, Panasonic in India, and Lawson in South Korea. Yakult's overseas business has been successful in developing countries such as China and India. Panasonic India, at first, failed to enter local consumer electrical appliance market in India. However, after the modification of local strategy, Panasonic has been able to stable sales. Lawson failed to take a position in convenience store market and withdrew from South Korea. Implications acquired from the comparative research are Fig. 2.

FURTHER RESEARCH

I have to collect more information on other leading Japanese companies, for example, TOYOTA. KOKUYO is one of the examples which are located in the similar situation with infrastructure companies. Thus, researches on infrastructure companies and other countries' compa-

	Yakult	Panasonic	Lawson
		Frictions between the local branch and the head office	
Human Resources	Unique sales system, Yakult Lady		Ineffective communication between Japanese managers and local employees
Localization		Failure in understanding local needs	Failure in understanding local needs
Results	Successful in overseas sales	Emerging steadily after making a localized product	Disappearance from the market after 10-year operation

Fig. 2. Comparison of three companies.

nies (e.g., South Korea, Europe, and U.S.) must be done in order to compare with Japanese companies and drew out useful implications.

Also, it is worth analyzing general trading companies (Mitsubishi Corporation, MITSUI & CO., LTD. etc.). They deal with infrastructure projects around the world from natural gas production projects to construction of power plants. Mitsubishi and Mitsui, for example, participate in the Sakhalin II project in Russia, one of the largest natural gas production projects in the world. General trading compa-

Fig. 3. Press interview by the Prime Minister of Japan Shinzo Abe and the President of Russia Vladimir Putin. *From: Ministry of Foreign Affairs of Japan's website.*

nies are different from construction companies to some extent, but it is meaningful to research.

Finally, I should investigate measures by Japanese public institutions such as METI (Ministry of Economy, Trade and Industry) and JBIC (Japan Bank for International Cooperation). These institutions are eager to support and stimulate exporting infrastructure by Japanese companies. In addition, actions by the Japanese government should be included. The Prime Minister Shinzo Abe, after the establishment of his administration from the end of 2012, has advertised Japanese products when he visits foreign countries. The prime minister visited Russia in April with about 120 business executives.

REFERENCES

1. McKinsey Global Institute (2013), Infrastructure productivity: How to save $1 trillion a year.
2. KOKUYO (2012), Annual Report 2012.
3. Ministry of Foreign Affairs of Japan's website. http://www.mofa.go.jp/mofaj/

All figures are clippings from the poster we used in the presentation at the 1st Russian–Japanese Collaboration Seminar for Sustainable Environment.

Hiroya Sasaki, Kiichiro Hatoyama
Department of Civil Engineering, the University of Tokyo

Meeting abstract of the presentation at the 1st Russian–Japanese Collaboration Seminar for Sustainable Development entitled:

How can elderly people's lives in temporary housing be activated in tsunami-damaged area? One solution from the viewpoint of mobility in Kamaishi

INTRODUCTION

In 2011, Great East Japan Earthquake occurred and it caused great tsunami and damaged north-eastern area of Japan severely. Kamaishi city is located in the area where severely damaged by the tsu-

Fig. 1. Location of Kamaishi city

Fig. 2. Temporary housing in Kamaishi

nami (Fig. 1), and approximately 1,100 people were killed. Population of Kamaishi city is about 36,000 persons and area is 441 km^2.

Many people lost their houses by the tsunami, and they are living in temporary housing now which is supplied by the government (Fig. 2). In Kamaishi, 5,476 persons are living in temporary housing now and 31% of the residents are over 65 years old. Daily care for residents of temporary housing has been done well, however many elderly people have still mental or physical problems because of drastic change of environment. Therefore, it is worried that elderly people who live in temporary housing may become inactive and get disease. Here, “Inactive people” shows those who are in situations as well as frequency of going out or communication decreases.

INTRODUCTION OF DRT

DRT (Demand Responsive Transport) is a new type of public transport. Because of the motorization, the number of bus users continues to decrease in rural area. However, conventional buses have to run along fixed routes and stop at bus stops in fixed schedules. Then, sometimes people say that “Buses convey just air”. To resolve this problem, DRT systems have been introduced in various places under flexible routes, bus stops and schedules. Instead, users have to make reservation before riding DRT.

DRT IN KAMAISHI

The DRT system was introduced to support mobility of elderly people in Kamaishi. It started to operate from October, 2012. Main targets of the DRT are those who live in temporary housing located in northern are of Kamaishi. In the area, frequency of fixed-route bus is very low (Fig. 3).

Especially in Hakozaki area, frequency of fixed-route bus is only 5 times a day and bus stops are far from temporary housing. There-

Fig. 3. Names of each area and situation of fixed-route bus in Kamaishi

Fig. 4. The service area of DRT in Kamaishi

fore, it is very inconvenient to move only by fixed-route bus. In central area of Kamaishi city around Kamaishi station, fixed-route buses run frequently, Therefore, DRT supplies service to go to or back from central area. In addition, users can get on/off freely inside northern area of Kamaishi city (Fig. 4). However, the number of DRT users is still very few (Fig.5).

INTERVIEW SURVEY

To know the present situation of Kamaishi, we have conducted interview surveys twice:

1. 2013/02/20 to 2013/02/26 90 houses
2. 2013/08/02 to 2013/08/04 320 houses

We have asked mainly by what, where and how often people move in their daily lives. Subjects are those who live in temporary housing. Each results are shown in Fig. 6 to Fig. 8. In Fig. 6, elderly people's frequency of going out per week is shown. Frequency of going out of elderly people who live in temporary housing in Kamaishi is clearly much lower than that of elderly people in whole Japan. In addition, main purposes for going out are limited to what are necessary to live on like shopping and hospital, and they rarely go out for recreation (Fig. 7). Then, the major mode to go out

Fig. 5. The number of DRT users per day

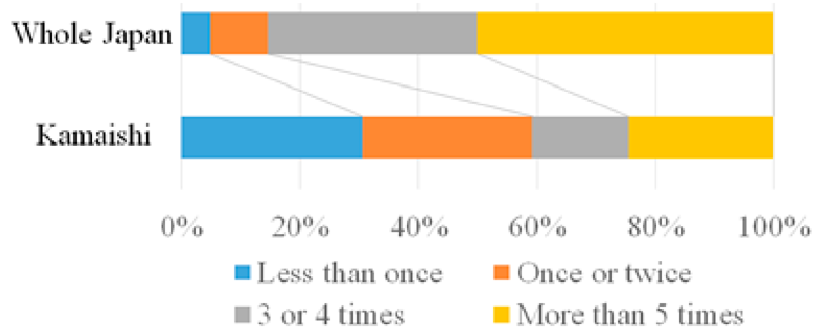
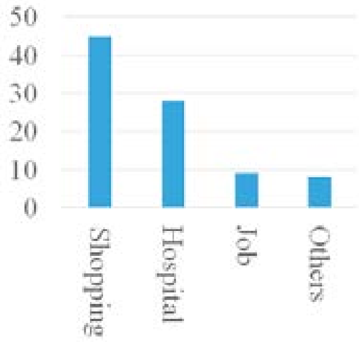


Fig. 6. Elderly people's frequency of going out per week



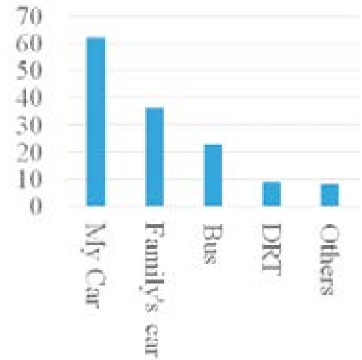


Fig. 7. Purposes for going out

Fig. 8. Transportation mode

is "private car" and those who don't have a private car also use their families' cars mainly (Fig.8). On the other hand, it may be difficult for those who don't have a private car to go out freely.

HOW TO ACTIVATE PEOPLE'S LIVES

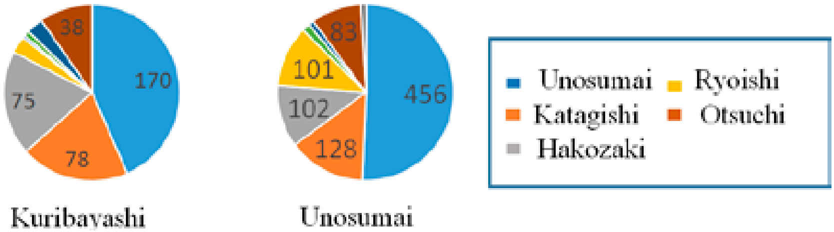


Fig. 9. Areas where temporary housing residents had lived before 3.11

Fig. 10. Situation inside DRT

Fig. 11. New community by DRT users

As we mentioned, elderly people's lives tend to be inactive in temporary housing in Kamaishi. One reason why they become inactive may be they have been scattered from former communities to various areas (Fig. 9). There are some events for former communities to meet again, but frequency is not so much. Therefore, to hold such kind of events are needed in Kamaishi.

OTHER DRT CASE IN OBIHIRO

Obihiro city is located in Hokkaido. Obihiro city also introduced DRT and it is said to be used well. There, elderly people moved by their children's cars before the introduction of DRT, however their children were usually very busy with their work. So, to encourage elderly people to go out, fare of DRT is set to be free now. And users can get to know each other in DRT (Fig. 10) and they made a new community by themselves (Fig. 11).

FUTURE PLAN

We will conduct in depth interview to know elderly people's desire to activate their lives. In addition, we will hold events to mend former communities. Then, we will consider measures how to activate elderly people's lives.

All figures are clippings from the poster we used in the presentation at the 1st Russian–Japanese Collaboration Seminar for Sustainable Environment.

Yohei Sawada, Toshio Koike,
Patricia Ann Jaranilla-Sanchez
Department of Civil Engineering, the University of Tokyo

Meeting abstract of the presentation at the 1st Russian–Japanese Collaboration Seminar for Sustainable Development entitled:

Towards sustainable water resources management against severe droughts. The case study on drought analysis at African river basin

INTRODUCTION

We presented the drought analysis at a semi-arid river basin by using the state-of-art eco-hydrological model as a poster presentation in the 1st Russian–Japanese Collaboration Seminar for Sustainable Environment. This article briefly summarizes the poster presentation describing our research motivation, methodology and preliminary results.

Drought severely damages water and agricultural resources. Both hydrological and ecological responses are important for the understanding of the progress of droughts. In Fig. 1, we show the mechanism of drought's progress based on the conceptual drought progress model [Wilhite and Grantz, 1985]. Firstly, precipitation deficit induces soil moisture deficiency and high plant water stress causing agricultural droughts. Secondly, hydrological drought characterized by deficit of river discharge and groundwater follows agricultural drought.

Our research objective is to reproduce these complicated progress of droughts by a numerical simulation. Although previous studies have analyzed several types of droughts by using hydrological models [Jaranilla-Sanchez et al. 2011], the ecological contributions to these processes have not been analyzed. Therefore, we develop the eco-hydrological model that can simulate vegetation growth and death as wwell as water cycle at river basin scale.

METHODOLOGY AND STUDY AREA

WEB-DHM-Veg is an eco-hydrological model that can calculate river discharge, ground water, energy flux, and vegetation dynamics at basin-scale [Sawada and Koike, 2013]. This is the coupled model between the distributed hydrological model, WEB-DHM, and the dynamic vegetation model. This model is applied to Medjerda river basin, Tunisia, North Africa (Fig. 2). The climate there is semi-arid and the crop production in Tunisia highly depends on their water availability. In this presentation, we evaluated the model performance to reproduce historical droughts at this basin.

RESULTS

Fig. 3 shows the estimated and observed monthly river discharge at Jendouba site. The model accurately reproduces observed river discharge in long-term (19-year) simulation. In Fig. 3, drought in-

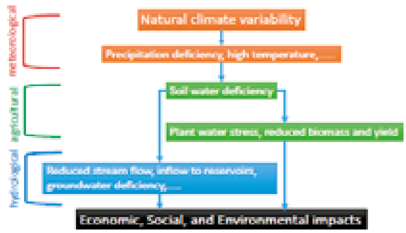


Fig. 1. Basic Mechanism of droughts

Fig. 2. Medjerda River

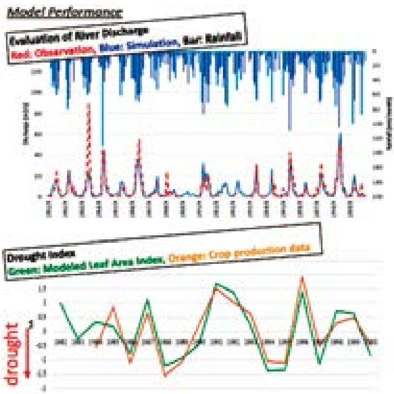


Fig. 3. The performance of WEB-DHM-Veg (*upper*). Estimated and observed river discharge at Jendouba site (*lower*) estimated and observed agricultural drought index

dices calculated by the method of Jaranilla-Sanchez et al. 2011 are also shown. We compare the drought index from modelled Leaf Area Index (LAI) with that from nationwide crop production in Tunisia. Modelled drought index correlates well with the drought index from nationwide crop production. We succeeds to simulate historical crop production deficits in 1988–1989 and 1994–1995 which have been reported in Food and Agricultural Organization (FAO) review.

These results indicate that the model correctly reproduce historical severe droughts at this basin. We accurately simulate both hydrological droughts characterized by river discharge and groundwater level deficits and agricultural droughts characterized by crop production deficits.

CONCLUSION

We successfully reproduce historical severe droughts by applying the eco-hydrological model, WEB-DHM-Veg, to the Medjerda river basin, which shows our model is applicable to drought analysis. Considering the interactions between the water cycle and vegetation dynamics is an essential step towards improving the skill in the analysis and prediction of hydrological and agricultural droughts. We address the importance of introducing dynamic vegetation modeling within a distributed hydrological model to establish sustainable water resources managements against severe droughts under a changing climate.

REFERENCES

1. Jaranilla-Sanchez, P. A., L. Wang, and T. Koike (2011), Modeling the hydrological responses of the Pampanga River basin, Philippines: A quantitative approach for identifying droughts, Water Resour. Res., 47, W03514, doi:10.1029/2010WR009702.
2. Sawada, Y. and T. Koike (2013), Development of a distributed hydrological – dynamic vegetation coupling model and its application to North Africa. Ann.Jour. Hydraul. Eng., Japan Society of Civil Enginnering, Vol.57 (in Japanese).
3. Wilhite, D., A., and M., H., Glantz (1985), Understanding: The Drought Phenomenon: The Role of Definitions, Water International, 10(3), doi: 10.1080/02508068508686328.

Rie Seto, Toshio Koike, Mohamed Rasmy
Department of Civil Engineering, the University of Tokyo

Meeting abstract of the presentation at the 1st Russian–Japanese Collaboration Seminar for Sustainable Development entitled:

Development of a satellite land data assimilation system coupled with WRF

INTRODUCTION

For flood prediction it is crucial to predict whether a rain area will be over the river basin or not after few hours, and this needs very fine prediction of time and space distribution. For highly accurate prediction of rain area, it is efficient to assimilate cloud observations into the model as initial conditions.

Satellite microwave remote sensing can observe various amounts regarding water including cloud, and is suitable for assimilation with model due to wide coverage and compatibility with model resolution. However, it is difficult to directly observe the cloud over the land from the satellite because land surface emissivity is so strong compared to the signal of cloud. Therefore we at first have to adequately represent the heterogeneity of land state, especially soil moisture distribution, estimate the surface emissivity, and then remove it as background information.

And of course, the accurate land state representation is important for lower boundary condition for atmosphere. In particular it has large influence on the mesoscale weather prediction through the interaction between land and atmosphere. Therefore, improving the reproducibility of land state in coupled land and atmosphere system using the satellite land data assimilation technique is both directly and indirectly valid for improving weather prediction.

However, now we have limited techniques about this (e.g. LDAS-A developed by Rasmy et al. 2010). On the other hand, models and observation techniques have been evolving rapidly, so to keep the system valuable it is critically important to flexibly update the system in response to them. Then we developed a satellite Land Data Assimilation System coupled with the Weather Research and Forecasting Model (WRF) (LDAS-WRF) based on LDAS-A.

GENERAL DESCRIPTION OF THE LDAS-WRF

In the LDAS-WRF, the whole system is controlled by coupler, main program. Land data assimilation system (LDAS), which is a part that assimilates soil moisture, consists of land surface model, the Simple Biosphere model version 2 (SiB2), radiative transfer model (RTM) and Ensemble Kalman Filter as a sequential data assimilation algorithm. The LDAS-WRF is composed by coupling WRF to this LDAS as an atmospheric driver. For observed data, microwave brightness temperature from AMSR-E is used.

The system flow is as follows:

- Coupler initialize the subsystems, setting up the initial and boundary conditions and configurations etc.;
- Coupler calls the atmospheric model, starts to integrate the model in three dimensions, and receives forcing data from atmosphere to the land surface, including precipitation, atmospheric temperature, pressure, and so on;
- Coupler passes the forcing data to the land surface model, makes initial ensembles of soil moisture, and starts to calculation of land processes in each grid;
- Coupler checks whether satellite observations corresponding to the time is available or not. If not available, Coupler again starts to integrate the atmospheric model;
- If available, Coupler reads the observation data and calls radiative transfer model, gets estimated brightness temperature. With estimated and observed brightness temperature, optimized soil moisture and error distribution are analyzed with EnKF algorithm;
- Coupler gives the improved soil moisture and fluxes to the atmospheric model and repeats the integration and assimilation cycle.

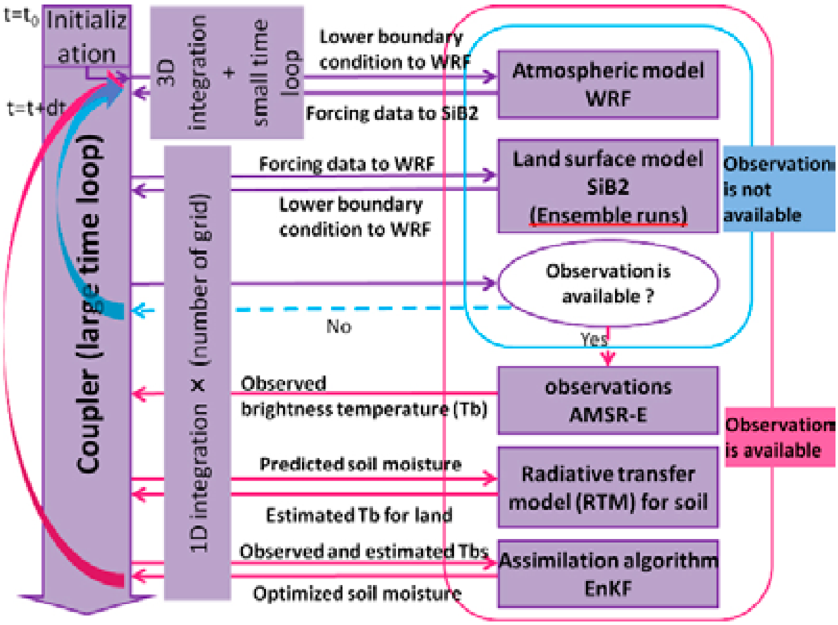


Fig. 1. Schematic figure of the system flow

EXPERIMENTS TO EVALUATE THE LDAS-WRF

SETTINGS

The LDAS-WRF was applied to a mesoscale region (82E – 86E, 30.5N – 33.5N) located around Gaize in the western Tibetan Plateau (Fig. 2). In this area vegetation is sparse without intense human activity, and the land-atmosphere interactions affect the atmospheric dynamics considerably, which is suitable for evaluation of the system. In-situ observations at Gaize (marked in Fig. 2) was used for validation. The target period was from May 20 to June 20, 2008. We conducted two experiments; with assimilation (the LDAS-WRF), and without assimilation (the WRF-SiB2).

RESULTS

Fig. 3 shows the time series of soil moisture and precipitation obtained from the experiments and observation. The blue line indicates the result of the LDAS-WRF, red line is for the WRF-SiB2, and the black line is for observed one. According to observation, in the first

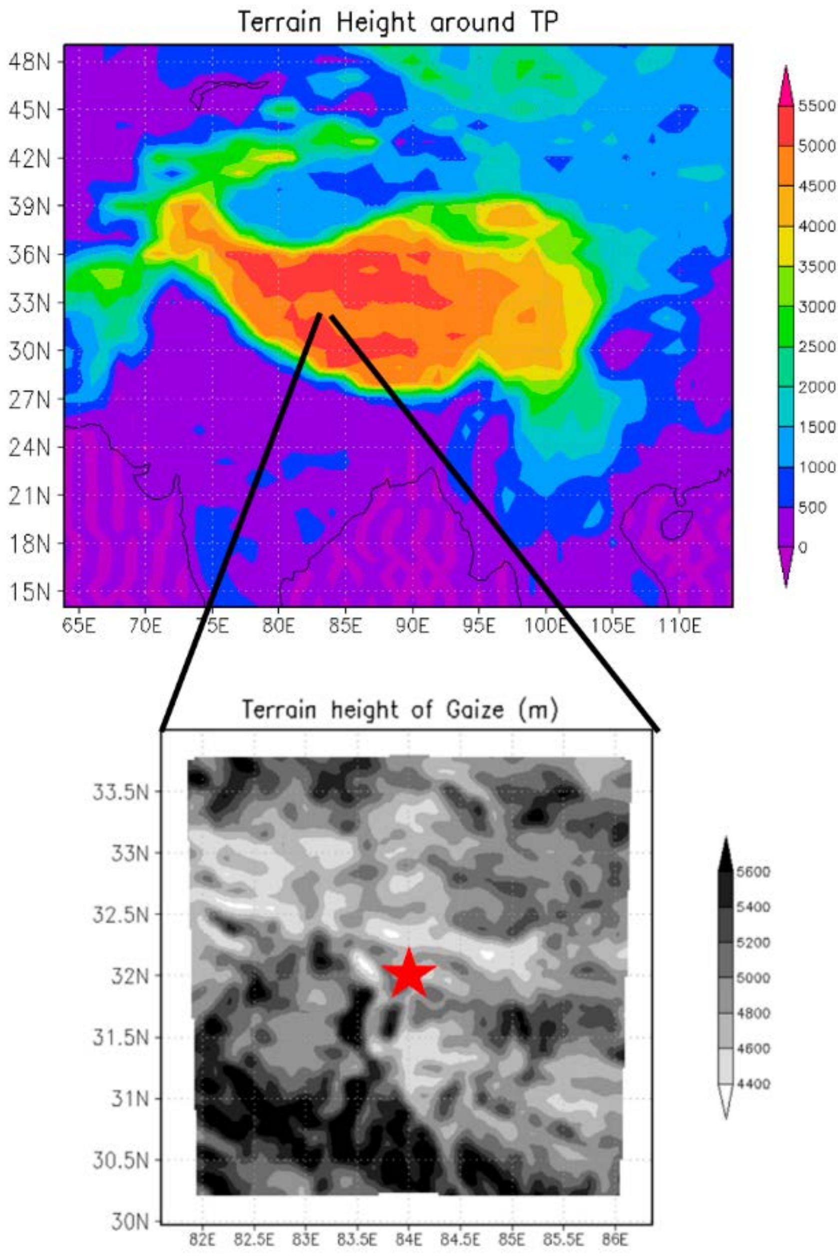


Fig. 2. Location of the Tibetan Plateau and Gaize

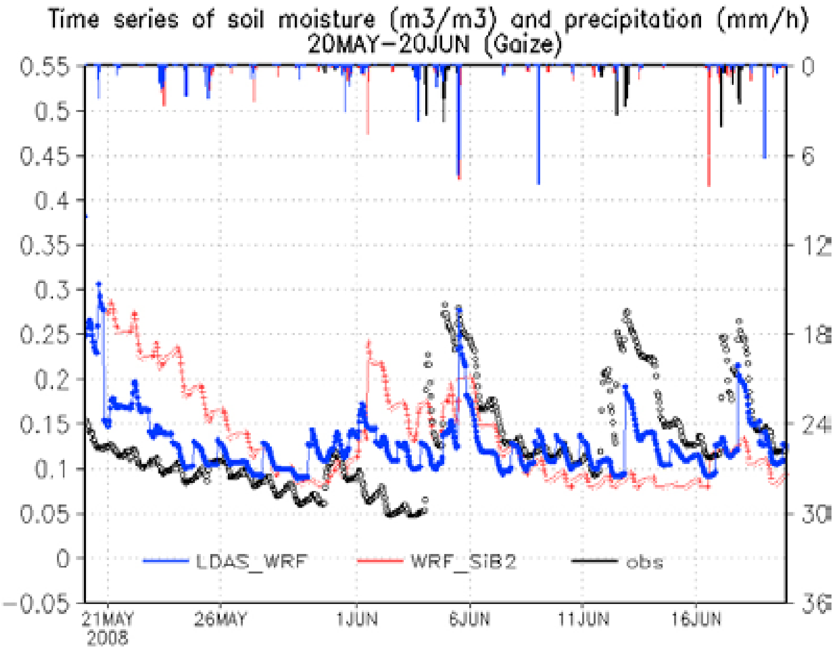


Fig. 3. Time series of soil moisture and precipitation

half of the period, the soil moisture remains low and after that increases roughly three times; on around June 6, 13 and 18. The LDAS-WRF successfully represented these time variation of soil moisture, while WRF-SiB2 couldn't show the actual pattern at all. The RMSE

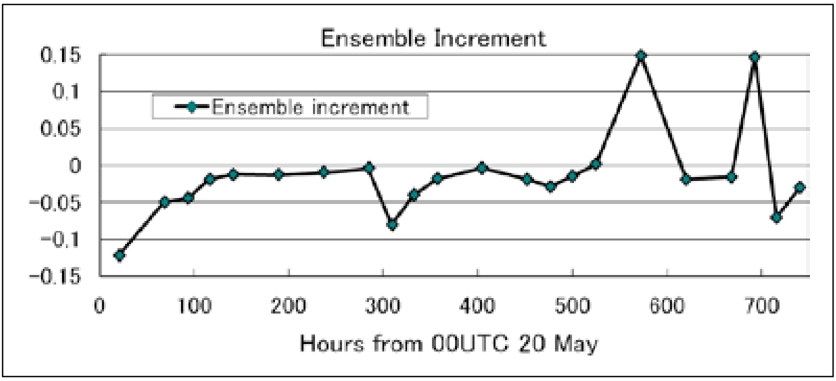


Fig. 4. Time series of analyzed increment

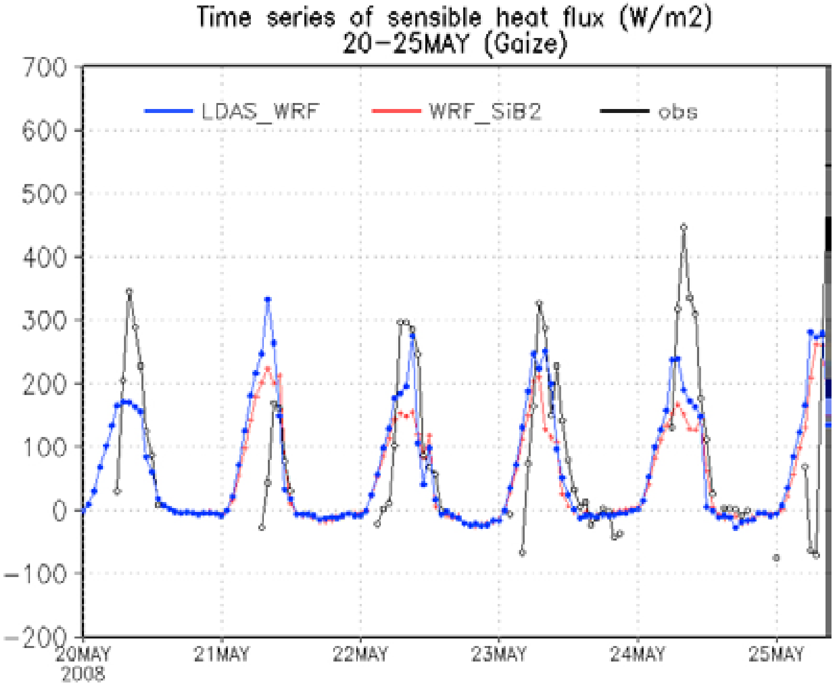


Fig. 5. Time series of sensible heat flux

throughout the period for the LDAS-WRF (0.0553) is better than that for the WRF-SiB2 (0.0835).

Fig. 4 shows the time series of analyzed increment, soil moisture change due to the assimilation. The horizontal axis of the figure is the number of hours from the beginning time. The assimilations were done about once a day. The increments show that the soil moisture was reduced considerably with the first assimilation, and kept at small value by negative increments during the first half of the period. On June 6, although soil moisture increased both in the LDAS-WRF and observation, the increment is almost zero. Therefore this increase is due to precipitation (Figure 3) in the model. On the other hand, on June 13 and 18, though there is little rain in the model, the soil moisture is increased to the value close to the observed one by assimilation.

Though only soil moisture was assimilated in the LDAS-WRF, energy fluxes and atmospheric profiles were changed keeping physical consistency in response to change of soil moisture (for example, time change of sensible heat flux from 20 to 25 May is shown in Figure 5). The effect of assimilation of soil moisture leads to better representations of other variables through land processes and its interactions with atmosphere.

SUMMARY

This study developed a satellite land data assimilation system coupled with WRF, to physically introduce the satellite observations of soil moisture and improve the representation of land surface and lower boundary conditions in Numerical Weather Prediction, toward accurate prediction of heavy rain as a final goal.

According to the numerical experiments in the Tibetan Plateau, we confirmed that the soil moisture was adequately assimilated and other variables were also improved. It was demonstrated that the LDAS-WRF has ability to apply satellite land observations to estimation of land conditions with high accuracy and provide more correct lower boundary condition to atmosphere in NWP.

REFERENCES

1. Seto, R., T. Koike and M. Rasmy (2013). Development of a Satellite Land Data Assimilation System Coupled with a Numerical Prediction Model, WRF. Ann. Jour. Hydraul. Eng., Japan Society of Civil Engineering, Vol.57 (in Japanese).
2. Rasmy M. et al. (2011). Development of a Satellite Land Data Assimilation System Coupled With a Mesoscale Model in the Tibetan Plateau. IEEE Trans. Geosci. Remote Sens., 49, 2847–2862.

All figures are clippings from the poster we used in the presentation at the 1st Russian–Japanese Collaboration Seminar for Sustainable Environment.

Sudesuriguge and Wataru Takeuchi
Institute of Industrial Science, the University of Tokyo

Meeting abstract of the presentation at the 1st Russian–Japanese Collaboration Seminar for Sustainable Development entitled:

Estimation of CH_4 emission from Siberian natural wetland by land surface dynamics characterization with remote sensing

INTRODUCTION

In this paper, snow cover changes from 2002 to 2012 and its relation to methane emissions were investigated in Siberian natural wetland. Snow cover amount and duration have a large role in both the natural and anthropogenic systems. Any changes in the climatology of the amount, duration, and timing of the snowpack may have long-lasting environmental and economic consequences [1]. Being one of the most important ecosystems, wetlands are presumed to be a source of methane emission. Methane emission always influenced by many reasons or environment conditions and it has complicate variation. Nowadays estimation methods by using passive remote sensing to approaching actual reality are come out one after the other even it is not easy to consider each of impact factors. Methane is a particularly effective greenhouse gas, and methane emission from arctic and sub-arctic are highly variable and poorly understood in terms of environmental controls.

Emission sources comprise anthropogenic activity, fossil fuel combustion, rice agriculture, livestock, landfill and waste treatment, and some biomass burning and natural sources such as wetlands, termites and the ocean [2]. Despite the importance of CH_4 emissions from the Siberian wetlands to the globally elevated CH_4 concentration since 2007, substantial uncertainties remain in estimating the

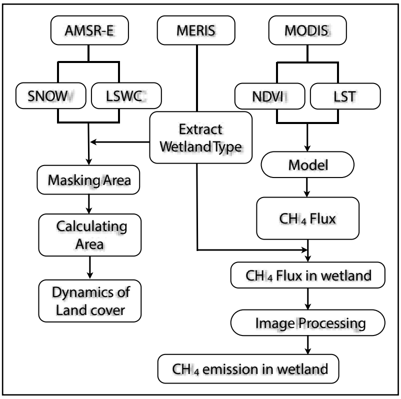


Fig.1. Framework of this study

Fig. 2. Siberian natural wetland

CH_4 fluxes and responses to climate change [3]. Land surface water and snow coverage have a good representability to climate change. Therefore, consider the climate change could have a good reference value when estimate the CH_4 emission.

Firstly, globcover land-cover map for the essential data, which is a product of MERIS from ENVISAT, was used to mask out the wetland distribution. Secondly, timing and duration of snow and water coverage were investigated and their areal changes were calculated from 2002 to 2012. Using average, the most value and other threshold value to find out the natural phenomenon of snow and water coverage in each year. Thirdly, apply the model as the NDVI and land surface temperature (LST) function by image processing to get the daily methane flux.

Finally, Snow and land surface water coverage (LSWC) behavior such as timing, duration and offset and onset date will be investigated from high confidence, valuable and density appearance of representative regions.

METHODOLOGY AND STUDY AREA

Data used in this study: 1) Product of MERIS from ENVISAT, has 300m resolution in WGS 84 map projection. It has 22 land-cover types in total and used type 110, 120, 130, 140, 160, 170 and 180 in this study to represent wetland; 2) LSWC and SNOW map (2003–2011),

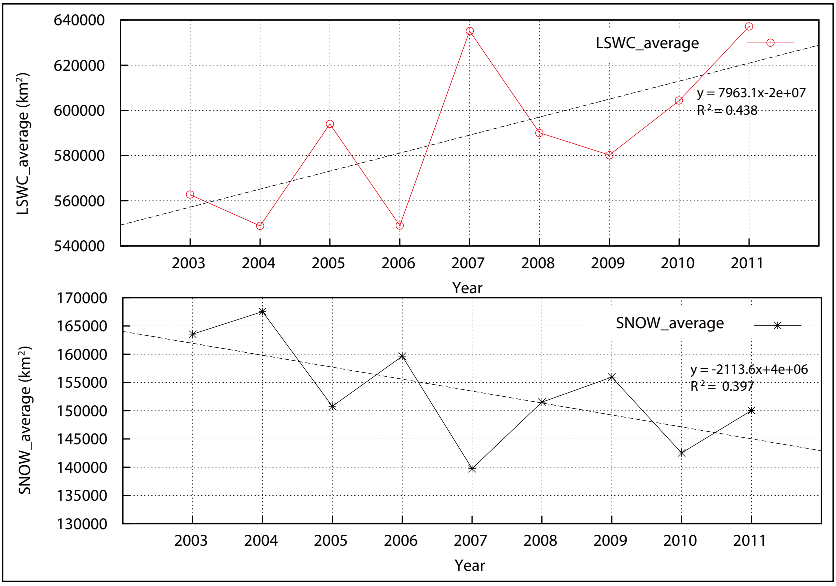


Fig. 3. Average value of each year of water and snow coverage

satellite image of AMSR-E, has 1km resolution in WGS84 map projection. In this study SNOW means snow coverage and LSWC means water coverage; 3) NDVI and LST image (2002-2012), satellite data from MODIS, 1 km resolution in WGS84 map projection.

RESULTS

SNOW AND WATER DYNAMICS

After calculating the area of snow and water coverage, Figure 3 shows the average area of each year. We could found that water coverage has raising trend and snow coverage has decreasing trend. Through comparing the changes, for water coverage, average area increased around 7.3% and snow coverage decreased around 12.9% in 2010 compare with 2003.

METHANE EMISSION ESTIMATION

F(NDVI) : $yCH_4 = 0.1505 \times NDVI + 33.371$ (1)

F(LST) : $yCH_4 = 0.4181 \times LST + 37.102$ (2)

Where, F (*NDVI*) represents methane flux as a function of NDVI (mg/

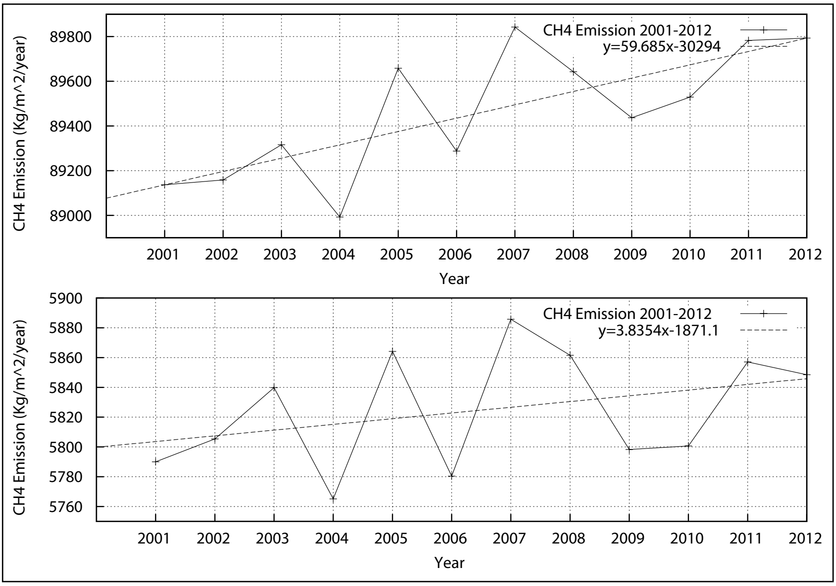


Fig. 4. CH_4 emissions from 2001-2012 as NDVI & LST function

km^2/day); F (*LST*) represents methane flux as a function of land surface temperature (mg/km^2/day).

Equation (1) and (2) were applied into image processing. The methane flux calculated with daily image, Figure 4 shows the total methane emission, (Kg/m^2/year) in Siberian wetland from 2001 to 2012. According those two same emission trends, the methane emissions were increasing in 10 years.

As LST function, mean methane flux in July and August in 2003 are 3.53 (mg/m^2/day) and 3.37 (mg/m^2/day); 3.52 (mg/m^2/day) and 3.37 (mg/m^2/day) in 2010. As NDVI function, mean methane flux in July and August in 2003 are 3.37 (mg/m^2/day) and 3.367 (mg/m^2/day); 3.37 (mg/m^2/day) and 3.34 (mg/m^2/day) in 2010.

VALIDATION

Here used the result published by Julia Schneider et al. In this literature, author use Lena Delta, located in Northern Siberia at the Laptev Sea coast between the Taimyr Peninsula and the New Siberian Islands as the study site.

Table 1. Comparison of the validation result and published data

Mean daily methane emission rates for July and annual emission rates for all land cover classes in the Lena Delta

Code	Class	Area	%	Mean daily emission July		Annual emission	
		km^2		$mg\ m^{-2}\ d^{-1}$	$10^6\ g\ d^{-1}$	$mg\ m^{-2}\ a^{-1}$	$10^6\ g\ a^{-1}$
WT	Wet sedge- and moss-dominated tundra	8277	28.5	16.8	139.1	1452.3	12,020.7
MT	Moist grass- and moss-dominated tundra	2173	7.5	17.2	37.4	1480.9	3218
NV	Non-vegetated areas	1697	5.8	0	0	0	0
MDD	Moist to dry dwarf shrub-dominated tundra	1832	6.3	58.4[a]	107	5048.5	9248.3
DMSD	Dry moss-, sedge- and dwarf shrub-dominated tundra	3519	12.1	0.4[b]	1.4	34.6	121.8
DG	Dry grass-dominated tundra	610	2.1	0.4[b]	0.2	34.6	21.1
DT	Dry tussock tundra	444	1.5	0.4[b]	0.2	34.6	15.4
WB	Water bodies	8894	30.6				
	Rivers and coastal waters	5886	66.2	0[c]	0	0	0
	Lakes (>0.36 ha=4 Landsat-7 pixel)	3098[d]	33.8				
	Thermokarst lakes on 3rd terrace	88.9[d]	3.0	–	–	24,000[e]	2213.6[e]
	All other lakes	2919.1[d]	97.0	3.1[f]	9.0	268	782.3
SW	Shallow water	1500	5.5				
	Vegetated lake margins and shoals	150	10[g]	43.3[h]	6.4	3480.8	553.9
	Sandbanks and shoals in rivers and along the coast	1431	90[g]	0	0	0	0
	Total	29,036	100	10.35[i]	308.7[i]	972.14	28,208.7

[a] Values for class MDD measured in June.
[b] Values adopted from Kutzbach and Kurchatova (2002); measured in the Lena Delta.
[c] According to Semiletov (1999) methane concentrations in the Lena Delta channels and offshore waters were close to his analytical measurement limit (~0.015 μM/l). We therefore set these emissions to zero.
[d] Area of lakes based on Morgenstern (2005).
[e] Value adopted from Walter et al. (2006); measurements cover the whole annual cycle, incl. winter emissions; measured in NE Siberia.
[f] Value adopted from Morrissey and Livingston (1992); measured in Alaskan North Slope region.
[g] Percentage ratio between subclasses is based on visual interpretation of the classification image and the Landsat 7 data.
[h] Values from this study, Wagner et al. (2003), and Spott (2003); all measured in the Lena Delta.
[i] Daily emissions of thermokarst lakes are not included.

Mean Methane emission (10^6 g/day)		
Year/Function	**July**	**August**
2003 / LST	63.9	62.3
2010 / LST	65.01	60.8
2003 / NDVI	62.1	63.7
2010 / NDVI	63.2	62.9

Through comparison, our estimation equations underestimated the methane emission (Table 1). In this referenced paper result, they show methane emission value from June to October. For convenient to compare, we have applied equations into same time period.

In our study, the area is 7128 km^2 in LST and 7099 km^2 in NDVI function. It is around 4 times smaller than the referenced area. The result in our study shows the value is around a quarter of reference value.

CONCLUSION

Through compare the reference value, the equations were overestimated. Except image processing problem, there are several probable reasons for concerning on the detail from this result. First, classify the land cover type is important beginning of whole study, because the rate of methane emission is quite depend on the land cover type. Second, the methane emission rates vary strongly among the individual land cover type. So that it is impossible to represents methane emission clearly and accurately. Third, determining the factors for methane emission, need to systematic investigate the extensive ancillary data such as soil moisture, soil composition, microrelief, biomass and so on. Fourth, it is better to combine with in-situ measurement data to develop and validate the estimation model.

To estimate methane emission, still have long way to go. Focus on modifying the equation or create new estimation model is the first important thing. Then will consider more impact factors such as precipitation, soil condition and biomass, run Forest-DNDC (denitrification and decomposition) model to estimate the wetland methane emission. After all estimating work, will combine with GOSAT and SCIAMACHY data to understand more knowledge about vertical characters of methane emission.

REFERENCES

1. Tryhorn Lee, Art De Gaetanoa (2012). a methodology for statistically downscaling seasonal snow cover characteristics over the Northeastern United States // International Journal of Climatology. 10.1002/joc.3626.
2. IPCC (2007). Climate Change 2007: the physical science basis, contribution of working group I. In: The Fourth Assessment, Report of the Intergovernmental Panel on Climate Change (S. Solomon, D. Qin, M. Manning, Z. Chen, M. Marquis, and co-editors (eds.). New York: Cambridge University Press. 996 p.
3. Sasakawa M., A. Ito et al. (2012). Annual variation of CH_4 emissions from the middle taiga in West Siberian Lowland (2005–2009): a case of high CH_4 flux and precipitation rate in the summer of 2007. The International Meteorological Institute in Stockholm, DOI: 10.3402/tellusb.v64i0.17514.
4. Sass, Ronald L. et al. (2002) Spatial and temporal variability in methane emissions from rice paddies: Implications for assessing regional methane budgets. Nutrient Cycling in Agroecosystems 64: 3–7, 2002.
5. Schneider Julia, Guido Grosse, Dirk Wagner (2009). Land cover classification of tundra environments in the Arctic Lena Delta based on Landsat 7 ETM + data and its application for upscal-

ing of methane emissions, Remote Sensing of Environment 113 (2009), p. 380–391.

6. Macdonald J.A., et al. (1998). Methane emission rates from a Northern wetland; Response to temperature, water table and transport // Atmospheric Environment. Vol. 32, No. 19, p. 3219–3227.
7. Bartlett, Karen B. and Robert C. Harris. (1993). Review and assessment of methane emissions from wetlands // Chemosphere. Vol.26, Nos. 1–4, p. 261–320.
8. Tchebakova N.M., G.E. Rehfeldt, and E.I. Parfenova. (2010) From Vegetation Zones to Climatypes: Effects of Climate Warming on Siberian Ecosystems, Permafrost Ecosystems: Siberian Larch Forests // 427 Ecological studies. Vol. 209, DOI 10.1007/978-1-4020-9693-8_22.
9. Sudesuriguge and Wataru TAKEUCHI. (2012). Estimation of CH_4 emission of wetland from thawing permafrost in northern countries. In: 33th Asian Conference on Remote Sensing.

All figures are clippings from the poster we used in the presentation at the 1st Russian–Japanese Collaboration Seminar for Sustainable Environment.

Yushi Suzuki, Toshio Koike
Department of Civil Engineering, the University of Tokyo
Meeting abstract of the presentation at the 1st Russian–Japanese Collaboration Seminar for Sustainable Development entitled:

Estimation of economic impact of drought by the integrated model for promoting investment in disaster prevention

INTRODUCTION

We presented our research concept about economic impact caused by drought by integrating eco-hydrological model and development economic model as a poster presentation in the 1st Russian–Japanese Collaboration Seminar for Sustainable Environment. This article briefly summarizes the poster presentation describing our research motivation, methodology, and future vision.

The motivation of our research derives from two issues; climate change and sustainable development. First, according to IPCC4, extreme meteorological events such as drought is likely to increase in the future because of climate change. Drought induces various influence and harms the economy on a region. On the other hand, disasters prevent economy from growing sustainably. In addition, disaster is considered to expand economic gap because poor classes are vulnerable to disasters in general and once they undergo a disaster they cannot recover their livings easily. Therefore, investment in disaster prevention is important to achieve sustainable development. However, nonexistence of the method to estimate the effect of investment in disaster prevention previously seems to lead low priority of investment in disaster prevention.

Our research objective is to assess the impact of drought and the effect of investment in disaster prevention in economic indices so as to facilitate investment in countermeasures against drought by integrating a land surface-dynamic vegetation model and a dynamic stochastic general equilibrium (DSGE) model.

METHODOLOGY AND STUDY AREA

The land surface-dynamic vegetation model mainly consists of the land surface model, LDAS-UT [Yang et al., 2009], and the dynamic vegetation model [Sawada and Koike, 2013]. It can calculate soil moisture, leaf area index, and brightness temperature. It can estimate these values of all places on the earth because it does not require any in-situ observation data for input.

DR2AD [JICA, 2013] is a development economic model that can estimate the effect of investment in disaster prevention by considering the relationship between economic growth and disaster prevention. To describe chronological transitions such as accumulation of human capital, DSGE model is adopted.

In our research these two models will be coupled and calibrated. After calibration, the model will be applied to the future case by using GCM outputs. By comparing the results of cases with or without investment in disaster prevention the effect of the investment will be demonstrated. Fig. 1 shows the research flow.

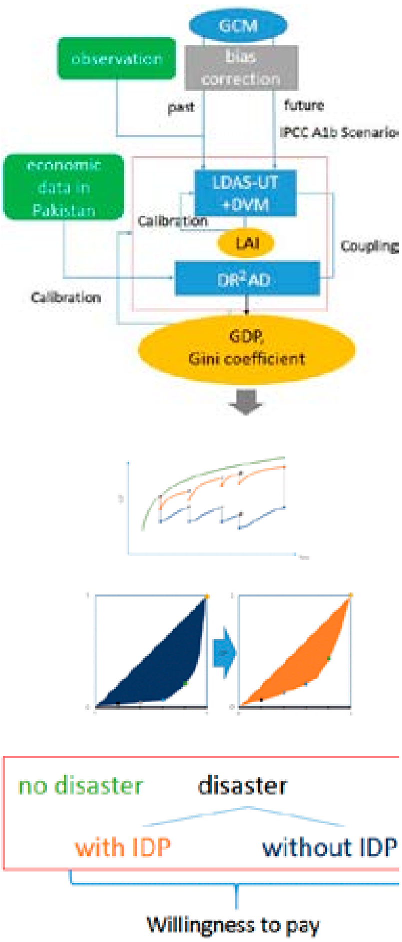


Fig. 1. Research flow

This model will be applied to Indus river basin, Pakistan, South Asia. The climate there is strongly affected by the monsoon and has recently tended to go extreme because of climate change. In addition, the economy in Pakistan seems to be subject to water resource or soil moisture deficit because agriculture is main industry in the country.

FUTURE VISION

Drought exerts bad influence on economy in the region not only by a crop failure but also by domestic water deficit, deterioration in condition of hygiene and so on. Therefore, we have to consider other type of impact caused by drought in order to acquire more reliable estimation for demonstration of the effect disaster prevention investment. For example, integration of distributed hydrological model such as WEB-DHM [Wang, et al., 2009] and the economic model may enable us to evaluate the impact of water resource deficit on the economy by calculating river discharge.

CONCLUSION

Objection of our research is to develop coupled land surface-dynamic vegetation and development economic model in order to calculate the damage caused by drought and the effectiveness of disaster prevention investment. Furthermore, we also aim at promotion of investment in prevention against drought by comparing model outcomes with or without disaster prevention investment. The model will be useful to make a decision to invest disaster measures.

REFERENCES

1. Lu H., Koike T., Yang K., Tsutsui H., Tamagawa K. (2009). Estimating Land Surface Energy and Water Fluxes by Using the Land Data Assimilation System developed at the University of Tokyo (LDASUT). Proceedings of 2009 IEEE International Geoscience & Remote Sensing Symposium (IGARSS09). P. 666–669.
2. Sawada Y. and Koike T. (2013). Development of a distributed hydrological — dynamic vegetation coupling model and its application to North Africa, Ann. Jour. Hydraul. Eng., Japan Society of Civil Engineering. Vol.57 (in Japanese).

3. Japan International Cooperation Agency (2013). A Proposal to link Disaster Risk Reduction to Sustainable Development — DR2AD Model VERSION 1.0. Japan International Cooperation Agency. http://www.jica.go.jp/english/news/field/2013/c8h0vm00006ug62h-att/130628_01.pdf (accessed 2013-11-15).
4. Wang L., Koike T., Yang K., Jackson T., Bindlish R., Yang D. (2009). Development of a distributed biosphere hydrological model and its evaluation with the Southern Great Plains Experiments (SGP97 and SGP99), Journal of Geophysical Research-Atmospheres. 114, D08107, doi:10.1029/2008JD010800

All figures are clippings from the poster we used in the presentation at the 1st Russian–Japanese Collaboration Seminar for Sustainable Environment.

Hideki Yaginuma
Department of Civil Engineering, the University of Tokyo

Meeting abstract of the presentation at the 1st Russian–Japanese Collaboration Seminar for Sustainable Development entitled:

A new road project evaluation methods considering earthquake disaster

INTRODUCTION

Transport network and its facilities were extensively damaged by the Great East Japan Earthquake of March 2011 (Fig.1). This teach a lesson that roads has the significant responsibility of acting as transport networks for stricken areas in a variety of activities such as the evacuation and rescue of civilians and the transportation of support materials.

In Japan, road project assessment has conventionally been based on cost/benefit analysis. However, the roles played by roads have now become more diverse and the current cost/benefit analysis-based assessment method is no longer necessarily appropriate for evaluating their disaster mitigation functionality. Japan's Ministry of Land, Infrastructure, Transport and Tourism (shortly MLIT) drew up evaluation method for assessing the disaster mitigation functionality of roads (provisional draft) in 2012.

The purposes of this study review the applicability of the new assessment method developed in Japan for evaluation of disaster mitigation. Especially, this study focuses on the two provisional version models (Model I and Model II) provided by MLIT.

NEW PROJECT EVALUATION METHODS

A method for assessing the disaster mitigation functionality of roads (provisional draft) has two models. Model I describes the evaluation for improvement of disaster mitigation effects between major nodes

Fig. 1. Road damaged by 3.11 earthquake

such as cities, bases and so on. On the other hands, Model II describes the evaluation for disaster mitigation for the entire network.

MODEL I: QUALITATIVE ASSESSMENT OF DISASTER RESISTANCE AND MULTIPLICITY

In this model, the assessment of intercity links is based on qualitative indices from the viewpoints of disaster resistance and multiplicity as described below.

Disaster resistance:

Main routes (i.e., those providing the shortest travel time or distance between certain cities) with no sections that may become impassable in the event of a disaster are assessed as disaster-resistant. Sections that may become impassable include those where tsunami damage, landslides caused by earthquakes or local downpours, avalanches, etc. may occur.

Multiplicity:

Disaster-resistant routes with a detour ratio of no more than 1.5 times the distance of the route itself are assessed as having multiplicity. For the detour ratio, the smaller of the time/distance values is used.

From these two viewpoints, each intercity link is rated A (highest), B, C or D (lowest) in terms of disaster resistance and multiplicity, and road improvement is started from those rated D.

MODEL II: QUANTITATIVE ASSESSMENT OF TRAVEL TIMES

In this model, the assessment of quantitatively measures the degree of improvement in disaster mitigation over the entire network based on the degree of travel time reduction brought about by road (link) improvement. This model has two index that is degree of weakness a^i of each link i and degree of improvement K^i defined by index a. These formulas as follows:

Degree of weakness with improvement

$$\alpha_w^i = T_w^i / T_{o_1}^i ,$$

Degree of weakness without improvement

$$\alpha_o^i = T_{o_2}^i / T_{o_1}^i , \quad K^i = \alpha_o^i / \alpha_w^i ,$$

where, t^i is travel time in the event of disaster case, with and without improvement of link i. It define as follows:

$$T_*^i = \sum_j t_j \, \delta_j ,$$

t_j: Travel time from municipal office j

δ_j: 1 if the route from ^{j} passes through ^{i}, 0 otherwise.

Current status	→	(Target) after improvement	Assessment:
D	→	B	very good

Table 1. Change in assessment value before and after road improvement

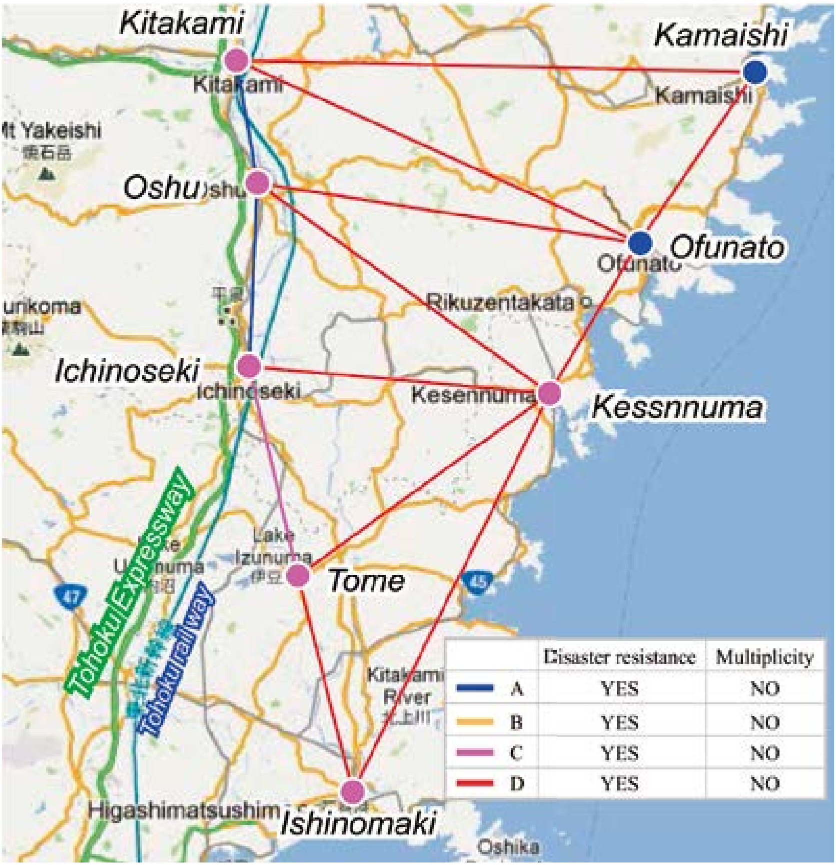


Fig. 2. Image of links between major bases and application results of Model I

APPLICATION RESULTS

Fig. 2 shows application results of Model I in pref. Iwate Tohoku region. Table 1 shows the comparison of ranks in Ofunato-kesennuma section and ranks a change from D to B with the improvement. Fig. 4

and Fig. 5 show the assessment of rank ratios each model in 4 different regions (Fig. 3).

Fig. 3. Locations of regions

CONCLUSIONS AND FUTURE WORKS

Japan now has two new indices that differ from the cost/benefit analysis (B/C) assessment index used around the world. It is important to decide how to combine these indices in road project assessment.

The draft outlined by MLIT in the summer of 2011 is provisional, and improvements, both in theory and practice should still be brought forth.

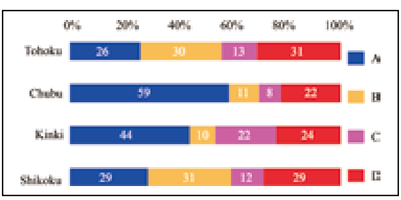


Fig. 4. Assessment rank ratios (Model I)

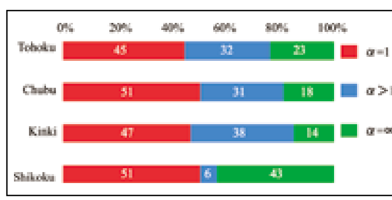


Fig. 5. Assessment rank ratios (Model II)

REFERENCES

1. Iead Hitoshi, Tetsuya Yamada, Tohru Tamura, and Kiyoshi Takahashi. (2013). A New Scheme for Evaluating Road Projects by Considering Their Effects after Disasters: Challenges Faced by Japan since the Great East Japan Earthquake of March 2011, Proceedings of the 10th EASTS Conference 2013 in Taipei, China.

All figures are clippings from the poster we used in the presentation at the 1st Russian–Japanese Collaboration Seminar for Sustainable Environment.

I. Akylbekova, T.Yu. Zengina
Department of Nature Management, Faculty of Geography, Lomonosov Moscow State University

Mining badlands in the urban land use structure (the case of Karaganda city, Kazakhstan)

Given the growing shortage of urban land resources for residential, public, commercial and industrial construction, recreation and natural rehabilitation purposes, the disturbed urban lands are an important reserve for further spatial development of residential areas.

Creation of mining badlands is the biggest environmental challenge faced by mineral mining projects. The issue of restoring disturbed lands becomes most pressing for mining on urban lands.

The city of Karaganda, located in the central Kazakhstan, was founded in 1934 from several workers' settlements built there to accommodate the workforce involved in the development of the Karaganda coal field. Today, Karaganda is the country's largest industrial centre.

The initial construction of the city saw an explosive and chaotic growth of settlements located near active mines, which resulted in residential areas being in immediate proximity to industrial facilities.

As it was, the ten largest mines of the coal field (Pyatidesyatiletiye Oktyabrskoy Revolutsii; Kuzembayeva; Gorbachova; Bayzhanova; Kostenko; Kirovskaya; Stakhanovskaya; Severnaya; Maikudukskaya; Karagandinskaya) and two concentration plants (Soburkhandskaya and Karagandinskaya) ended up within the city limits. The Kostenko and Kirovskaya mines are currently active and continue to operate inside the city.

In order to identify existing industrial badlands and study environmental issues of coal mining, a current land uses in Karaganda were mapped. Images of disturbed lands at the Kostenko mine taken from deciphered high-definition satellite photography were subjected to a more detailed examination. A series of maps of different scale allowed for a quantitative assessment of the disturbed urban acreage and an analysis of such lands' spatial features. The materials of this study will be used in the development of recommendations for ecological and functional zoning of the city and for an ecological and economic substantiation of land reclamation activities. The results of the study may also help in making a more accurate computational and statistical assessment of the environmental factor's impact on the value of land plots in Karaganda.

As Karaganda's history is closely related to the development of coal plots, the city is scattered over a large area and is comprised of six remotely located districts: Stary Gorod ('Old Town'), Novy Gorod ('New Town'), Yugo-Vostok ('South-East'), Maikuduk, Prishakhtinsk and Sortirovka.

Urban lands within Karaganda total 51.9 thousand hectares [1]. In terms of utilisation purposes, the lands are divided into the following categories:

- Agricultural lands: 8.9 thousand hectares (17%);
- Residential lands: 18.8 thousand hectares (36%);
- Industrial, transport, communications, defence and other non-agricultural purpose lands: 16.1 thousand hectares (31%);
- Forest lands: 4.4 thousand hectares (9%);
- Reserved lands: 3.7 thousand hectares (7%).

The lands within the coal-bearing part of the city (the eastern part of the Karaganda coal field) is used for industrial, agricultural, residential and recreational purposes. Currently, the coal-bearing territory hosts the following facilities:

- Tower blocks and numerous detached houses with household plots in Novy Gorod;
- Industrial facilities (mines, concentration plans, water treatment facilities etc.);
- Summer houses and forested lands;
- A protected common pine plantation (a state natural monument).

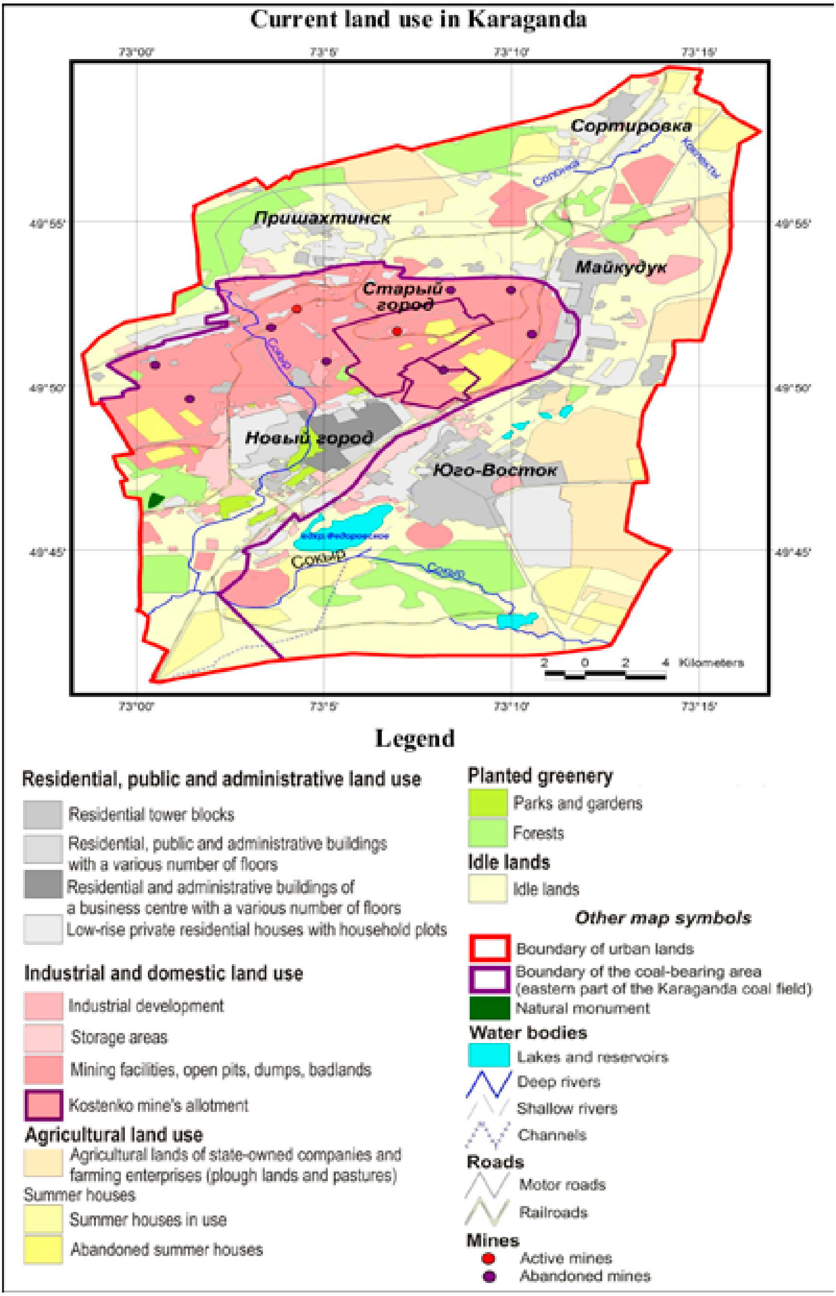


Fig. 1. Current land use in Karaganda

At the same time, the city is the home for a large area of bad and disturbed lands, which include depleted and operational pits and minefields; overburden and wallrock dumps, slime ponds, unauthorised waste dumps and solid domestic waste landfills [2].

The current spatial features of the mining badlands were reflected on the map of current land use in Karaganda, which we developed (Fig. 1). The map was created by means of geoinformational mapping techniques with the use of modern GIS packages. The base image for the map was a 2009 base map of Karaganda at a scale of 1:25 000. The boundaries of digitalised lands and facilities were validated and updated through deciphering of satellite imagery at a scale of 1:100 000 and 1:200 000 (Fig. 2).

In particular, abandoned and active groups of summer houses were identified, boundaries of residential areas were updated, and new layers (roads, rivers, greenery) were added. These exercises enabled us to estimate the surface area of mining badlands and their share in the city's land balance.

It was established that the mining badlands cover 26.3 thousand hectares of urban lands and account for 50.6% of the city's total area. It should be noted that the central part of the city is represented by mining facilities, pits, dumps and badlands, which border the densely populated Novy Gorod district.

Also, a general conclusion was made that the city lacks greenery. The existing system of plantations (forests, parks and gardens) has low qualitative and quantitative indicators [2].

Forested lands have an uneven layout and cover rather small areas. In light of strong winds, flattened landscape and dusting from existing dumps, the city's residential areas must be walled with a belt of wind breaking trees.

More detailed examination of the mining badlands was also conducted based on reconnaissance routes around the mining allotment of the Kostenko mine, which is located in the eastern part of the Karaganda coal field and is within the city's urban territory.

Currently, the Kostenko's mine allotment includes the abandoned Stakhanovskaya mine. Total land use area is 1340.3 hectares. Following years of coal mining within the allotment, the land surface

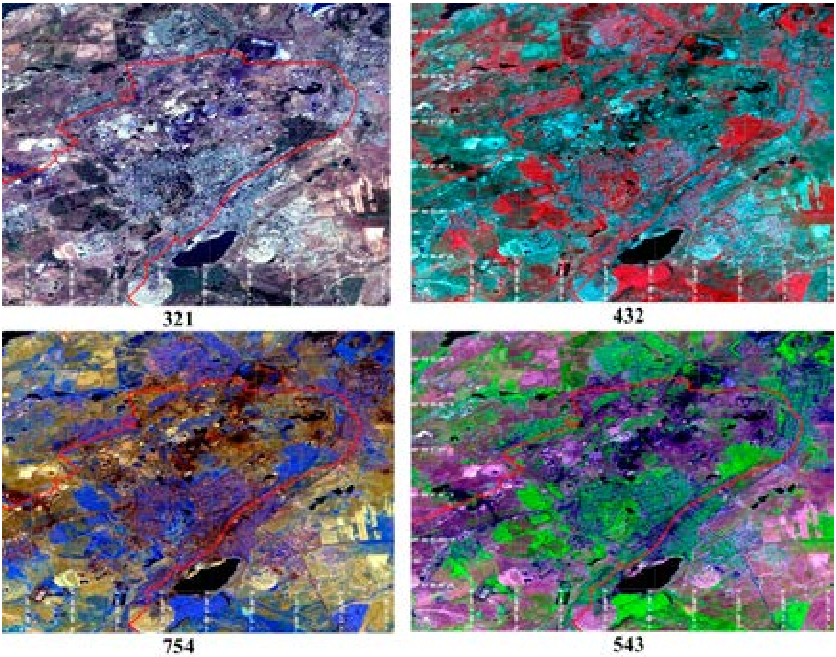


Fig. 2. Fragments of the synthesized satellite images on the Karaganda coal basin's north-east territory (satellite "LANDSAT-7", camera ETM+) (*signatures under fragments of satellite images indicate band numbers used for synthesizing; red line indicates the Karaganda basin's coal-bearing boundary*)

has deformed significantly, and various technogenic disturbances took place.

For instance the landscape at the Kostenko mine's industrial area is represented by an uneven surface of dumps, numerous flooded and dry sinkholes and depressions, heaps of construction and domestic waste, earth banks and pits. Land subsidence caused by extraction of coal from underlying rocks created extensive sag ponds (or flooded sinkholes) throughout the mining allotment, especially along motor roads. Local vegetation is highly degraded, with small patches of green areas with previously planted fruit trees and shrubs observed only near summer houses, which had been abandoned following the mining-induced subsidence and flooding of the territory.

The south-western part of the mine hosts storage facilities and residential houses belonging to the city's Novy Gorod district. The Stary Gorod district is partially located within the mine's 700 metre sanitary protection zone and is represented there by private households. Aside from the coal mining complex, the allotment also includes mothballed facilities of abandoned mines and other industrial companies like the Gornye Mashiny ('Mining Machines') plant, the Parkhomenko plant and others.

As was established, the total area of disturbed lands within the mining allotment is 417.36 ha or 30% of the total land use area of the mine. Technically restored lands cover 18 hectares, i.e. just 5% of the total disturbed area [3].

Today, restoration of mining badlands of the Karaganda field is mainly done for sanitary purposes. However, we believe that reclaimed lands would be better suited for recreational purposes. For instance, the abandoned Stakhanovskaya mine, which has been re-planted with greenery, could well be transformed into a public garden or park as the city suffers a shortage of planted lands.

Therefore, given that the city is partially located within the industrial coal mining zone, the improvement of Karaganda's current planning system requires special approaches that would provide for the development of an effective system of measures to reclaim disturbed urban lands and modify their designated purpose.

Restoration of economic utilisation of abandoned lands is the main objective of determining the long-term outlook for the spatial development of the city and developing socio-economic development programmes (primarily, the new Master Plan).

REFERENCES

1. Report by the Karaganda regional land relations department on availability of lands with an indication of their categories, owners and users in Karaganda on the state of 1 November 2009.
2. Explanatory note of the Karaganda Master Plan, 2007.
3. Environmental impact assessment of industrial activities at the Kostenko mine in 2009. Issued by LLP "Ekoekspert", 2010.

S. Chalov[1], G. Mouri[2], D. Shkolny[1],
A. Tsyplenkov[1], E. Belozerova[1]
[1] Lomonosov Moscow State University, Russian Federation
[2] The University of Tokyo, Japan

Sediment transfer in the extreme volcanic environment (case study of the Kamchatka peninsula)

INTRODUCTION

Insufficient understanding of the interaction of numerous factors, including both climate, precipitation (both average and peak), discharge (volume and velocity), basin geology, human impact, and the size of the drainage basin [3] underlie wrong conclusions regarding seaward flux of fluvial sediment. Estimates of sediment transport rate are widely known to have large uncertainty [2]. Sediment fluxes from small mountainous rivers (e.g., western South and North America a most high-standing oceanic islands), have been greatly underestimated in previous global sediment budgets, perhaps by as much as a factor of three [1]. In case of volcanic environment many of sediment discharge drivers (e.g. loss of surface materials by the erosional forces) are significantly increased in comparison with other mountains areas, the fact that could lead to even more serious underestimates. Sediment transport in and to river channels in volcanic mountainous terrain widely presented in Pacific region (including areas of the Russian Federation and Japan) is strongly influenced by climate condition, particularly when heavy precipitation and warmer climate triggers a mud flow in association with snow melting in the catchment volcanic area. High porosity of the channel bottom material leads to the interactions between surface and ground water which causes temporal variability of water and sediment flow. Rivers flowing from glacier-clad Quaternary

GLOBAL SCALE

- Hydrometerological data analyses since 1950
- Data Reanalysis and downscaling on 5 arc minute spatial resolution
- IPCC scenarious

CATCHMENT SCALE

- GIS-based inventory of vegetation, soils and sedimentological patterns
- 137Cs inventory
- Sediment budget modelling (SEDNET)

RIVER NETWORK SCALE

- Water flow and water quality long-term statistical analyses
- Hydrogeochemical field campaigns

Fig. 1. Concept of Physical-Based Sediment Budget Model for the lumped volcanic watersheds

volcanoes have high sediment loads and anabranching and braided planforms. Their floodplains aggrade in response to recurrent large landslides on the volcanoes and to advance of glaciers during periods of climate cooling. Whereas some research was devoted to the eruption-induced snowmelts and associated increases of snow-melt type mudflows, the sediment loads of the rivers perturbed by former and recent volcanic debris flows are remains unclear.

Main purpose of this research is to provide empirical data for recent sediment transport estimates from volcanoes flanks and then to develop a physical-based sediment budget model in a lumped watershed system.

METHODOLOGY AND STUDY AREA

This research focuses on the sediment transport of rivers draining slopes of Avachinsky volcano which is located at Kamchatka peninsula. As far as no long-term hydrological data is available for the rivers draining volcanoes, the main purpose of the study is field-based assessments of water and sediment discharges within case study river length is about 25 kilometers. Water discharges, levels, suspended sediment concentration (SSC), turbidity, sediment load were measured at the gauging station 4–12 times daily depending on hydrological condition in 2007, 2010, 2012 and 2013. Total amount of gauging station was 12 along the river and its tributaries.

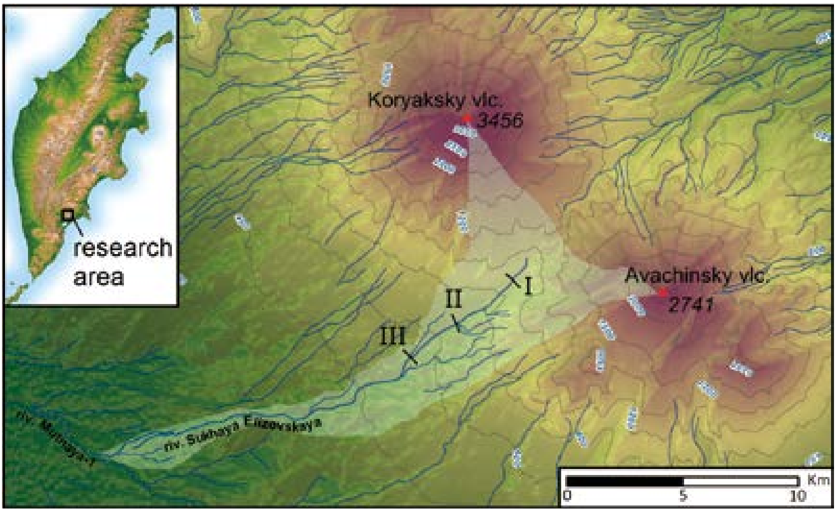


Fig. 2. Location of gauging stations (I, II, III) along Sukhaya Elizovskaya river (watershed is highlighted)

The proposed sediment budget model keeps the advantages in fast simulation of lumped models. Sediment Budget Model, which is developed in this research, concern about the soil erosion and volcanic landslides (lakhars) into account, and compute the surface runoffs and sediment runoff to simulate the long-time scale movement.

RESULTS

Sediment transport is determined by diurnal, within-year and long-term regime of water flow fluctuations. Diurnal oscillations reflecting variations in the melt rate of snow and ice in the basin are superimposed by the numerous short-lived discharge fluctuations of irregular periodicity and magnitude. Due to the increase of water flow at the daily time the sediment transport increases up 10 times along mountain channels and up to 1000 times in the lahar channel. The short-term fluctuations are explained by either damming of the river by collapsed ice and further dam bursting, or filtration of the surface water. Along the lakhar channel the 15–20 minutes fluctuation of water and sediment flow is observed with 2–3 orders of magnitude (Fig. 3 up). Water and sediment flow fluctuations have a strong

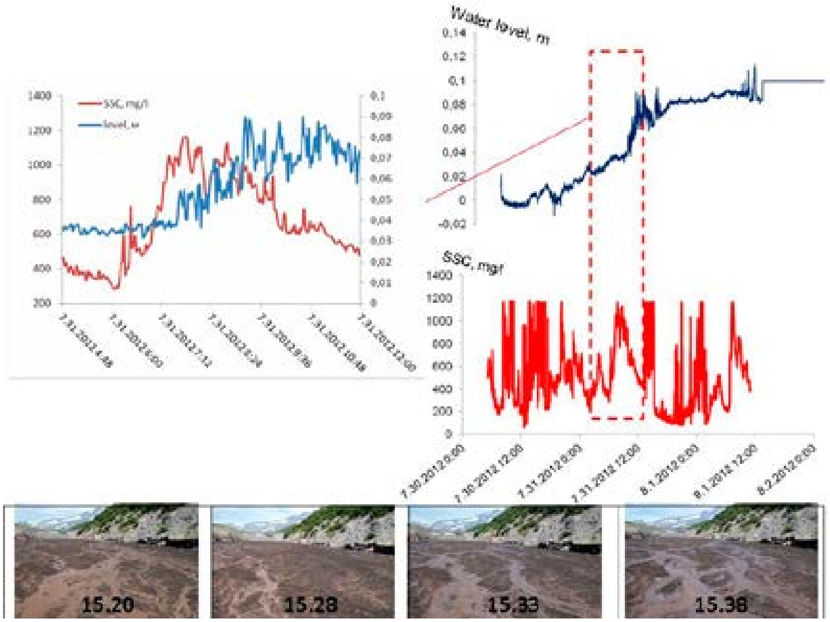


Fig. 3. Short-term fluctuations of water level (level, m) and suspended sediment concentrations (mg/l) (*up*) and related fast channel changes (*down*) of the Sukhaya Elizovskya river (summer 2012)

impact on channel behavior. Channel aggrade in response to recurrent large landslides on the volcanoes and associated glaciers and snowpacks melting. Typical anabranching and braided planforms shift their structure due to related material delivery (Fig. 3 down).

Results show that most sediments are introduced during extreme flood events owing to snow melting, and thus extreme rain events that now accompany climate change are very important in sediment supply. Snow melting-related sediment disasters can be accurately validated using water- and sediment-dynamics models that are founded on realistic geo-morphological characteristics and sediment flux of rivers. We tried to put all these phenomena into the conceptual model to estimate of the sediment delivery from the volcano slopes into the river system. These preliminary results indicated up to 30% contribution from the volcano flanks into the total seaward flux of fluvial sediment in the region.

CONCLUSION

The research follows the needs of clear understanding of the sediment patterns within the rivers of the Kamchatka peninsula as far as the increase of various human activities (road constructions, mining etc.) alters stream hydrology. We document and attempt to explain sediment origin, patterns and modes of transport along the river valley. The method used in this study can reveal the effects of volcanic environmental improvement policies applied individually or simultaneously as multiple measures, which can compound improvement effects. The method can also be used for evaluations from the perspectives of various users, which can help multiple interest groups reach suitable agreements and decisions. Through the method introduced here, the implementation of best management practices should become more possible. Uncertainty, particularly regarding volcanic environmental changes, is represented by probabilistic linkages. Further modelling efforts are underway to define the interactions among catchment management, volcanic environmental systems, disaster prevention, and economic values in the form of conditional probabilities. Changes in future climate will influence soil erosion, particularly suspended sediment (SS) yield, with a special magnitude in the volcanic areas, resulting in challenging needs for the understanding and modelling of the sediment transfer in the Pacific coasts of Russia, Japan and adjacent countries.

REFERENCES

1. Milliman J.D., Syvitski J.M.P. 1992. Geomorphic/tectonic control of sediment discharge to the ocean: the importance of small mountainous rivers // Journal of Geology, 100: 525–544.
2. Schmelter M.L., Erwin S.O., Wilcock P.R. 2012. Accounting for uncertainty in cumulative sediment transport using Bayesian statistics // Geomorphology, 175–176: 1–13.
3. Syvitski J.P.M. 2011. Global sediment fluxes to the Earth's coastal ocean // Applied Geochemistry, 26: 373–374.

A.G. Goretskaya, A.V. Evseev
Department of Nature Management, Faculty of Geography, Lomonosov Moscow State University

Experience in using natural display in preparing students geo-ecologists

Sustainable development problems are in the focus of attention during the last decade. Society composition must correspond to natural resources supply of a territory, resource and environment functions reproduction of geo- and ecosystems, their resistance to antropogenic impact. This concept presents the fundamentals of training lecture courses dealing with processes of environment changes and their influence on population living conditions and life quality. Environment pollution is an actual problem for the World and its studies attract great attention. These facts are reflected in the training process. Lecture courses "Ecological monitoring", "Fundamentals of biological monitoring and bio-indication", "Methods of field and laboratory investigations" were developed at the department of Rational nature management, Geographical Faculty, Lomonosov MSU. They acquaint students with methods of environment media indication aimed at receiving information about pollutants penetration and accumulation for the sake of ecological assessment of a territory. Lecture courses are followed by field practical training in different regions (the Kola peninsula and the Crimea). Technogenic soils, surface waters, bottom sediments, higher and lower plants pollution is studied by indication methods (Fig. 1).

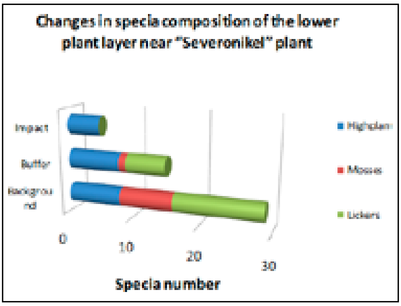


Fig. 1. Changes in specia composition of the lower plant layer near "Severonikel" plant

Tab. 1. Typical metal concentration in plants-biomonitors in background arctic regions (mKg/g, dry weight)

Species	**Fe**	**Cu**	**Zn**	**Pb**	**Cd**	**Ni**	**Co**	**Sr**
Cladonia sp.	150,0	1,5	15,0	2,0	0,2	1,0	0,2	0,4
Cetraria sp.	130,0	4,5	25,0	3,0	0,1	2,0	0,2	1,0
Sphagnum sp	800,0	3,0	20,0	4,0	0,3	4,0	0,5	2,5
Politrichum sp.	200,0	10,0	30,0	4,0	0,15	5,0	1,0	2,0
Pleurosium Sgreberi	400,0	12,0	40,0	5,0	0,2	2,0	1,0	3,0

Metals background consecration values for snow and ice in the arctic region (ppb):

Co, Pb, Cd - 0,2; Sr- 0,4; Ni- 0,6 ;Al- 5.0; Zn-10,0; Fe- 15,0

Field conditions enable students to watch and analyze different levels of pollution display, perform sampling followed by analytical samples processing in a chemical laboratory. Knowledge received due to lectures and accepted practical experiences enable students to reveal zones of technogenic ecosystems degradation near non-ferrous metallurgical plant "Severonickel" in future (Tab. 1).

Thus permanent student educational cycle is achieved: theoretical knowledge of environment monitoring-field studies and sampling in zones of technogenic impact-laboratory processing of field samples-field data interpretation (Fig. 2).

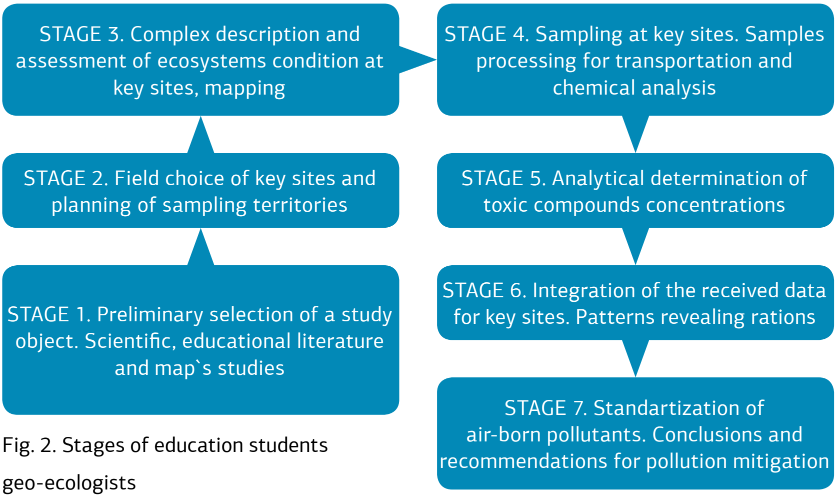


Fig. 2. Stages of education students geo-ecologists

Combination of lecture course, practical training and laboratorial materials processing enables students whose specialization is ecology and nature management to receive better knowledge of ecological monitoring fundamentals and practical experience of natural environment changes analysis.

S.M. Golovkova, A.A. Sayanov
*Department of Nature Management, Faculty of Geography,
Lomonosov Moscow State University*

Green roof: benefits and functions

Green roofs are symbols of sustainability providing needed environmental services to cities and offering to environmentally oriented urban dweller a sensible impact to nature (Fig. 1). Modern green roofs can be categorized as extensive, semi-intensive, or intensive [1]:

1) Extensive green roofs featured by drought tolerant plants grown in a thin layer (50–150 mm) of lightweight soil. They are not designed to be accessible, except for occasional weeding.

2) Semi-extensive green roofs, also known as semi-intensive roofs, have deeper soil (150–300 mm) and can support a greater variety of plants. However, their depth makes them heavy and they require a relatively strong structure to support them.

Fig. 1. Sample of extensive green roof in Moscow

Fig. 2. Sample of intensive green roof – skygarden in Moscow

3) Intensive-green roofs consist of plants grown in deep soils, allowing the growth of shrubs and even small trees. Usually grown in irrigated containers, they require more maintenance than extensive and semi-extensive roofs. They are usually designed to provide an accessible amenity space (Fig. 2.)

Green roofs in urban environments bring a significant contribution to sustainable development. Green roofs allow you to use their functions:

1) An important function is to improve the thermal insulation of the object. Due to air backlash and processes of the microorganisms activity in the soil, green roof can improve the thermal stability of the space up to 25%.

2) Noise insulation reduces the noise level, "Green Landscape" provides a good sound insulation decreasing level of noise in the room up to about 40 decibels [2].

3) During the rainy season, if there is sufficient amount of rainfall, you can save this water for irrigation of green spaces and use it throughout the summer. Since the "green roof" is a natural filter, the excess water can be stored also for other purposes.

4) Green plants on the roof attract butterflies, birds and other animals. Thus a sense of nature is preserved in the city.

5) Decrease air pollution (plants on the roof can capture up to 50% from passing over the surface air flows and reduce the concentration of dust and harmful microorganisms).

6) "The effect of urban heat islands": In urban life a huge number of cars, "throws out" into the air fuel products and, specifically, the exhaust gases, and the amount of intake air conditioning, which is welcomed by consumers and producers, ever growing. Due to these reasons the expense of the temperature in the city becomes approximately five degrees above the ambient temperature. If 20% of the roof square is the "green roof", it contributes to the improvement of air quality and reduction of total heat on approximately three degrees, which allow to reduce the costs of cooling.

7) "Flood prevention". During heavy rains "green roofs" hold up to 50% water, which minimizes the probability of flooding of streets. In addition, the load on storm sewers is reducing. In a case of not a "green roof", sewage systems quickly become clogged and require additional costs for cleaning due to drain water containing dust and mud. If rain water has passed through the filters of a "green roof", this wastewater is not a danger to drain.

8) Decorative effect, "green roof" is considered the "fifth facade", because it attracts attention with its beauty more than the facade of the building. It is aesthetically pleasing, attractive, improves the appearance of the area and the city as a whole, and the environmental effect is indisputable. In addition, it is also extra seating, among the favorite flowers and trees, without leaving your home and without using any transportation to get closer to nature.

There are deficiencies in green roof: the cost of a green roofing is still significantly higher than the cost of a conventional roof. But the cost is quickly compensated by saving heating and cooling systems, water storage and reducing operational roofing costs (Fig. 3).

The functions of green roofs. For each type of green roofs we can reveal degree of conformity its functions. For example, functions of insulation, sound insulation and an ability to clean rainwater are peculiar for the most extensive type of roofs. And intensive gardening is characterized by high decorative and recreational opportunity.

The use of different types of green roofs depends on several factors that determine the further choice of the type landscaping:

- Functionality (operated roof, "green" technology)
- Architectural features (limit loads, stylistic decision)

Fig. 3. Design project of intensive type green roof

- Weather conditions (choice of variety of plants, design solution)
- Cost of a green roof (compared to alternative solutions).

Solutions for each individual project are considered on existing data. If you need to create energy efficient buildings the best solution is the extensive type, allowing to use the roof as an additional seating areas. In office or residential high-rise buildings is an important factor recreational function, which fully provides the type of container with intensive landscaped [3].

Modern materials and technology provide an opportunity to create a protection coating for sustainable dynamic load, which allows

THE DEGREE OF COMPLIANCE FUNCTIONS BY TYPE OF GREEN ROOFS

	thermal insulation	noise isolation3	air purification	water purification	habitat	decorative effect	global warming	recreation
extensive	high	high	low	high	moderate	moderate	moderate	low
semi-extensive	high	moderate	moderate	moderate	high	moderate	moderate	moderate
intensive	low	low	moderate	low	high	high	low	high

■ low ■ moderate ■ high

using a roof area for a variety of purposes: arrange playground courses, recreation areas, parking cars, etc. You can create entire gardens with lawns, flower beds, ponds and fountains on the roof. Green roofs are an integral part of the concept of sustainable development, as well as a modern "green" technology in the field of energy conservation and energy efficiency.

REFERENCES:

1. Ignatieva M., Stewart G. and Meurk C. (2008). Low Impact Urban Design and Development (LIUDD): matching urban design and urban ecology, Landscape review journal 12 (2). P. 61–73.
2. Edmund C. Snodgrass. (2011). The Green Roof Manual: A Professional Guide to Design, Installation and Maintenance, First Edition. Timber Press, ..? 296 p.
3. Environmental solutions in the Moscow City / Kurbatova A.S., Bashkin V.N., Myagkov M.S., Savin D.S. Ed. N.S. Kasimov. Smolensk: Magenta, 2004. 576 p. (in Russian).

L.K. Kazakov, V.N. Danekina
Department of Nature Management, Faculty of Geography, Lomonosov Moscow State University

Ecological network as a basis of landscape planning and ecologization for urban and suburban territories

Anthropogenic transformation of the natural environment is becoming more extensive and can have both positive and negative environmental consequences for man and nature. It is more noticeably in urban and suburban areas — cities, suburbs and spa areas. In such cultural landscapes person is well protected from many of the adverse environmental factors. At the same time, in urban areas due to population density, its active life often develops environmental problems. People in the city are lack in many components of the natural environment — clean air, water, vegetation, places for recreation in natural landscapes and even the sun. Natural landscapes in urban areas become degraded, severely fragmented or disappeared. Save a favorable environment by technical means costs more expensive. In the cities and suburbs tourists and vehicles impact on the islands of the natural landscape. That is why the design of urban and other urban landscapes requires more attention.

Landscape planning and designing are the most popular course in land planning. Urban planning concepts have appeared in the Renaissance (T. Campanella, etc.), there are focused on environmental improvement of life and the preservation of the natural environment. In the early nineteenth century E. Howard presented an ideal model "garden city" — a small monocentric city inscribed environment, with friendly production.

In urban planning and regional planning built a lot of “ideal” model of territorial organization natural and economic systems that use the principles of radial-ray, crystal, network, and other systems and their placement organization. In models by B. Kristaller and A. Lesch, framed to accommodate the settlements are a network or lattice. An example of a model of the organization urban area is the model of polarized landscape by B.B. Rodoman [9]. It combines several ideal models of the territorial organization of economic activity, the industrial zone of urban areas, affecting the ecological environment, residential development and the nature of polarized space — separated from each other and are separated by natural and human-induced transient complexes of various household goods. Depending on the natural features of the area and its economic specialization, the model can deform its frame without destroying the structural, environmental, and natural and economic integrity of the urban landscape and the surrounding area.

Contemporary urban design provides a change of the environment and urban landscape design with given favorable properties. Greening projects in modern urban planners is based on the theory of “planning zoning”, the essence of which is to optimize the relative position of the territorial urban structures and relationships of residential, industrial, municipal, and other functional areas, in order to control human-induced influence on the surrounding natural and built environment.

Nowadays, with the greening of economic projects in the regions more and more attention is paid to natural and ecological framework developed territories.

Urban planners, designers, architects have long been widely used concept of a planning, urban development frameworks, compositional axes and centers. In practice, planning and socio-economic geography in the middle of the twentieth century, the term appears frame territories, as well as close to the frame of the concept of socio-economic and environmental infrastructure, and then the area (region, etc.). In Russia, the concepts and ideas about ecological network of the territory appeared in the works of Dokuchaev [2] and his followers in the early XX century. They were put into practice in the creation of forest belts in the forest-steppe and steppe of south of the European part of the Soviet Union (now Russia and Ukraine). Concepts and terms natural, natural and environmental, ecological, landscape and ecological network, environmental infrastructure areas applied in geography, geo-ecology and environment in the 70–90 years. They are actively developing Russian and Soviet scientists — N.F. Reimers, V. Vladimirov, Y.A. Vedenin, B.B. Rodomanov, A.N. Ivanov, L.K. Kazakov, A.A. Tishkov, G.I. Shvebs, V.A. Nikolaev, A.N. Drozdov, A.G. Isachenko, E.U. Kolbovsky, J.E. Mander, P. Kavaliauskas, and others [1, 2, 3, 4, 5, 6, 7, 8]. In Western Europe, formed the concept of ecological networks (ecological nets or network) - the system of protected areas — reserves, national parks, etc., connected by green ecological corridors in 1980–2000. In Russia such a system involving "green corridors" of protected areas known as environmental or natural-ecological network of the territory.

Ecological network of the city — it is connected by a system of wedges and green belts, water parks and recreational areas, which is used to create a green building and the remaining natural foundation of the urban area. By E.U. Kolbovsky [6], ecological network of the city is the territorial system, specifically formed to improve the environmental situation of urban areas. It consists of a variety of suburban forests, parks, wooded meadows, vegetation, and recreational areas around the building, sanitary protection and other protective elements of the cultural landscape, connected in a network of "cores" (areal units of ecological network) and "corridors" (line units of ecological network).

The important goal in the early stages of the design of urban and suburban landscapes is to identify, preserve, and the formation of structural elements of the landscape and ecological network territory.

The principal provisions of the functional zoning of urban and suburban areas are:

1. Enlarged zoning that provides the maximum separation of environmentally harmful objects. Economic objects associated with the city, but prevents to the nature degradation, should be placed in the urban industrial utility and storage areas, and separated from buildings, health care facilities and the important elements of natural and ecological network by buffer

zones. Landscaped objects of mass short recreation and special purpose (squares, boulevards, public gardens, cemeteries, etc.) and the sanitary zones can be elements of the buffer zones.

2. Compact size and concentration of urban engineering structures. Their dispersal, linear and dispersed development caused greater damage to the natural environment (buildings along the coastal zones of rivers and reservoirs, the fragmentation of the elements of landscape-ecological network).
3. Landscape and ecological functional zoning of the landscaped dominant of the ecological network — the valley of the rivers and streams, riparian and coastal zones of lakes and reservoirs, embankments, forests, parks, and environmentally important forms of relief elements and others around them are placed recreational and residential areas.

That is, when territorial greening urban landscapes with the release of functional planning zones are taken into account structures or elements of ecological network

The structural elements of an ecological network (Fig. 1) are traditionally:

1. Core areas, the most significant ecosystems, with a high level of preserved nature, constituting the frame of the network;
2. Buffer zones, next to the core areas, providing a protective function, with a sort of filter effect;
3. Ecological corridors, that is continuous portions of the territory which can act as connections for some species or groups of species, as well as points or scattered areas (called stepping stones) which can be significant for sustaining passing species, for example providing an area of support for migrating birds;
4. Areas of potential renaturalization — the territory, which can potentially be included in the ecological network like core areas or ecological corridors [10].

In the formation of core areas their basic elements are established systems of objects of natural reserve fund, national parks, where banned and severely restricted economic activity. They retain and reflect the basic features of natural areas and biodiversity. Ecological corridors connecting the core areas better preserved, and they

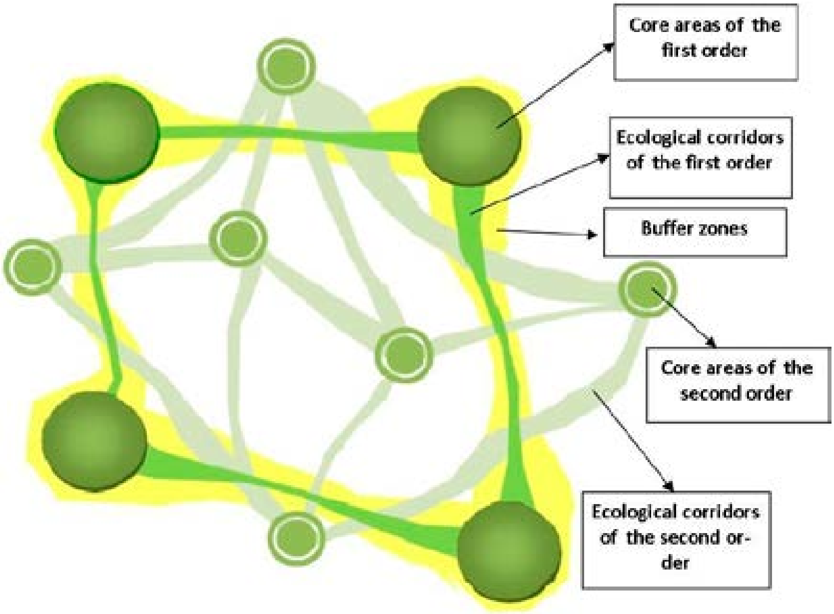


Fig. 1. Possible “ideal” model of the landscape-ecological network (*Danekina V.N.*)

are best created in the form of water protection zones or zones along watercourses on the other thalwegs relief. Such ecological corridors are attractive and have a large ecosystem value, including as transport , migration artery linking the urban and suburban landscapes in holistic basin paragenetic systems of different scales (Fig. 1).

Fig. 2. Ecological network of the territory of Southwest Crimea (*Danekina V.N.*)

Table 1. The comparative types of functional elements of the landscape-ecological network for the urban and suburban areas (compiled by Danekina V.N.)

The functional elements of the landscape-ecological network	**The structure of natural system**	
	The landscape-ecological network of urban areas	*The landscape-ecological network of suburban areas*
The core areas	Protected areas in urban areas, city parks, large forest	Protected areas
Ecological corridors	Valley and the major channel, small rivers and their tributaries, plantations along the transportation routes, water protection zone along the seas around the lakes	The channels and floodplains of major rivers, watersheds, protective forest plantations, water protection zone along the seas around the lakes, reservoirs
Buffer zones	Water Protection, touristic, protection zones, agricultural areas	Water Protection, touristic, protection zones, agricultural areas
Zones of potential reservation	Land on which the natural geosystems restore	Territory of rare species of flora, etc.

As a specific example in Fig. 2 is a schematic diagram of the ecological network of Southwest Crimea with its suburbs, almost a third of its territory is related to the natural reserve fund. It includes three main important parts reclaimed landscapes of Crimea: the piedmont and mountain subtroFigal South Coast, which urbanizing landscapes and degraded. The ecological network this urban resort should be formed taking into account the landscape and ecological characteristics, existing protected areas, protection zones of coastal areas and coastal zones along the beds of rivers and valleys. The Water and the Land Code of Ukraine allocated specially protected coastal protection strips, along the sea of not less than 2 km away.

Landscape-ecological network for urban and suburban areas should be formed taking into account the landscape and ecological characteristics, as well as the basic functions of the city and its suburbs, including the economic, recreational and environmental specificity (Table 1).

In the Southwest Crimea can identify a number of factors that negatively affect the ecological status of the region:

1. Individual building without regard to the real value of coastal areas and the requirements of the Water Code, to limit the eco-

nomic activities within the coastal protection strips along the Black Sea. Often, excessive watering in suburban areas, the construction of houses and cottages in the coastal areas close to the cliffs lead to negative geodynamic processes and destroy the existing landscape.

2. The destruction of the coastal strip (buildings, tourists and recreational influence, overgrazing, etc.) leads to disruption of normal metabolic processes in the land–sea. This negatively affects the biodiversity of terrestrial and coastal marine communities.
3. Pollution of coastal protection zones of Crimea by household and construction waste, municipal and industrial wastewater, water from agricultural land and from ships. For example, untreated sewage from Balaclava and Batiliman spread to a Golden beach, to nature conservation Cape Aya.

Realization of the concept of a single landscape — ecological network of the Southwest Crimea and coastal areas of the Crimea, with the use of technology “green” building will maintain a favorable environment. Now the technical equipment of urban planning, landscape and ecological resettlement permit any design changes in the nature. Their realization depends only on economic considerations.

REFERENCES

1. Vladimirov, V.V. (1999). Urboekology. Moscow: Publishing House of the MNEPU.
2. Dokuchaev, V.V. (1994). Russian black earth more precious than gold. Moscow: Publishing House of Moscow University.
3. Drozdov, A.V. (2006). Landscape planning with elements of engineering biology. Moscow: KMK.
4. Kazakov, L.K. (2007). Landscape study the basics of landscape planning. Moscow: Publishing House of the “Academy”.
5. Kazakov, L.K. (2011). Landscape study. Moscow: Publishing House of the “Academy”.
6. Kolbovsky, E.Y. (2008). Landscape Planning. Moscow: Academia.
7. Pozachenyuk, E.A. (2003). Territorial planning. Simferopol: Share.

8. Reimers, N.F. (1994) Ecology (theory, laws, rules, principles, hypotheses). Moscow: Young Russia.
9. Rodoman, B.B. (1974). The polarization of the landscape as a resourse of preserving the biosphere and recreational resources // Resources, the environment, resettlement. Moscow.
10. Protected Areas and Ecological Networks // STRA-CO (2004) 10, the document developed by the Governments of The Netherlands and Russian Federation, 17.12.2003.

A.A. Klishina, T.A. Vorobyova
Department of Nature Management, Faculty of Geography,
Lomonosov Moscow State University

Moscow region: the problems of rationalization of agricultural areas (case study of Kolomna district)

INTRODUCTION

The gradual transfer to postindustrial market economy causes increasing contrasts between the center and periphery. This is one of principal problems of the Moscow region which creates many obstacles for development of its long-exploited agricultural regions. In contrast to proximal Moscow suburbs, which, during long transformations of territorial structure, have intergrown into the city and become adapted to its requests, the more distant regions slowly lose their agriculture. Without sufficient support from the authorities, the regional agriculture is unable to compete with industry and rapidly developing tertiary sector of the economy. This sets up the question of developing the distant districts where the bonds to the capital city are weaker, and local attraction centers exist.

METHODOLOGY AND STUDY AREA

The main methods used in this study were statistics and cartographic, which permit to study the structure of nature management in detail and to find the main vectors of its rationalization, considering local environmental and socio-economic issues.

The Kolomna district is situated in the south-eastern part of the Moscow region. Administrative center of the area is city of Kolomna. Kolomna district is relatively small — 109,1 thousands ha. Its ag-

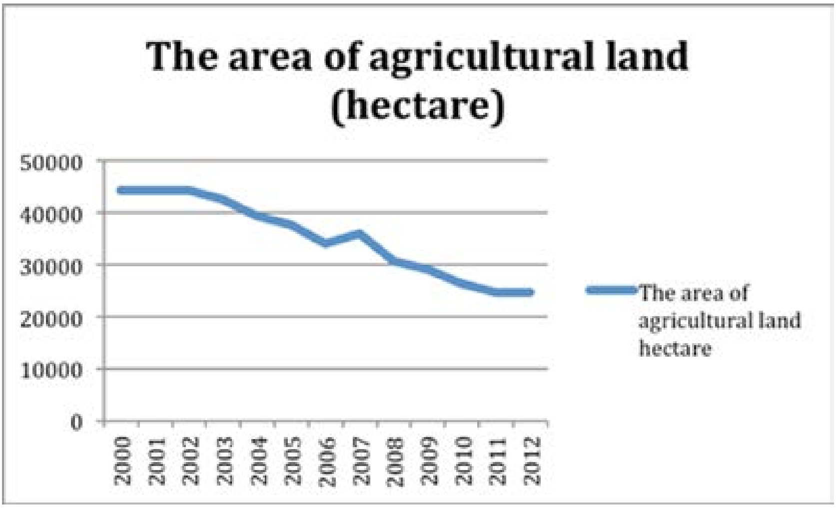


Fig. 1. The area of agricultural land (hectare)

ricultural part covers 59,1 thousands ha, i.e. slightly above 50% of the overall area. Rural areas in the suburbs develop in a certain way. Four major functions are selected among traditionally distinguished rural functions: agriculture, organized recreation, environmental and residential functions. Thirteen agricultural enterprises works in the area. The main products are vegetables, crops, potatoes, and a livestock-breeding products [1].

Arable farmland area between 2000 and 2012 fell by almost half, and now stands at 24.6 thousands ha, of which arable land are located on 19.6 thousands ha. It is still covers the basic area, its major part is used for growing forage crops. The overall capacity of crops, potatoes, and vegetables has a positive tendency, but insufficient. (Fig.1; 2).

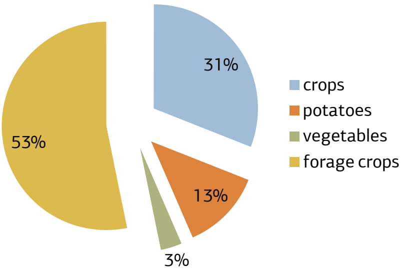


Fig. 2. The structure of sown area (%)

In the last 12 years, the cattle stock decreased significantly (Fig. 3). Positive dynamics (two-fold increase) was observed for beef cattle only.

The number of agricultural workers falls with high rate (al-

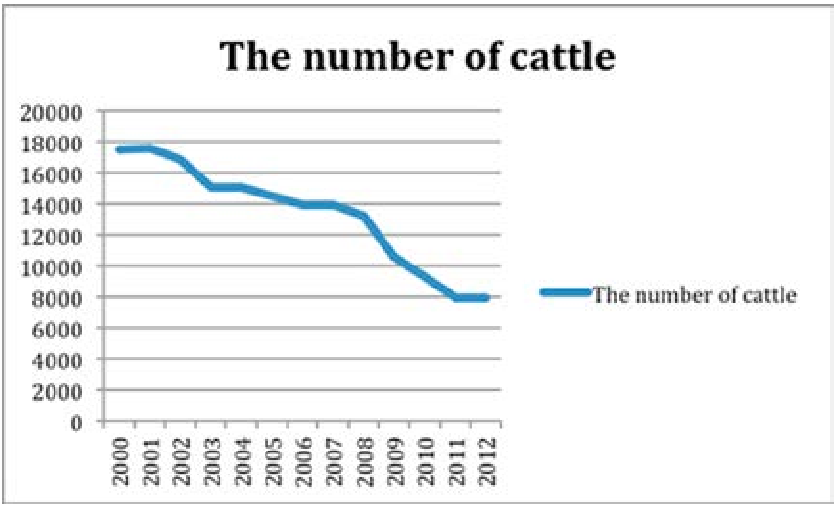


Fig. 3. The number of cattle (cattle)

most fourfold in the last decade); in 2012, the number was 1215 pers. (Fig. 4). It is explained by set of factors: low wage, high labor input, insufficient state support of agriculture and farmers, falling of interest to a rural way of life.

In Kolomna district there are all preconditions for recreation. Therefore construction of country and cottage sites happens promptly. In its territory more than 30 cottage settlements and 50 country sites are located. This is accounted for by favourable bioclimatic conditions and set of historical and cultural monuments. The residential function has been developing at high rates in contrast to all others, particularly intensively in the municipalities, which are the nearest to the center and in the south district.

The role of the agriculture have decreased during the period under consideration [2]. The reduction in the agricultural output has turned out to be particularly significant in the municipalities, which are the nearest to Moscow and in the eastern part; the municipalities in the near belt have remained leading in the recreation complex. The polarization in the development intensity of the central and peripheral parts of the territory has been increased for the oblast as a whole and for the Kolomna district in particular.

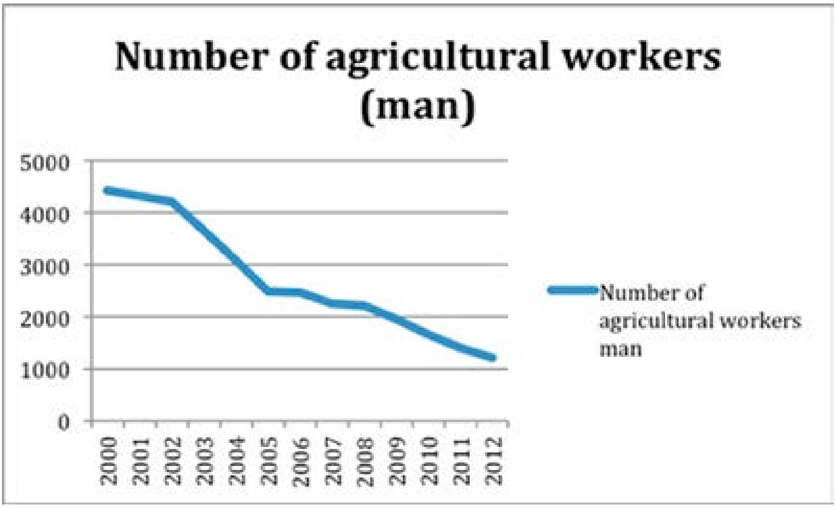


Fig. 4. Number of agricultural workers (man)

RESULTS

The current experience demonstrates that the crop agriculture in the district becomes inexpedient due to low efficiency, wear of machinery and insufficient number or workers; in fact, more than a half of farmlands aren't used for designated purpose. In the meantime, large areas used for growing forage crops, provide a proper basis for milk and beef cattle farming. The increasing needs of Moscow cluster provide high demand for suburban vegetable-growing with minimal transportation expenses.

The depopulation of rural districts is a general tendency for the Moscow region which demands for finding new directions for its development. We suppose that optimal for the current situation are the directions which are addressed to both economic and ecological issues. There are three directions transform rural areas:

- deepening — agro-food supply chain (organic farming, high quality production and regional products);
- broadening — rural areas (nature and landscapes management, neo on-farm activities, diversification, agro-tourism);
- re-groundining — mobilization of resources (new ways use of the area).

The district has all necessary prerequisites for growing ecologically pure production, which is to satisfy one of the most common and popular demands. Outside Russian Federation, agricultural tourism is developing rapidly. A good example comes from Switzerland where it evolves for more than 30 years. Its primary goal was to cope with the "drain" of rural population. The "last zest", sold abundantly, is a part of the healthy rural tourism program "sleep on hay". Among other alternatives, we can point to recreational nature management which is possible due to natural, historical, and cultural potential of the district. Kolomna district is the historical and architectural monument: there are 101 monuments of town planning and 25 monuments of history and culture, preserved until present time.

CONCLUSION

The processes characteristic of the oblast as a whole are particularly reflected in the Kolomna district: reduction in the role of agriculture in the rural area and its localization in certain points. Solutions of agriculture problems in the long-exploited agricultural regions include intensive development in a new and alternative directions. The unity between society, landscapes and agriculture is an important tool of rural and agricultural policies.

REFERENCES

1. T.A. Vorobyova, A.A. Klishina. Cartographic support existing environmental studies in order to optimize it. Sustainable Development of Territories: GIS theory and practical experience. Proceedings of the international konferentsii.Smolensk, 2012. P. 311–314 (in russian).
2. T.G. Nefedova. Social constraints of the agricultural sector of Russia // SPERO. Social Policy: Expertise, Recommendations, review. 2008. Number 9. P. 37–53 (in russian).

N. Kolupanov
Department of Nature Management, Faculty of Geography,
Lomonosov Moscow State University

The rational use of associated petroleum gas as an attribute of sustainable development of oil production in the Russian Arctic

INTRODUCTION

Nowadays more than one-third of the world's oil and gas production is accounted for the continental shelf. Each year more than 1 billion tons of oil and more than 800 billion cubic meters of natural gas are produced in water areas. Extraction of oil both offshore and onshore is accompanied by liberation of associated petroleum gas (*APG*) which should be utilized as rational as possible.

Development of offshore hydrocarbon deposits in the Arctic marks a new stage in development of oil and gas industry in Russia. Doing this kind of economic activity in the Arctic is difficult because of high requirements on minimizing risks of any kind, especially because of the need to ensure environmental safety. Requirements for a high level of environmental safety here are caused by fragility and high sensitivity of Arctic ecosystems to any human influence and also its special assimilative capacity.

In arctic conditions utilization of APG must represent a failsafe mechanism as any other aspect of hydrocarbons extraction in this region. Sustainability of APG utilization will be determined on the basis of existing normative and legal regulation and the state control, the current level of development of productive forces and technological capacity of economic subjects, degree of favorable economic conditions and ecological culture level of oil producers management system. Obviously APG should be used in the Arctic almost completely, rather than just over 95%. Our research objective is to explore the current resource base of APG in the Arctic, actual innovative technologies of APG utilization and best practices of state regulation of APG utilization that will contribute the most economically efficient use of APG and prevent gas flaring.

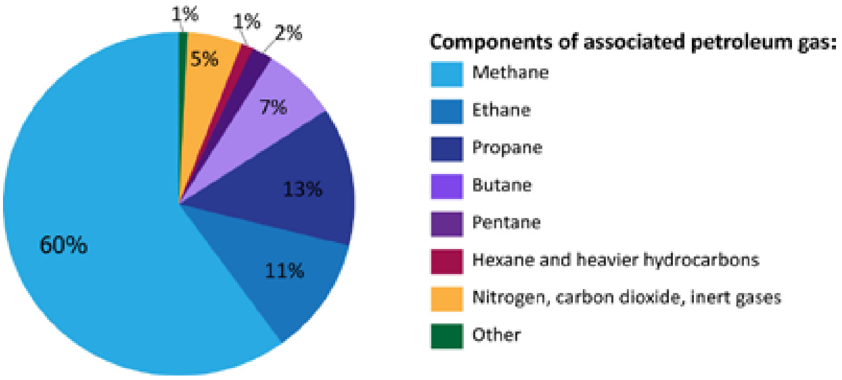


Fig. 1. Average composition of associated petroleum gas in Russia

METHODOLOGY AND STUDY AREA

In this work we have analyzed different factors that determine features of development of hydrocarbon production in the Arctic and features of development of APG utilization in Russia at the present time. In particular, we examine practiced directions of APG utilization in Russia, determine their economic characteristics and development trends and compare them. In this work we highlight available the most advanced technologies of APG processing in the world that are innovative for Russia. We researched positive state regulation experience of Great Britain, the Netherlands and Norway in APG utilization as the nations with developed offshore oil production. Experience of these nations is reflected in models of effective APG utilization governance with key mechanisms and instruments of state regulation that formed the basis of success in achieving a high level of APG utilization.

RESULTS

Investigation of offshore hydrocarbon resources in Russia demonstrates concentration of about 75% of them in the Arctic regions with severe climatic conditions and poor infrastructure. Average bedded gas-oil ratio of offshore oil fields in the Russian Arctic is about 450 cubic meters of APG per ton of oil (at reservoir conditions), and this index is highest in the Kara Sea — about 800 cubic meters of APG per ton of oil. And perspective APG resources in the Russian Arctic water areas are estimated at about 1.5 trillion cubic meters [1].

We have identified features APG, which significantly affect on a choice of the way of its economic utilization:

- Gas-oil ratio, produced volume of APG and its resources on the oil field.
- High calorific efficiency (Factor of energy resource): from 9000 to 15000 kcal/m^3 (e.g. for natural gas 8000–10000 kcal/m^3).
- The content of the mixture of paraffin hydrocarbons C_3 – C_6 (gramm/m^3) defines value of APG as mineral raw materials for petrochemical industry (Factor of petrochemical raw materials).
- The instability of the APG chemical composition at different stages of development of an oil field.
- Growth of the proportion of heavier hydrocarbons in produced APG from greenfields to brownfields.
- The difference of the APG chemical composition from one oil field to another.

The significance of energy resource factor and petrochemical raw materials factor in each case is an important starting point for a choice of the way of APG utilization. Fig. 2 shows ways of APG rational utilization and ranks them according to economic efficiency. However lack of pipeline infrastructure and sufficient gas processing facilities within the Arctic Circle limits the possibility of a choice of high-performance large-scale ways of APG utilization: mainly it is limited to processing into liquid products. In such conditions the low-tonnage gas chemical industry is becoming the priority way of APG utilization. But this industry is new and only passes through the process of formation.

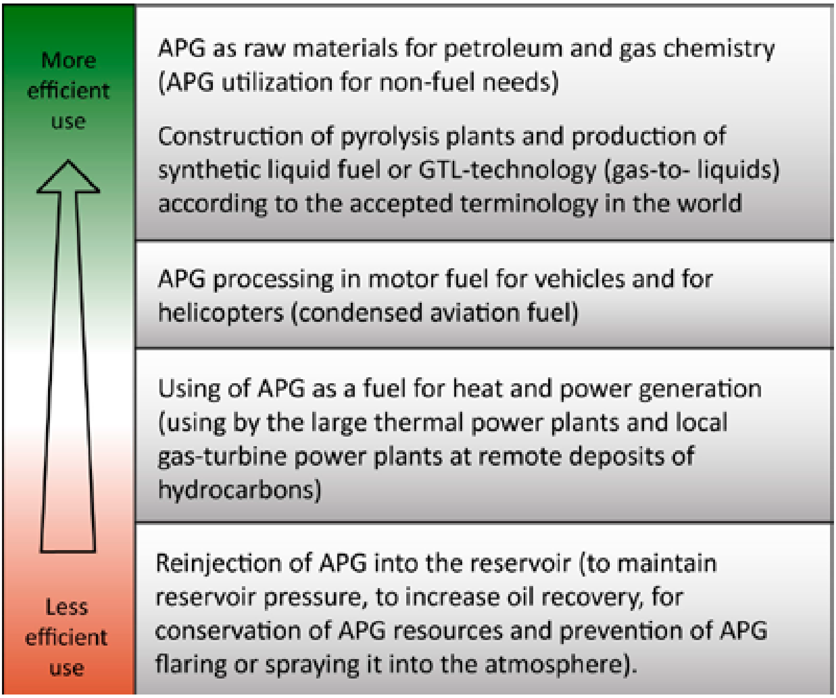


Fig. 2. Ways of rational utilization of associated petroleum gas

GTL-technology (gas-to-liquids) is one of the most promising ways of APG processing. GTL process production includes a synthetic liquid fuel, synthetic oil, diesel fuel, lubricating oil and paraffins. Produced synthetic oil is transported with oil of mineral origin for further processing. Diesel fuel is transported or used directly in the place where it is produced. Cheap gas raw material is the key factor in commercial expediency of low-tonnage plants. GTL-process installations are actually the only technology that can effectively monetize small gas resources in the conditions of absence of a gas transportation system [2].

Current development of low-tonnage GTL industry requires solving of the following foreground tasks:

- Transition to modular design/production of GTL-installations
- Ensuring sustainable work of GTL-installations on gas raw materials with varying composition

- Minimization of pollutants emissions and waste from operating GTL-installations
- Integration of GTL-installations in infrastructure of superior system
- Optimization of conditions of mixing and joint transportation of synthetic hydrocarbons and oil of mineral origin

The minimum level of APG utilization is set by requirements of government regulation of oil sector. The government defines the responsibilities of subsoil users, stimulates and helps them, monitors and applies appropriate sanctions if it is necessary. Great Britain, the Netherlands and Norway have a great experience in providing the highest level of APG utilization. We have researched positive state regulation experience in these nations which have high-developed offshore oil production. And we highlight the most important mechanisms and instruments of governance that formed the basis of success in achieving a high level of APG utilization:

- Flexible and effective economic mechanisms to encourage reduction of APG flaring by companies
- Establishing maximum allowed annual APG flaring volumes
- Possibility of quotas transfer for APG flaring (for purposes of security and emergency situations)
- Ability to transfer saved APG flaring volumes to other areas of oil production, where some oil producers have exceeded quotas of flaring
- Providing third party access to the gas-transport system
- Policy of the development of small oil fields providing pipeline transport for APG
- Establishing the hydrocarbon tax on carbon dioxide emissions stimulating operators to reduce APG flaring
- One of the main ways of APG utilization in Norway is injection into the formation. APG is redistributed from wells with high gas factor to another oilfield with low gas factor
- The Norwegian government doesn't set specific standards for APG flaring, but permits APG flaring in a very limited number of situations

- In Norway APG flaring in volumes which are more than necessary for safety is not allowed without the approval of Ministry of Petroleum and Energy.

CONCLUSION

We can observe significant growth in the value of APG in Russia as a natural resource in recent years, and we suppose that APG has the potential of its transformation into the rank of strategic resource. Low-tonnage gas chemical industry is the priority vector of APG utilization in the Arctic. Development of GTL-technology is one of the most innovative events in APG utilization. Hydrocarbon production in the Arctic must meet highest standards, and the role of government shouldn't be underestimated. We also highlighted the importance of state programs to achieve full APG utilization in the Arctic.

REFERENCES

1. Circum-Arctic resource appraisal: estimates of undiscovered oil and gas north of the Arctic Circle. USGS, May 2008.
2. D. Pchelintsev, V. Imshenetsky, S. Medvedev, Mini-GTL: new vector of development of low-tonnage gas chemical industry. Neftegazovaya Vertikal Journal. #20/2013, p. 68.

A. Medvedkov

Faculty of Geography, Lomonosov Moscow State University

Life support systems and "feeding landscapes" in the middle Yenisei region under conditions of globalization and climate changes (on the example of the Kets ethnos)

INTRODUCTION

At present, the processes of globalization and global warming make a quite pronounced impact on the lives of indigenous people in the northern regions of the country, e.g., Nenets, Chukchi, Kets, etc. For them, fishing, hunting, herding, and natural landscapes are not only a source of livelihood resource, but also part of the traditional culture. Climate change (impact on productivity of "feeding landscapes," increase of natural hazards, etc.), social factors (alcoholism, loss of the Kets language, poaching, etc.), and new worldviews that have emerged and have been growing in the post-perestroika period are the main sources that threaten the well-being, livelihoods, and the preservation of cultural traditions of the Kets ethnos and its identity. The issues of developing appropriate measures and strategies for adaptation of the traditional economy and way of life of Kets and other ethnic groups to a changing climate and market economy become extremely relevant.

Kets is one of the smaller nations of Central Siberia that consists of dispersed groups mainly in the middle and lower reaches of the Yenisei River, as well as in the lower reaches of the Podkamennaya Tunguska River (Yenisei Ostiak, Yenisei). They became known in the XVIIth century through the first Russian Yenisei explorers. The modern name of

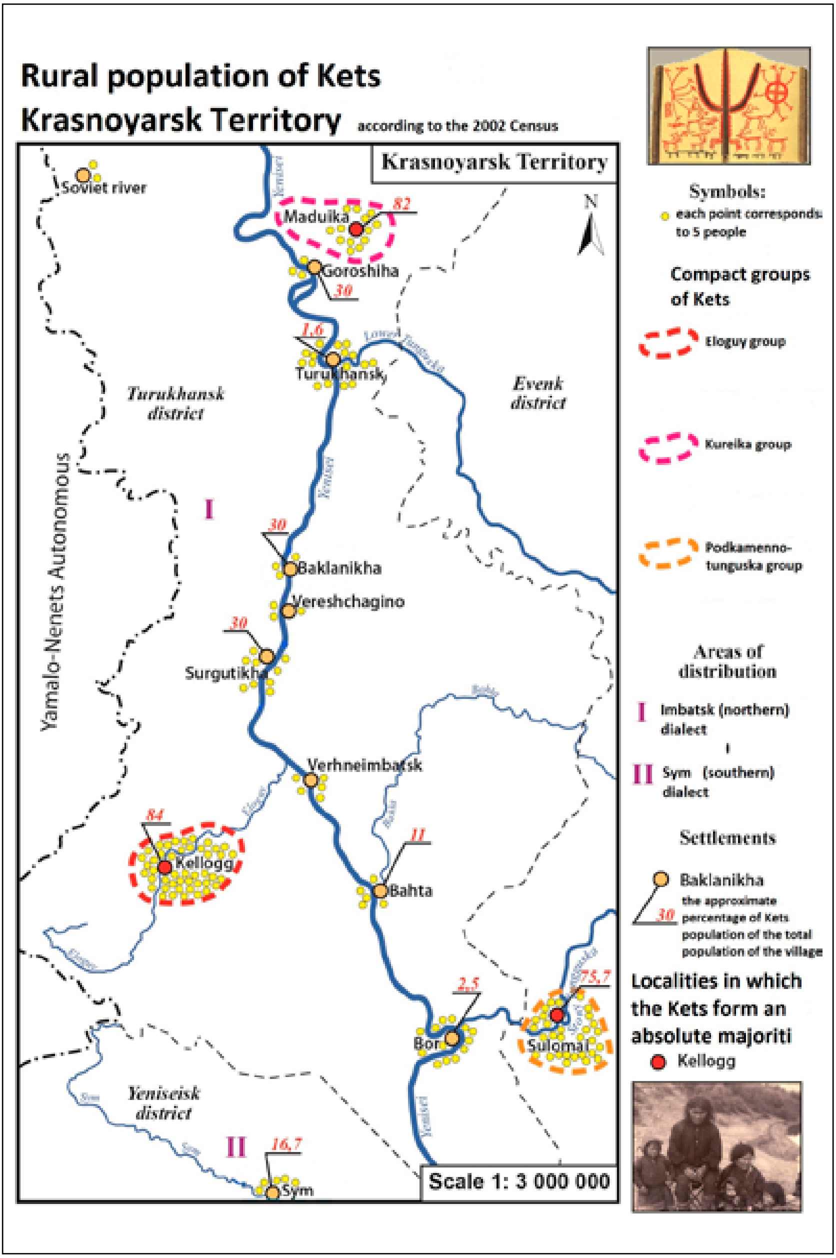


Fig. 1. Map “Settlement and the number of Ket in the Krasnoyarsk Kray.”

Compiled by the author

the people — Kets — appeared in the 1920s. This is not a self-ethnic name; it was imposed superiorly. This was due to the fact that the Khunt (with whom Ket were in contact in the upper reaches of the Taz River) and the Kets immediate neighbors — the Selkup — continued to be called Ostyak. The total number of Kets is close to 1,200 people. There are three large groups of Kets with the names of the rivers along which they settled: Yelogui, Kureyka, and Podkamennotunguska. The traditional territory of their settlement is the Turukhansky and Evenk Municipal Districts of the Krasnoyarsk Kray (Fig. 1). In terms of the linguistic and national characteristics, Kets are classified as the most unique ethnic group not only in Russia, but in the world. The uniqueness of Kets is evident in the fact that their language has a distinctive formation that has no analogues among the neighboring nations. The Kets language (now the relic) is the last of the living languages of the big family of the Yenisei people. The Kets culture has being adapting well to the riverine conditions. This includes experience in economic activity, the means of material life support, and many skills and knowledge necessary for the development of the riverine areas. The basis of the traditional life support prior to the arrival of the Russian people on the Yenisei North was fishing (especially in summer) and hunting on large ungulates (moose, caribou) and waterfowl. With the arrival of Russians and the introduction of the yasak (tribute paid off in furs) and then with the development of trade relations in the region, trapping has spread (hunting a squirrel, sable, etc.). Reindeer herding for Kets has always had a secondary role because of the late migration of deer and small feed resources for the development of reindeer herding. Deer was used solely for transportation purposes; to date, the Kets reindeer has completely disappeared.

MATERIALS AND METHODS

Hydro-meteorological data of the local weather stations and the general Russian reference sources were processed to identify fluctuations of the temperature and precipitation parameters in the Central-Siberian region beginning in the XXth century. The monitoring data based on the surveys of Kets families were used to assess changes of environmental parameters and the fodder value of the natural sys-

Tyganovy – a typical Ket family from the village Sulomai, i.e., “the Ket’s “Petersburg” (the second in population mono-ethnic Kets settlement). *Photo by the author*

tems of the middle taiga (at the level of complex natural boundaries) under climate warming. The traditional economy is “rigidly” tied to the landscape and all the stressful situations in the natural complex are immediately reflected in their self-sufficiency and social well-being, which suggests a high degree of reliability of the information we have collected. The total number of households surveyed is 25 (per the number of hunting areas within the hunting community Sulomai; 57 respondents that represent about half of the residents of the village Sulomai). All respondents point the decline in yields of berries (especially blueberry and bilberry), and during dry summer — of rowan and cranberry; there are fewer mushrooms. One of the examples identified during the Sulomai survey is especially revealing: a woman noted that prior to the 1990s, she could gather and hand over 30 pails of cranberries and now she can hardly gather 2 pails. There are similar examples for other berries. The respondents noted an increase in the number of “sick” (rotten) berries, increasing the probability of its abscission in the last 15–20 years. They associate the increase in the number of bears attacks on people with low berries yields.

The Kets families that have their own hunting areas transferred through inheritance have important information about the dynamics of the production of any type of animal or berry crop over a long period, i.e., a few decades. Many Kets have their own environmental calendars that mark important hydro-meteorological and phenological events. Such data in the absence of the established system of monitoring in the taiga zone of Central Siberia have an important scientific value in identification of the response of natural and environmental resources of the taiga and the traditional economy of the indigenous population to climate warming. The author has also conducted field surveys (over 5 field seasons beginning in 2008) during which he recorded the yield and percentage of flowering berry and estimated resources of commercial plants in different types of natural systems.

RESULTS

PROBLEMS OF PRESERVATION OF THE KETS ETHNIC AND CULTURAL TRADITIONS

The main problems of Kets are alcoholism, unemployment, unfavorable demographic situation (increased mortality in middle age, the younger generation leaving for cities in more populated areas), and the loss of the Kets language. Penetration of Baptism plays a certain role in the fight against alcoholism. Drinking Kets, having become Baptists, stop drinking alcohol, become more economically and socially active. However, with acceptance of the evangelical faith, Kets have to pay a tithe of their meager incomes: fish, furs, or cash. These processes lead to the transformation of some elements of the traditional worldview of their pagan religious system, culture, and ritual practice. The Orthodox Christianity “combined,” as a rule, with the traditional beliefs and cults, never behaved as aggressively as evangelism.

Along with the gradual disappearance of traditions and the assimilation processes in relation to Kets, the Kets language is dissapearing too. In elementary school, the Kets language is now taught and a primeir and other tutorials have been created. However, this is not sufficient to revive the language of the indigenous people and

Dorozhkina, Tatiana Orlovna is a member of the small ethnic group Ket s, a resident of the village Sulomai. She is assessing the evening catch of tugun, i.e., a valuable whitefish. *Photo by the author*

this does not always find understanding and support even among Kets themselves. Today, education remains the only area of the use of the Kets language. The students of senior classes, who received the Kets language in the first three classes of elementary school, do not remember its basics. This is due to three main reasons.

First, in the vast majority of settlements, there are only elementary schools, while students can continue their studies only in the regional centers and in larger towns where the Kets language is not included in the curricula and there is lack of qualified teachers on the subject. Thereofre, unfortunately, the effectiveness of teaching the Kets language in school is extremely low. Given the specificity of the region and of its transport and remoteness, there are good prospects for the development of distance education.

Second, in daily communication in their national settlements with parents, friends, and peers, the younger generation of Kets do not speak their language.

Third, the attempts to revive the Kets language is not always understood, even among the members of the ethnic group, not to mention the district-level authorities. For a long time, the language has been transmitted only from parents to children. In the period from 1920s to present, the Kets language has not been widely used. Today's young generation and their parents do not know their language, perhaps only a few words. According to various estimates, only 15% of the aboriginal population has command of the Kets language. It indicates the widespread distruction of the process of natural language transmission within families from parents to children. Some even claim that the Kets language is not needed for communicate either for themselves or for their children. We have identified such trends through sruveys of the local population even in mono-ethnic villages.

LIFE SUPPORT SYSTEMS IN A CHANGING CLIMATE

Kets have a life-style that is based on the traditional methods of economy and the use of a wide spectrum of the bio-resource component of the environment. Today, the land of their traditional habitation is widely used by poachers; management of the hunting sector began to transition to enterpreneours who are removed from the interests of the Kets ethnos. Through the present day, there has been the process of alienation of Kets from their resource base.

In the modern period of impoverishment of indigenous peoples, the use of bioresource potential often takes a variety of forms of poaching. In order to preserve and restore the natural resources, it is necessary to allocate territories of the traditional natural resources use (TTU), establish the rules of thier use, and create federal stimuli for external and internal sources of the economic development of these nations.

Due to climatic changes (Fig. 2 and 3), there is a reduction of productivity of natural systems: reduced yields of berries, pine nuts, and mushrooms (the impact of short strong frosts in the spring, during the flowering, and of dry heat), reduced number of sable and other game animals because of poor food supply, increase of the number and extent of forest fires due to lower water content and reduction of water logging of permafrost landscapes, as in many of them according to our observations, the roof of permafrost went down 1–2 m and, sometimes, deeper.

The years of low reproduction of game resources became the rule rather than the exception, especially in the areas east of the Yenisei.

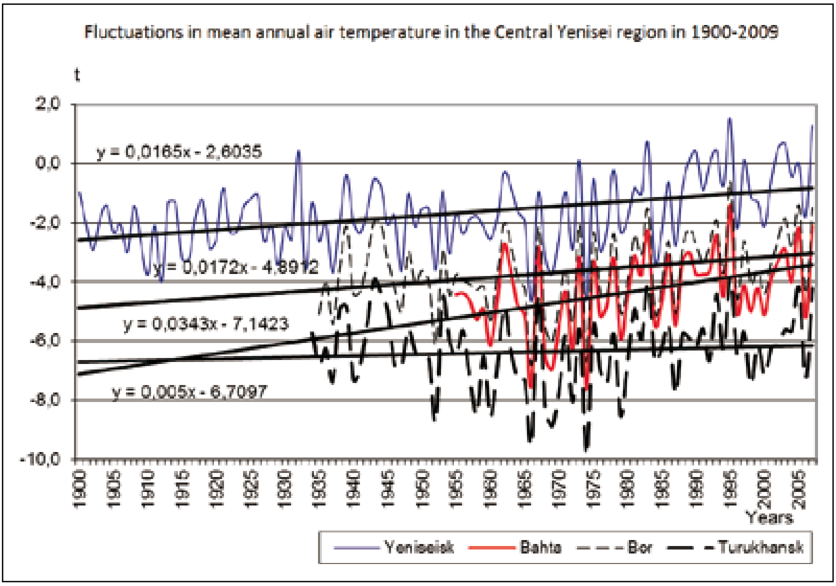


Fig. 2. Fluctuations in mean annual air temperature in the Central Yenisei region in 1900–2009. *Compiled by the author*

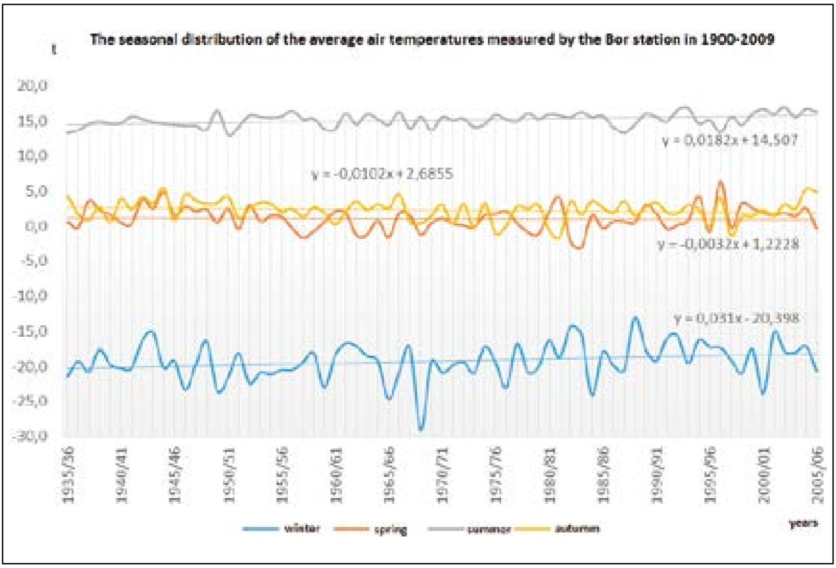


Fig. 3. The seasonal distribution of the average air temperatures measured by the Bor station in 1900–2009. *Compiled by the author*

A kurum overgrown with lichen and young birch in the Bolshaya Chernaya River valley (the left tributary of the Podkamennaya Tunguska River in its lower reaches).
Photo by the author

This can be explained by a greater degree of frost-danger in the right-bank areas compared to the left bank because of the geomorphological features of the area: the higher degree of dissection of the relief, presence of deep valleys, high values of absolute marks, etc. Cold air flows into the valleys causing more frequent frosts in the spring. It is important to note the smaller depth of the snow cover on the right bank, compared to the left. In the era of global warming, there has been observed increased frequency of thaws. For example, Kets pointed out that 20 to 25 years ago, cold weather lasted at least one month, and now, it is no more than 2 or 3 weeks. These observations of Kets are supported by the weather stations in the region, indicating more frequent thaws and warming in winter. As a result, the depth of the snow cover is lower, which impacts the productivity of berries. It is known that the reduction of snow cover increases the likelihood of freezing of billberry and blueberry. Many Kets note that a decrease in snow cover, makes it more difficult to hunt moose. The result of these processes is the phenomenon of "hungry taiga" inherent in the last two decades.

There are marked changes in the habitat of tick-borne encephalitis; the tick is now detected in the region of 63°N. The ixodes ticks (Ixodes persulcatus), over the past 25 years, have moved 250 km to the north and now occupy the middle taiga subzone of our research area. The likelihood of tick-borne infections has increased. The activity of the ticks has been especially strong in the last 10 years. According to our surveys, it affects the population of the local villages Vorogovo, Bor, Sulomai, Kuzmovka, and other settlements; there, people have been freuqently requesting vaccination against tick-borne encephalitis.

In the third quarter of the XXth century, during the stable cold winters, vipers (Vipera berus L.) were virtually absent in the middle-taiga right-bank of the Yenisei River geosystems. The local population began noticing the expansion of poisonous snakes after the abnormally warm years of the second half of the 1990s, which coincided with the time of the mass melting of ice in the rock glaciers (kurums). Now snakes are everywehre on the melted kurums.

Kurums is a type of the permafrost landscapes of the Yenisei Siberia that was the least stable in the era of global warming. Within kurums, even on slopes with poor heat-supply, the goltsy ice thawed, small depressions formed, and cold streams disappeared. They were overgrown with lichen, shrubs, and scattered trees. Pika, which plays an important role in the diet of sable, is abandoning kurums. These processes are promoted by late spring frosts and the loss of underground water resources at the base of the kurums.

Due to the reduction of food resources, the number of sable and other game animals is decreasing. The increase in the share of birch and aspen in the dark taiga contributes to this process. At the stage of modern warming, it is harder for dark-needled species to maintain their dominant position in the tree layer; they are being replaced with the pioneer-species, which leads to worsening of forest and food resources.

Instances of hydrological anomalies also increased. A sharp warming in early spring and exisitng frozen impervious layer cause high and even catostrophic flooding that conisides with melting and drifting of ice. For example, in the snowless winter of 2001, there formed an ice dam 30 m high, which caused serious flooding. As a result, the settlement of Ket s on the Podkamennaya Tunguska River was completely destroyed. The old-timers do not recall floods of this magnitude. Now, due to the increased frequency of floods of ice-dammed origin, Kets are forced to move their homes to the watershed areas. After 2001, the regional services has been conducting blasts of ice dams.

CONCLUSION

We can assume that the trophic pyramid of the middle taiga has been significantly disrupted due to global warming and the growth of climate instability. Naturally, these changes adversely affect the traditional natural resource use of Kets who cannot meet their growing material needs. The issue of development of appropriate measures and strategies is becoming increasingly relevant; they should become the leading adaptation basis of the traditional economy and way of life of the local population to a changing climate.

The reduced life-support functions of the “feeding landscape” (in the terminology of L.N. Gumilev) requires a focus on the comprehensive development of the traditional forms of natural resource use and their diversification, support of their resource and manufacturing base, and the organization of processing of raw materials and products. At the present stage, the Kets subsidiary farms are weak, though, they could become an important sector of food self-sufficiency of the local population. It is possible to establish plantations growing valuable species of mushrooms, berries, and herbs to increase the volume of commodity production. This would create additional incentives for the traditional Kets natural resource use. The creation of local plantations of medicinal plants would contribute to the formation of the region’s production of environmentally friendly raw materials for medicines. These resources are available in the Kets TTU, where gathering of medicinal plants was carried out in the Soviet time. The capacity volume of such procurement has been identified for some species of medicinal plants. Some Siberian regions have a successful experience with the use of non-timber forest resources.

Currently, in the Krasnoyarsk Kray, a concept of creation of market for non-timber resources for 2005–2015 has been developed with the efforts of two administrations; this concept is focused on developing of competitive conditions for the buyers of mushrooms, berries, and medicinal plants who come from the neighboring Russian regions. In addition, non-timber forest management is rightly seen as a way to preserve the most valuable land from logging, primarily of the dark coniferous taiga. Along with this, it is necessary to set up small processing facilities that could receive caught fish and gathered wild plants from the local population and process and sell these products, which would increase employment in the taiga settlements.

The way out of large-scale poaching and logging could be the creation of the ethnic cultural natural protection complexes, for example, of the environmental-ethnographic parks, reserves, etc., where the priority rights to land and economy of the indigenous people are realized. Our surveys of the Kets population confirm our views on the significance of this strategy. According to the residents of the village Sulomai, giving the Central Siberian Reserve the environmental-ethnic status and the inclusion of hunting and fishing grounds of Kets in it could protect against poaching and would strengthen the Ket's right to the TTU. Such experience exists abroad, where the creation of biosphere reserves meets not only the objective of preservation of the natural but also of the cultural environment and of preservation of traditional forms of the natural resource use and of landscapes with the balanced resource use. It is apparent that government handouts in the form of small payments that promote social anemia in mono-ethnic villages should be replaced with support for their quality work and traditional crafts.

THE FINAL STATEMENT

It seems that in the context of global warming and growth of climate instability, a close relationship between the traditional economy of indigenous peoples, the natural resources, and environmental, and geographical factors of the environment becomes even more pronounced.

N.N. Mogosova ,T.A. Vorobyova
Faculty of Geography, Lomonosov Moscow State University

A comprehensive assessment of the environmental conditions in urban politics

INTRODUCTION

We presented a comprehensive assessment of the environmental analysis in the South part of city of Moscow by using, geoinformational systems (GIS), mathematical model and environmental monitoring data as a poster presentation in the 1st Russian–Japanese Collaboration Seminar for Sustainable Environment. This article describes the basic methods of research and summarizes the data obtained as a comprehensive assessment of the city.

Making cities environmentally healthful places in which to live, work and play is a growing concern throughout the world. The focus of much of this concern is on ways to measure and manage the environmental spillovers of one urban function on other urban activities. Some of the most dangerous and annoying spillovers result from manufacturing activities and transport. These impacts are most acute for residential areas and other environmentally sensitive urban functions. In the past, city planning has sought to reduce or eliminate these impacts by physically separating environmentally intrusive and environmentally sensitive land uses. Elected officials and planners have come to realise that this strategy is no longer effective as cities grow in size, and as local and national policies call for increasing the density and mixture of uses in urban areas [2].

Our study aimed to analyse the ecological state of the natural components of the urban environment, including the pollution of air, soil, water bodies, vegetation and noise exposure. The obtained data were the basis for the creation of an overall assessment of the ecological state of the Southern Administrative District of Moscow.

METHODOLOGY AND STUDY AREA

The research is based on environmental monitoring data for all natural environments of the city, which include both automated data from the stations of air pollution control and natural sites of permanent observation survey of soil, water bodies and vegetation. This information has been Added to GIS (ArcGis 9.3), which were constructed spatial maps of ecological state of the area (fig. 1). Outdoor air pollution was based on traffic flows and settlement patterns of concentration of harmful substances.

Geographic information system (GIS) is a one of the up-to-date and the most fast-growing tools for urban environmental research. The main task of the methods of modeling, remote sensing and geo-information technologies is to support urban environment quality management, especially decision-making process with the aim to enhance environmental safety of the population. Analysis of the current environmental situation along with inferring of cause-effect relations between natural environments, socio-economic conditions and public health depend mostly on informational support [4].

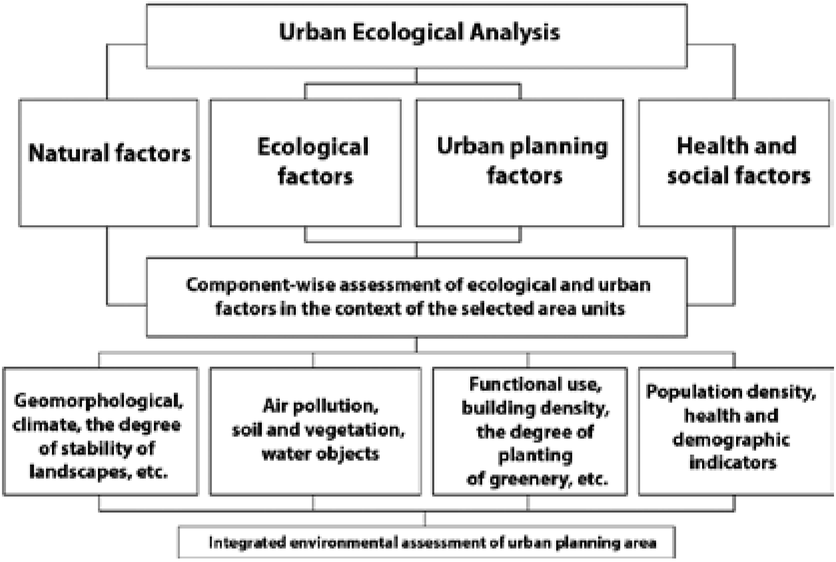


Fig. 1. The structure of the complex environmental assessment of urban area [3]

Same since 2010 the Moscow State Budgetary Environmental Institution “Mosecomonitoring” maintains the database of resident`s complaints integrated to the environmental GIS of Moscow. The incoming complaints are classified by types. Certain dot layers show resident`s complaints on ambient air quality, water pollution, noise discomfort or a set of issues of residents` concern. The mobile analytical laboratory makes on-site assessment of the situation for each complaint. The data on excess of maximum allowable concentration or standards, if any, enter an attributive table of GIS base layer. During analysis of resident`s complaints natural and functional peculiarities of the area is taking into consideration. At that it should be identified a pattern of anthropogenic objects distribution and environmental risk sources in accordance to the applicant`s (complainant`s) address [5].

RESULTS

Transport and communication system of the city — one of the main sources of environmental pollution. The peculiarity of its impact is expressed in linear forms, linked to transportation and communications facilities. The impact of transport on the nature manifests itself mainly in bringing the liquid, solid and gaseous substances with high chemical activity and toxicity, as well as in noise pollution.

The highest density of traffic in there on the main radial highways connecting the centre to peripheral areas (fig. 2 A). At the Kashira and Warsaw highway of cars reaches 12 thousand per hour. Kashirskoye separated from the Warsaw highway just north of the intersection of Nakhimov Avenue and at a considerable angle in areas to the south and southeast. Andropov in the Prospectus, and the Sevastopol Nakhimov Avenue just load is high enough intensity ranges from 1.5 to 6 million vehicles per hour.

The situation in air pollution (fig. 2 B) is most acute in the areas of intersection with Nakhimov avenue. Here PDKmr exceeded 2–3 times of nitrogen dioxide and 3–4 times for carbon monoxide. Moreover, if the nitrogen dioxide concentration in the centre of the intersection are reduced and do not exceed the limit ratios, the carbon monoxide remains on the high level of 1.2 PDKmr.

About 50% of the area of the city belong to the category of weak soil pollution, with an average contamination of 28%, and with a strong 29% of the area of the city, they are mainly concentrated in industrial areas and adjacent to highways.

As a result, a special noise exposure prone areas with the residential area adjacent to the territories in the area of Warsaw and Kashira highway. Here, the distance to the standard levels of noise can be up to 300–400 meters. Andropov Avenue and Prospect Nahimovskiy also are sources of noise discomfort. As a result, the noise levels in residential houses located in the first row along the motorways is 62–70 dBA. Exceeding regulatory levels of noise is 7–15 dB.

This evaluation of the state of soil, vegetation, water bodies, noise discomfort and air pollution allowed to allocate 5 gradations of environmental stress on the territory favourable to critical. The critical level of pollution (pollution index of more than 150), apply to industrial sites, located in the northern part of the region. Areas with intense levels of pollution are more differentiated (125 to 150). This is the first residential development sites along major highways (fig. 3).

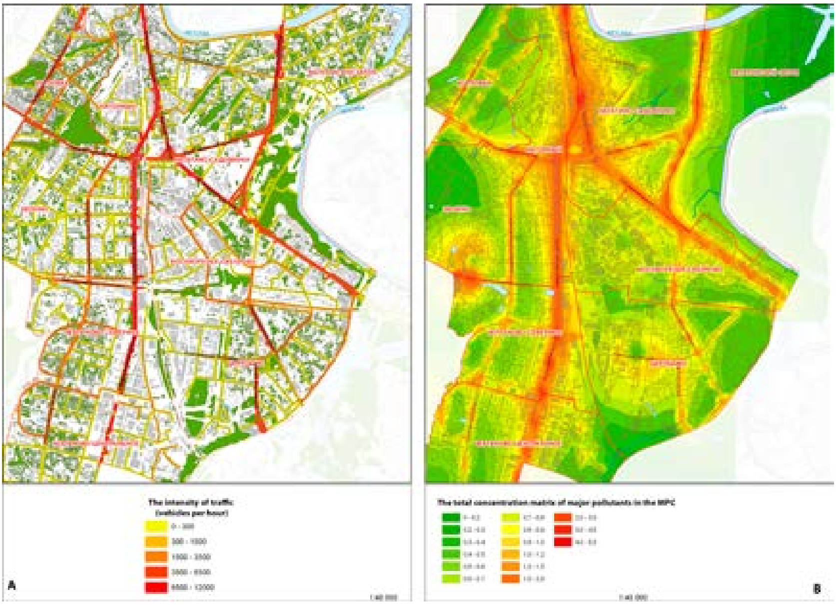


Fig. 2. A) The intensity of traffic, B) Air pollution.

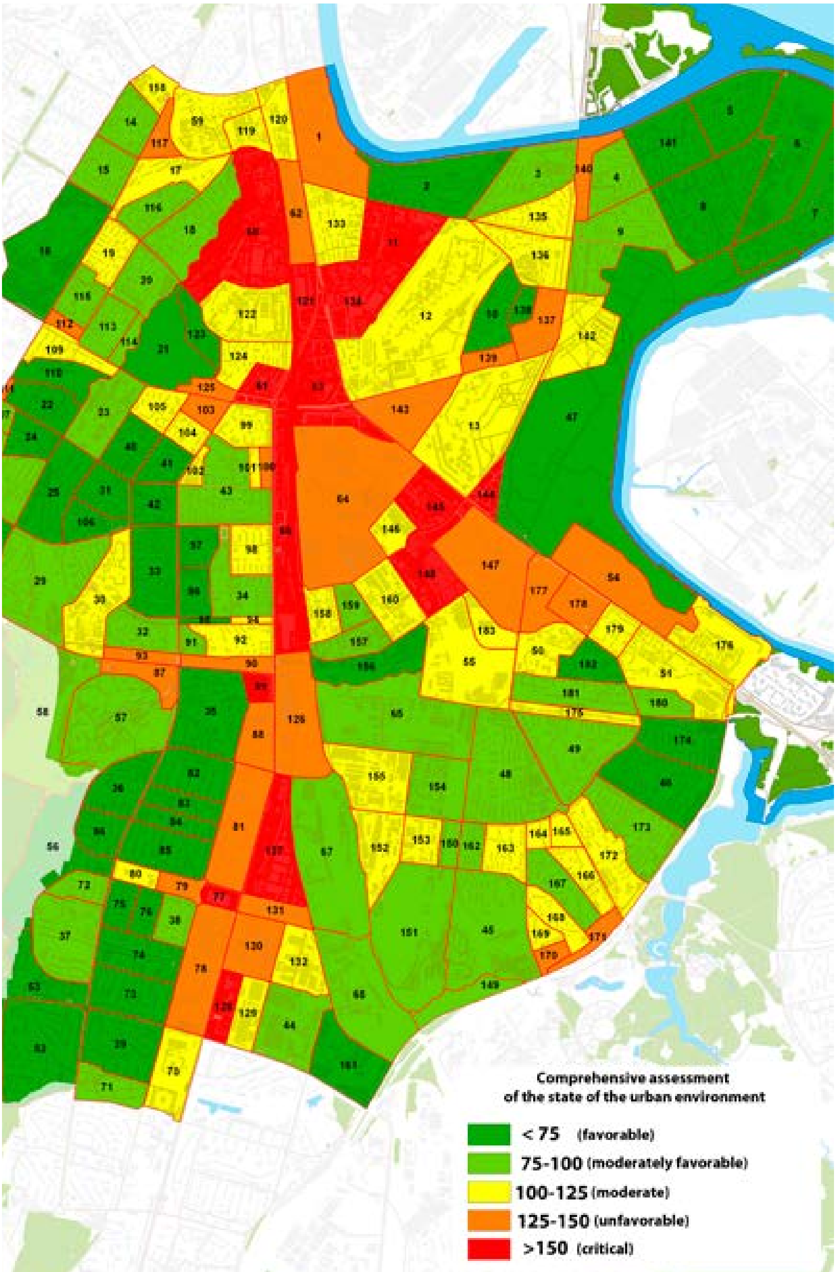


Fig. 3. The complex environmental map of part of South Administrative District of Moscow [1]

CONCLUSION

Residential or public buildings subject to strong anthropogenic pressures need to use a set of measures as landscape planning and managerial issues. Such measures may include the first increase in woody vegetation cover, which creates a natural barrier to contaminants and noise exposure, and increase the level of self-purification of the environment.

Integrated environmental assessment of the urban area is an integral part of urban planning. It allows for the implementation of the master plan of the city in terms of environmental and urban planning requirements with the use of economic, legal and administrative mechanisms, including measures to reduce the impact on the environment, rehabilitation of natural areas thereby positively affecting the quality of life of the population of the city.

REFERENCES

1. Mogosova N.N. Assessing the environmental state of the area in a modern city planning. Regional environmental problems. Moscow, 2013, № 2. P. 10–20 (in Russian).
2. Urban environmental planning: policies, instruments and methods in an international perspective. 2nd ed (Urban planning and environment) / [edited] by Donald Miller and Gert de Roo, 2005. P. 3–4.
3. Vorobyova T.A, Mogosova N.N. Analysis of the state of the urban environment using GIS. InterCarto/InterGis 19: Sustainable Development of Territories: GIS theory and practical experience, 2013. P. 56–62 (in Russian).
4. Vorobyova T.A., Polivanov V.S., Polyakov M.M. Municipal GIS information supply environmental control. Vologda, 2006. – 250 p. (in Russian).
5. Zakharova P.V., Mogosova N.N. Geographic Information technologies in the course of state environmental monitoring in Moscow. The VII International Conference "Remote Sensing — the Synergy of High Technologies", Moscow, 2013.

G.D.Mukhin, T.A.Boldanov
Department of Nature Management, Faculty of Geography, Lomonosov Moscow State University

The problems of nature management in Republic of Buryatia and directions of its rationalisation

INTRODUCTION

Baikal region is characterized by a high level of nature conservation law-making. Environmental legislation for traditional industrial development requires especial attention to the rational nature resource management in the region.

The analysis and the assessment of natural conditions and resources as well as forms and ways of their use were taken as a basis of the map chart for the contemporary nature management in the Republic of Buryatia (fig. 1). The study had brought to light the results and the problems of nature management from the point of efficiency of natural capital using.

The analysis of nature management results and problems detected during mapping with taking into account environmental legislation in Baikal Nature Territory had allowed to determine main directions of rationalization for each important nature management type.

RESULTS

The study of territorial-field structure of the nature management has resulted in assignment of 10 zonal types and more than 30 subtypes of nature management and some dozens of territorially localized kinds of nature management. Every assigned unity has been characterised by quality of used resource, forms and ways of its using. Comparing quality and quantitative characteristics of used resource

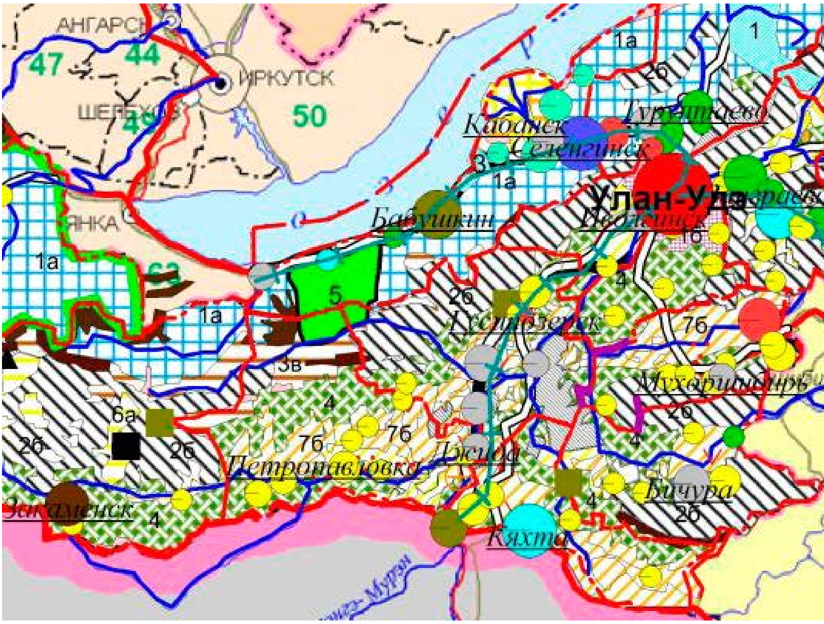


Fig. 1.Contemporary nature management in the Republic of Buryatia (fragment of the map). The legend in the table 1

with environmental and economic results has allowed to establish main directions of rationalization in the Republic of Buryatia. These results are shown in the table 1.

CONCLUSIONS

Conjugative analysis of nature potential, ways of its use and results of nature management is supposed to be a constructive method for development of primary directions in the regional nature management.

The main directions of nature management rationalization:

Mining nature management. The total cost of explored reserves of mineral raw materials is more than 200 milliards of dollars, but the mining industry input into the Gross Regional Product is very low. There is necessary to develop new deposits of nonferrous materials in the eastern and north-eastern part of the Republic according by environmental technologies of extraction and processing of raw materials.

Table 1. Part of the legend to the map of contemporary nature management in Republic of Buryatia

Indexes		**Characteristics of resources quality**	**Forms and ways of land use**	**Results and problems of nature management**
type	*subtype*			
Resources consumption nature management (zonal)				
Forestry Protection forests with high cadastral value				
1.	a)	Riparian forests along Baikal coast	Silvicultural activities for environmental and water protection aims, intermediate use logging, procurement of non-timber products	In total forests have protection functions. The unauthorized felling occures
	6)	Sanitary protection forests around towns	Silvicultural measures for the preservation, hygiene and health functions, sanitary felling, harvesting of non-timber products	Forests have protection functions. The unauthorized felling occures
2.	6)	Commercial forests within the area of relatively high economic development and transport accessibility	Intensive main felling with local disturbances use of the AAC rate	Exhaustion of wood resources, decline of timber quality and development of negative processes
3.		Reserve forests, far off with low-yielding sparse larch stands and mountain pine communities with low cadastre value	Hunting, fishing, harvesting of non-timber products	Unexausted nature management, minimal anthropogenic impact on landscapes
4.		Farm's forests	Grazing, hunting, harvesting non-timber products	Increased impact on forest ecosystems, local disturbances and cuttings
Agriculture				
6.	a)	Forest steppe landscapes of mountain valleys with highly productive pastures in combination with arable areas	Cattle grazing and horse herd farming	Incomplete use of the pasturable resources

6.	6)	Gray forest soils and floodplain soils	The cereral spring crops (≈ 55–65%); forage crops (≈ 25–30%) and potatoes (≈ 5–10%)	Beginning erosion by water
7.	6)	Chestnut soils, chernozems, and floodplain soils partially irrigated	Spring cereals (≈ 60–70%), fodder (≈ 30–40%) and small crops of potatoes	Processes of deflation and water erosion
8.	a)	Low mountain taiga and valley landscapes with dominating pastures in combination with arable land	Cattle, sheep and goat grazing	Insufficient use of pasture potential
	6)	Chestnut and gray forest soils	Forage crops cultivation mainly	Deflation processes on chestnut soils
9.	a)	Dry steppe mountain valley landscapes with a equal proportion of pastures and arable land	Cattle and sheep grazing	Insufficient use of pasture potential
	6)	Chestnut and floodplain soils	Balanced combination of cereal and forage crops	Intensive processes of deflation
10.		Forest steppe valley and suburban landscapes with intensive agriculture	Cattle breeding, pig and poultry farming, cultivation of potatoes and vegetables	Soil contamination
Traditional nature managent				
		High mountain meadow, tundra, forest-tundra landscapes with sparse larch forests and dwarf-pine communities	Reindeer herding, hunting, fishery, subsidiary farming	Unexausted use of natural resources, the effects of mining and transport activity

Resource consumption local nature managent				
Mining Functioning deposits				
		Coal mining (Bayangolskoe). Ore (C1 category) stocks are 304.7 million tons, ore C2 – 41.4 million tons, including 246.2 million tons of ore C1 tons within open-cast contour	Open mining 10.0 thousand tons	The area of disturbed lands is 0.5–1 thou. ha. Contamination of soils, water
		Brown coal (Gusinoozerskaya, Sanginskoe, Zagustanskoe, Okino-Klyuchevskii Daban - Gorhonskoe). The main reserves of brown coal are located in Gusinoozersky coal basin	Open-cast mining, 1012.0 thousand tons	The area of disturbed lands is 0.5–1 thou. ha. Contamination of soils, water
		Axe-stone (Ospinskoe, Gorlykolskoe, Hargatinskoe, Golyubinskoe, Kavoktinskoe, Haitinsk)	Mining 909 tons of raw jade and 272 tons of high-quality jade	The area of disturbed lands of individual deposits of up to 100 hectares, the total amount to 1.0 thousand hectares
Enviroment forming nature management				
Intented for building and farming Sizes of residential places				
		The number of population in residential places	Urban settlements, villages and countryside	Municipal economy problems, the overall pollution
The main kinds of industry and economic activities accoding to its effects on the environment				
		Multifunctional Industrial and Transport	Multivariable use	Overall pollution
		Fuel and energy	Heating plants, regional power stations	Air pollution
		Mining	Quarries and mines	Disturbed lands
		Pulp and Paper Industry	Selenge cellusose cardboard complex	Chemical pollution of air and soils

		Forestry and wood industry	Production of lumbers	Impact on forest ecosystems
		Industry in conjunction with other activities	Manufacturing industries	Environment pollution
		Agriculture	Villages	Municipal economy problems
		Recreation	Recreational settlements	Municipal economy problems, unorganized tourism
		Fishery	Fishing and fish processing	Municipal economy problems
		Transportation	Linear objects	Air pollution, contamination of the roadsides, noise pollution

Agricultural nature management. The efficient using of the agricultural environmental potential requires combination of traditional and contemporary forms of agricultural development with renewal of traditional cattle breeding and production of pollutant-free products.

Forestry. Implementation of deep wood processing, moving logging areas to the north and to the east of the Republic (out of Baikal Environmental Zone) according by unexausted forest use.

Recreation nature management. The perspecives of tourism development are connected, first of all, with creation of especial recreation zones such as "Baikal harbor". It is necessary to develop local tourist clusters within 15 municipal units.

Nature concervation management. It is necessary to create the new especially protected nature territories (EPNT) not only in the vicinity of Baikal lake, but in its watershed basin too. The EPNT area should reach 10–12% of the Republic area.

O. Shuvalova
Department of Nature Management, Faculty of Geography, Lomonosov Moscow State University

The link between environmental and social issues: pollution and health

INTRODUCTION

Cities are like magnets attract industrial, cultural, environmental and demographic potential. The various intersections among society, environment and economy lead to complex problems within cities. This fact predetermines the interest of global community to the concept of Sustainable Development. The priority of regional development plan for the aims of sustainable development was proposed at the World Summit "Cities and sustainable development" in Manchester, 1994. The Aalborg Charter (1994) of cities for sustainable devel-

Fig. 1. Location of Volgograd region in Europe

opment provides a framework to deliver local sustainable issues on local authority level, takes up questions about the necessity to consider and identify weak and strong points of each city individually in order to make a plan for development. Nowadays many international programmes are devoted to energy efficiency, climate change, land use and recourse consumption in urban areas. To develop indicators and estimate the potential of sustainability of the cities in quantitative and qualitative term is the main task at the moment. This issue is not new: several systems of indicators are proposed by UN, World Bank, Commission on Sustainable Development and other organizations. Usually these indicators are unitary and do not oriented on regional issues. Concerning Russian heterogeneous regions, some indicators cannot be used or can be used in a specific matter.

CASE STUDY

Volgograd region (Volgogradskaya oblast) is located in the south-east part of European Russia. The area of the region is 112.900 km^2 which is almost equal to that of Bulgaria (110.900 km^2), greater than the Benelux countries (the Netherlands, Belgium and Luxemburg — 74.640 km^2), double that of Croatia (56.590 km^2) and three times greater than Switzerland (41.285 km^2) (Fig. 1).

Population of the region is 2,6 mln people, density — 23,1 people/km^2. The cities of Volgograd region are only 15% from all the municipalities, but at the same time approximately 76% of regional population lives in it. The main industries are chemical, heavy engineering industry and metal manufacture, while agriculture oriented on wheat, barley, rye, sunflower, corn production.

METHODOLOGY OF ASSESSMENT

The method chosen to assess the level of environmental and social sustainability of the region was objective and consisted of gathering and analysis of statistical data. Taking into consideration the availability of statistical data and recommendations proposed in the policy document “The strategy of socio-economic development of Volgograd region (2008–2025)” [2] the list of environmental indicators was proposed (Table 1).

Table 1. Criteria and indicators for assessment of environmental sustainability in Volgograd region [3]

Component of environment	**Criteria**	**Environmental indicator**	**Dimension**
Atmosphere	Pollution of the air	Emissions to atmosphere from stationary sources relative to square of the district	Tonne/km^2
Hydrosphere	Pollution of water resources	Discharge of sewage into water resources relative to volume of water resources in the district	Mln. m^3/km^3
Lithosphere	Use of land	Waste production relative to square of the district	Tonne/km^2
Biosphere	Anthropogenic pressure	The ratio of the level of anthropogenic load to the natural potential of the district	–

The list of medico-demographic indicators is proposed for estimation of social sustainability (Table 2).

Table 2. Criteria and indicators for assessment of social sustainability in Volgograd region (*developed by author*)

Component	**Criteria**	**Social indicator**	**Dimension**
Demography	Birth rate	The number of people born to 1000 of population	‰
	Mortality rate	The number of people died to 1000 of population	‰
	Child mortality rate	The number of children died in the first year of life to 1000 of born children	‰
Health	Child morbidity	Number of cases of morbidity (at the age of 0–14)	per 100 thous. people
	Adult morbidity	Number of cases of morbidity (at the age of 18 and older)	per 100 thous. people

Multi-criteria analysis is used for integration of indicators at the districts' level.

RESULTS

Air pollution is largely characterized by the emission of pollutants from fixed location sources, taking into considering all pollutants in

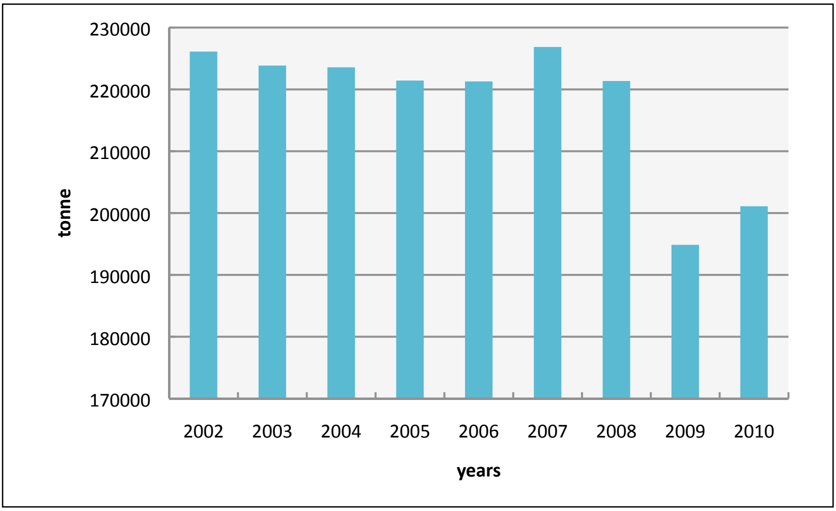


Fig. 2. Air pollution in Volgograd region [1]

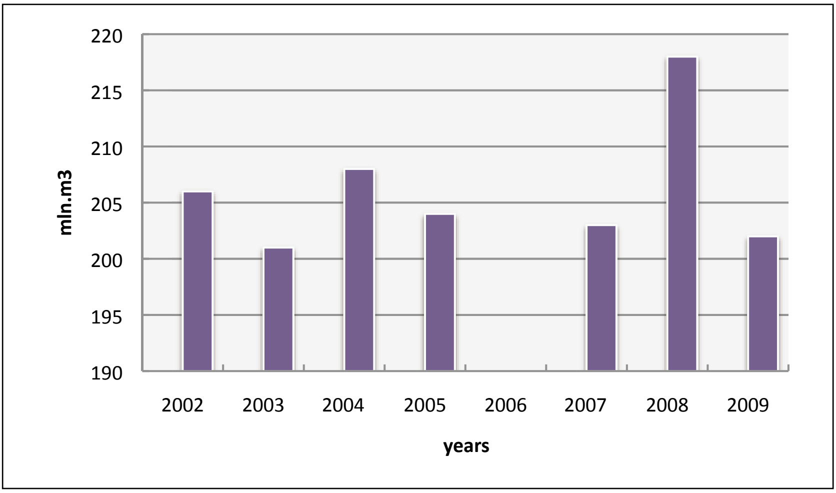


Fig.3. Discharge of sewage into water resources in Volgograd region [1]

the atmosphere after the reduction of dust and gas by filtering facilities and without further purification. There has been a noticeable reduction of total air emissions in recent years (Fig. 2). The highest levels of the air pollution are observed in cities and in some sub-regions: Yrupinskiy, Alekseevskiy, Zhirnovskiy, Kotovskiy, Olkhovskiy,

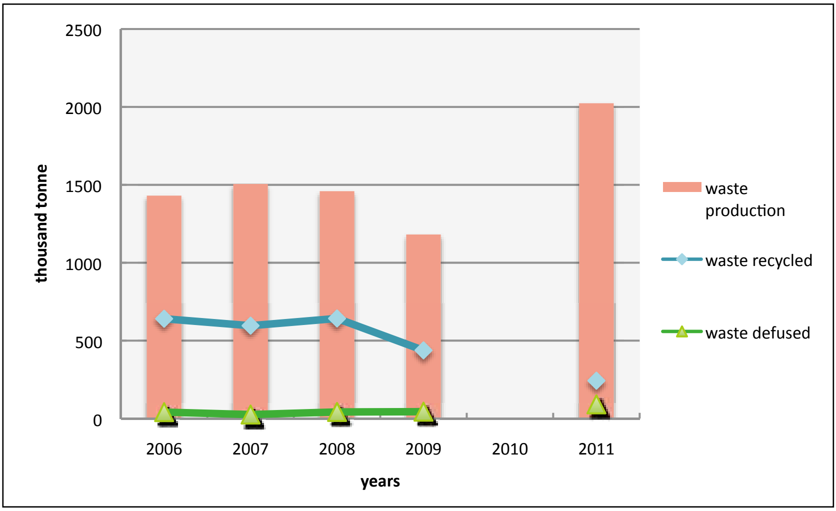


Fig. 4. Waste production in Volgograd region [1]

Gorodishenskiy. It is largely explained by regional industrial activities in these places, where facilities for controlling gas pipelines are located. 42% of all regional emissions are generated within the two major cities of the region — Volgograd and Volzhsky.

Water resources are very important in life of Volga people. Volga is cultural and economic artery of the region, which is influence on economic and social development (Fig. 3). Its ecological situation characterized with heavy metals pollution, phosphorus, nitrogen.

Waste production is characterized with annual positive dynamic — it increases every year by 2,5 mln.tonne (Fig. 4). Despite waste is available for recycling (37% is paper, 30,6% — organic waste, 1,9% — wood, 3,8% — metals), the recycling industry is not developed.

Land is the primary natural wealth of the region thus ensuring food security. Production of grain and oilseed crops for the world market makes a vital contribution to GDP, building economic wealth and raising living standards for the indigenous population. The present distribution of the Land Fund is the result of intensive development of 1,6 million ha of virgin steppes in 50–60 years of XX century. The high level of plowed land (78,7%), heavy concentration of cattle

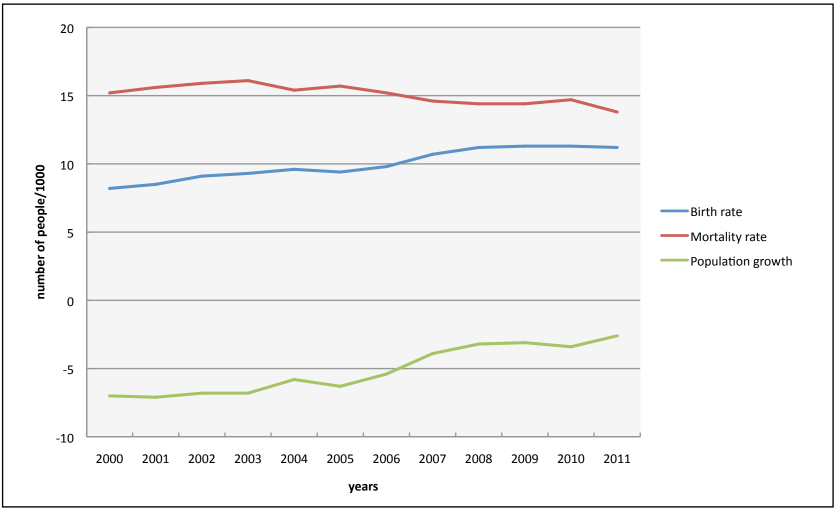


Fig. 5. Demographical situation in Volgograd region [1]

in the pastures and intensive farming systems have led to depletion of natural potential [4].

Since 1992 in Volgograd region as well as in whole country, it is the process of depopulation (Fig. 5).

Last years the situation has been improved due to the introduction of stimulations in frame of National Programme "Health" started in 2005. Thus, stimulants are:

- developing and opening of children's nurseries.
- providing career security for woman

It is necessary to mention that trend of morbidity in general is positive especially among children and juvenile (Fig. 6). Analyzing different kind of morbidity it was detected that growing trend is nearly characterized all the groups of morbidity. For the last decade the level of respiratory diseases decreased can be caused by decline of "dirty" industries. But very last year the level of mentioned diseases tends to grow what corresponds with crisis reanimation of industry. Digestive system diseases and urolithiasis are directly connected with the water quality. The dynamics here is fairly stable or growing (Fig. 7)

In this paper we consider several environmental indicators for urban area in Volgograd region with stress on social aspect, especially

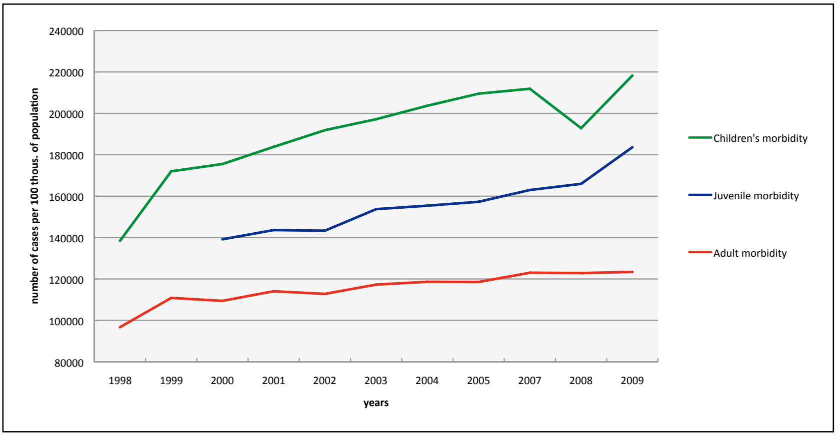


Fig. 6. Morbidity among different age groups (children, juvenile and adult) [1]

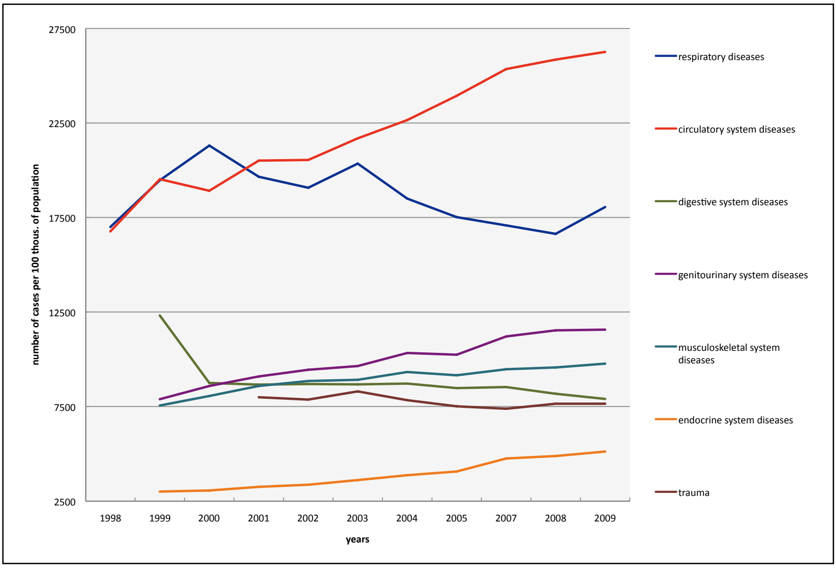


Fig.7. Morbidity among different kind of diseases [1]

health issues. Thus, air and water pollution are two foreground environmental issues that influence on health. It has been proved in many scientific papers. For instance, high concentration of CO_2 in air leads to faints, NO_x influences on immune system and lungs, also leads to bronchitis and pneumonia, SO_2 disturbs mucous of eyes and respiratory.

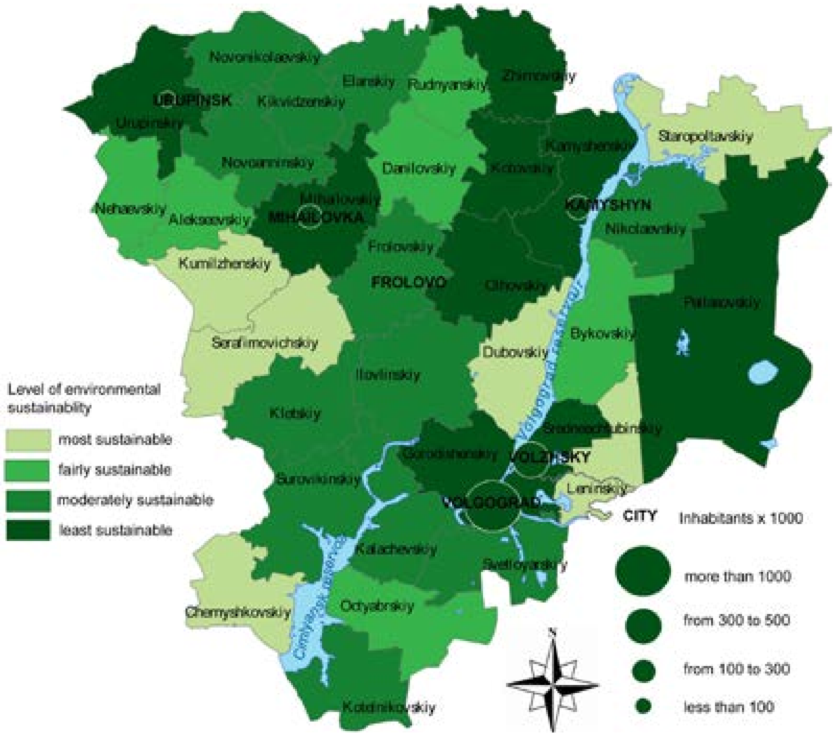


Fig. 8. Environmental sustainability

Spatial regional analysis (Fig. 8, Fig. 9) shows very weak correlation between air and water pollution and the range of diseases. It can be explained by the fact that big cities have excellent opportunities for early diagnostics and better treatment, moreover hospitals in cities attracts the best medics. At the same time there is a correlation between environmental issues and level of child mortality, particularly in medium-size cities, suburban rural municipalities and municipalities with oil extraction specialization.

Thereby, pollution of air and water are determining factors of city's sustainability. Together with health indicators they reflect city-dwellers quality of life. Taking into account that better quality of life is the main aim of human sustainable development it is necessary to monitor these factors. For more comprehensive analysis it is perspective to regard the links between environmental-economic and socio-economic issues.

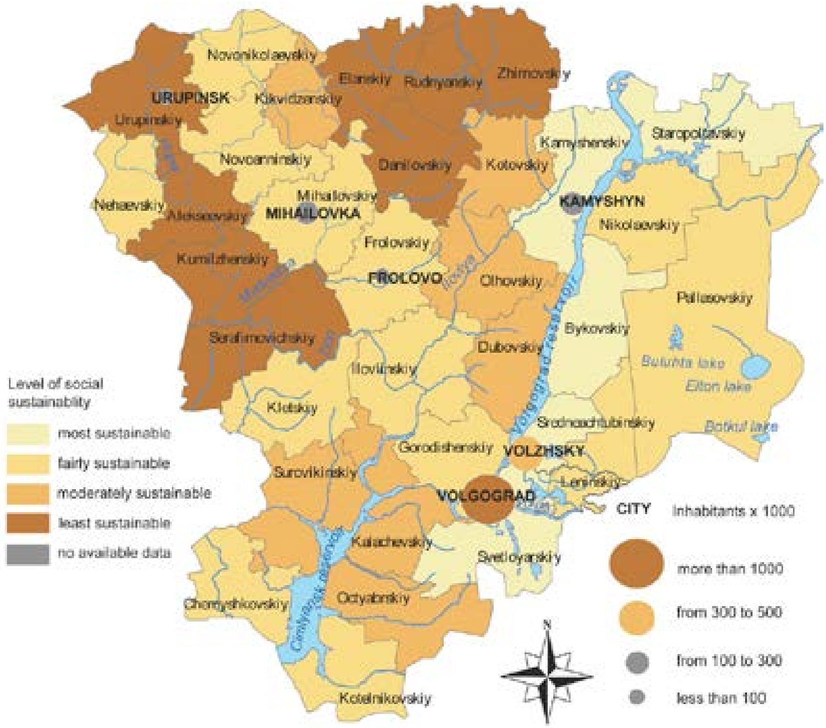


Fig. 9. Social sustainability

REFERENCES

1. Statistical review. Protection and Environmental Management of Natural Resources in Volgograd Region, 2010, 2011.
2. Strategy of socio-economic development of Volgograd region (2008–2025). – Volgograd, 2008.
3. Shuvalova, O. Environmental sustainability assessment in Volgograd region // Problems of regional environment 4, 2012. P. 31–36.
4. Volgograd region: natural conditions, resources, economy, population and geoecological situation. – Volgograd, 2011.

E.Yu. Vasenkina
Environmental Centre IFPA

Environmental management framework in Russia and Japan: similar and specific features

INTRODUCTION

We focus on the comparative performance of the two countries in terms of features and modern state of development of environmental governance systems in them. Such comparison is an important and necessary stage for searching the spatial regularities of national environmental management systems frameworks in the new area of research for geography — the Environmental management geography.

Our research objective is to identify key parameters that should be the basis for a comparative analysis of national environmental management systems in two or more countries and their subsequent geographic interpretation. The previous studies dealt with the discussion of general methodological and theoretical issues of Environmental management geography [2, 3]. The current abstracts summarize similar and specific features of two different national environmental management systems (Russia and Japan) that initially formed in different geographical, economic, social and political conditions. Thus, we come to the description of the phenomena that constitute the objectives of the study of Environmental management geography.

BASELINE DATA AND METHODOLOGY

We use the concept of environmental governance as a basis of comparison that is a field of cooperation and equal participation of key stakeholders in the environmental management [1, 4]. Selecting of parameters corresponded to the three key stakeholders' relevant fields: government, business and civil society. We take into account structural features, relations with key stakeholders, effectiveness, while comparing the instruments of environmental management. We used a method of schematic diagrams construction, providing visibility of comparison for some management tools. In some cases, the existing schemes have been adapted.

RESULTS

In this poster paper, we compared the two countries in three areas: tools of administrative regulation, the role of civil society and the role of business-society in governance (Fig. 1 – Fig. 5). Figure 1 shows a list of primary comparison parameters.

These two countries represent an example of different general structure of environmental management system on the national level. In the first case (Russia), most of the functions are concentrated in a single agency. In the second case (Japan), the regulatory functions of resources use and environmental protection are distributed

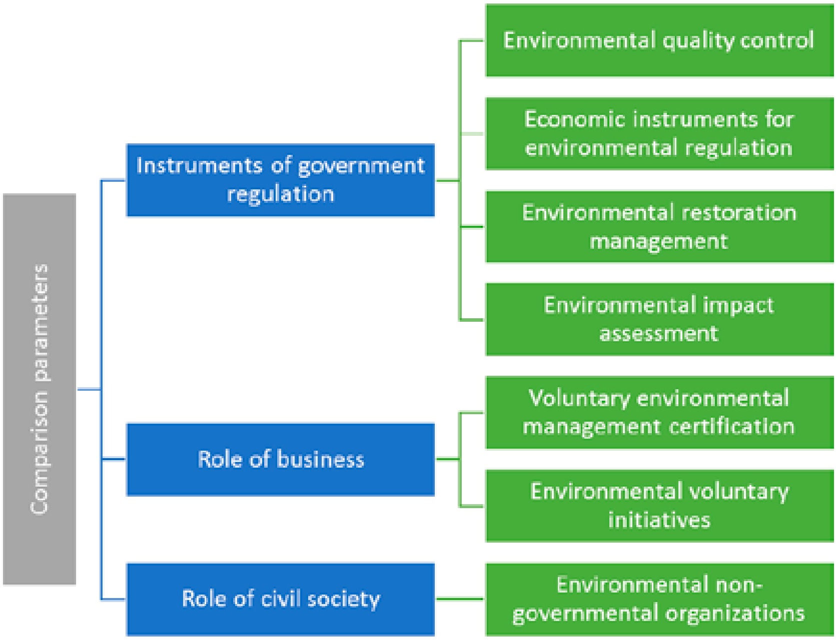


Fig. 1. A list of primary comparison parameters

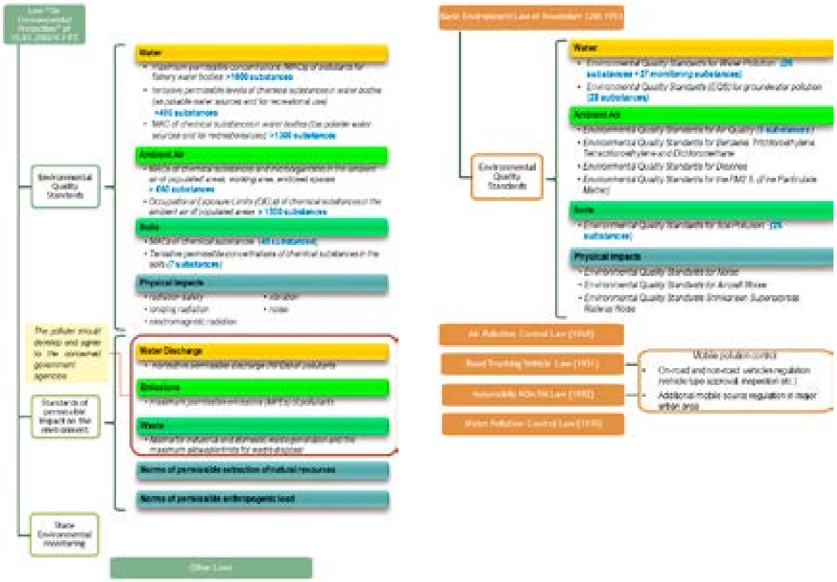


Fig. 2. Schematic diagram of legislation bases of environmental quality monitoring and environmental pollution control in: Russia (*left*), Japan (*right*)

among different departments. Thus, it is possible to talk about different types of organization of national environmental management systems: monocentric and polycentric.

Similarities in the structural organization of environmental management systems are preconditioned by common management tools, such as tools for environmental quality monitoring and pollution control, environmental economics, a network of protected area, environmental impact assessment, etc. The specifics of individual countries is related to how these instruments are accommodated into the existing management system and how to ensure their operation.

CONCLUSION

This work is an intermediate stage of a comprehensive study on searching the spatial regularities of national environmental management systems frameworks. The main result of this stage is the primary list of parameters characterizing the national environmental management systems and adequate to the tasks of geographical

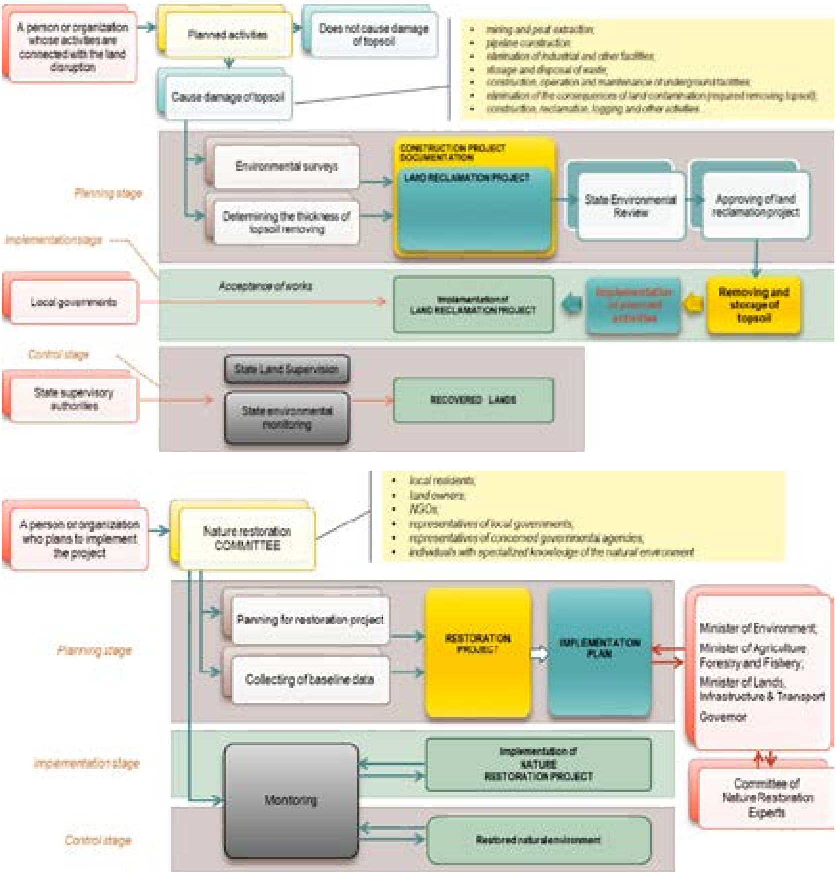


Fig. 3. Schematic diagram of operation of management tool in environment restoration in: Russia (*upper*), Japan (*lower*)

interpretation. We also identified additional features, which may be important for comparing the national environmental management systems in two or more countries.

It is not enough to have information about availability of specific management tools for an adequate comparative geographical analysis of different countries. It is also important how these instruments are accommodated into the existing system, how they are operated and what result can be achieved. The whole complex of parameters determines the specifics of national environmental management systems.

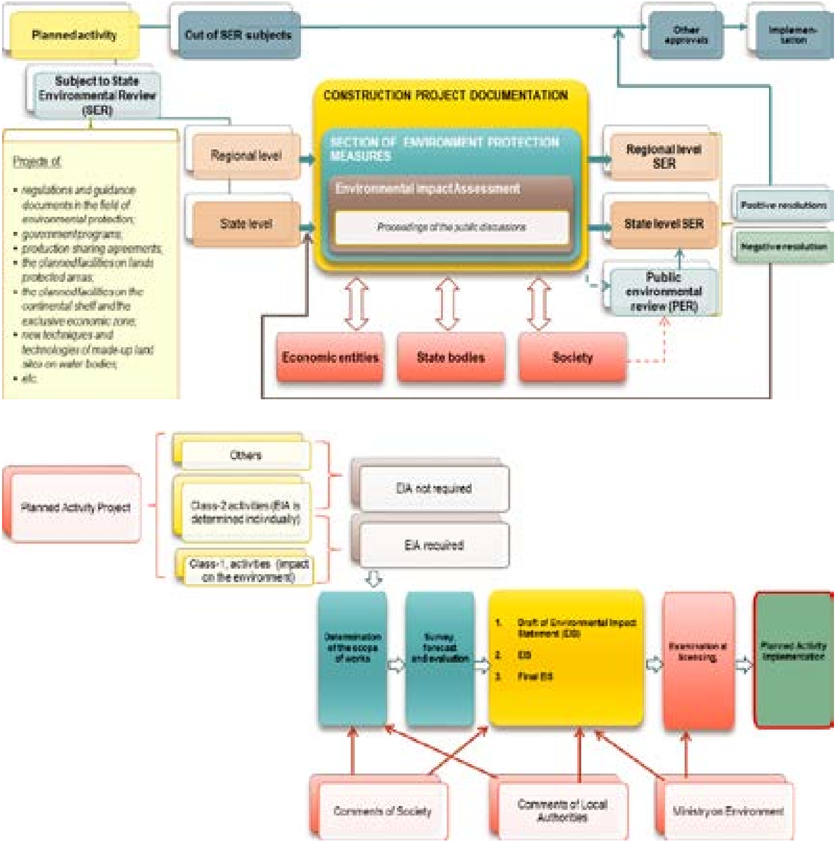


Fig. 4. Schematic diagram of operation of environmental impact assessment in: Russia (*upper*), Japan (*lower*)

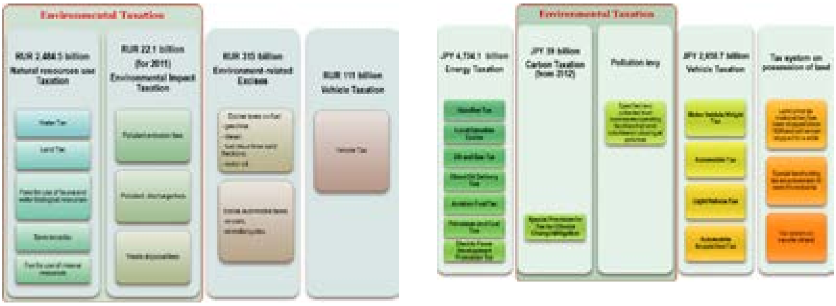


Fig. 5. Environment-related taxes, fees and charges in: Russia (*left*), Japan (*right*)

The problem of selecting a set of indicators for the comparative analysis of national environmental management systems is closely related to the availability of detailed information on the processes occurring in the natural, social and economic spheres, as well as within environmental management systems.

REFERENCES

1. Bridge, Gavin, and Tom Perreault (2009), Environmental Governance. In: A Companion to Environmental Geography, edited by Noel Castree, David Demeritt, Diana Liverman and Bruce Rhoads. Malden: Wiley-Blackwell. Pp. 475–97.
2. Vasenkina E. and Y. Mazurov (2012), Environmental management: geographical context. In Environmental management: theory, practice, education, ed. by M. Slipenchuk, Faculty of Geography, Lomonosov Moscow State University. Pp. 32–39 (in Russian).
3. Vasenkina E. (2012), Geography of national environmental management systems in the world. In Environmental the International Scinetific and Practical Conference dedicated to the 25th anniversary of the Departament of Environmental management, Faculty of Geography, Lomonosov Moscow State University. Pp. 32–39 (in Russian).
4. Hempel, Lamont C. (1996), Environmental governance: the global challenge. Island Press, Washington. 291 p.

E.L. Vorobyevskaya, T.Yu. Zengina,
N.B. Sedova, A.V. Ustyantsev
*Department of Nature Management, Faculty of Geography,
Lomonosov Moscow State University*

Complex geographic researching in the Baikal region

INTRODUCTION

Complex geographic research has been carried out for several years in the Republic of Buryatia by the students and teachers of the geographical faculty of Moscow State University. Our researching was aimed at the assessment of the current state of ecosystems of the Baikal Natural Territory and the identification of prospects for the development of different types of nature management in the areas of research.

Special attention was given to the development of tourism in Buryatia. Wonderful landscapes and image of Baikal together with mountains, fresh air, pure crystal water make this region important and valuable for tourism.

The aims of our expeditions vary and depend on the area. The following areas have been studied: Severo-Baikalsky, Pribaikalsky and Barguzinsky Districts of the Republic of Buryatia.

SEVERO-BAIKALSKY DISTRICT

Main aim was the forecasting of possible changes of modern nature management in the Severo-Baikalsky District in the case of the development of the Kholodninskoye lead-zinc pyrite deposit. To study the environmental impact we made an estimation of current conditions of the landscapes in the area of the Kholodninskoye lead-zinc pyrite deposit. “Kholodninskoe” located in the catchment basin of Lake Baikal takes the 4th place on zinc and lead reserves in the world [1]. The ore body has not been developed, but the streams from mines

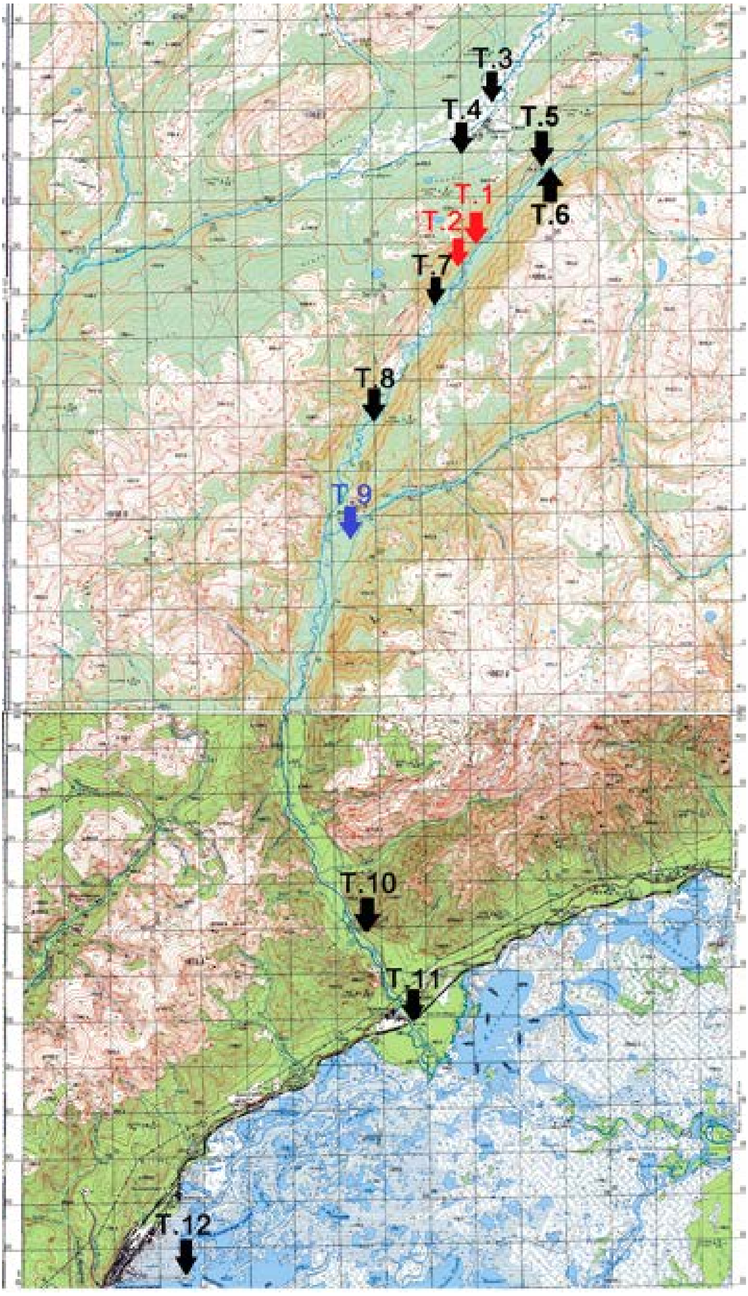


Fig. 1. Sampling points

continue to pollute rivers with heavy metals and carry pollutants to Lake Baikal. The sampling points were selected (Fig. 1) and the samples of soil, vegetation, bottom sediments and water were processed in the laboratory of the Department of Environmental Management. The obtained results show that the maximum mineralization (730 mg/l) and the increased concentrations of 40 chemical elements were found in the mine streams: for Zn in 17000 times; for Cd, Mn, Ce in more than 1000 times [2].

Another important aspect is socio-economic. Here we collected information on current activities and problems of Evenk community of traditional nature use “Oron”. The Evenk community, a traditional reindeer-herding culture, is working to protect its culture and way of life in the face of increasing resource extraction.

North part of Baikal becomes more attractive for tourists. The area which drew our attention in the Severo-Baikalsky District is Khakusy. Khakusy is the area of hot mineral springs on the Lake Baikal cost. The combination of Siberian taiga forest together with white sand and hot mineral waters provides special power to this place and makes it a health curing area. The assessment of recreational potential for the development of ethno-ecotourism in Khakusy was made.

As a result of our studies the map of contemporary nature management of the Severo-Baikalsky District was made.

PRIBAIKALSKY DISTRICT

In the Pribaikalsky District complex summer and winter investigations were undertaken. Main aim was the estimation of current conditions and prospects for tourism development in the Pribaikalsky District in the context of forming Special Economic Zone of tourist-and-recreational type (tourist recreational zone — TRZ) “Baikal harbour” (Fig. 2).

Landscape research included the study of the landscape structure and ecological capacity of the territory, the study of hazardous exogenous natural processes in the area and the assessment of recreational potential of landscapes. As a result recreational complexes attractive in a different way were distinguished.

Hydrochemical research was carried out to estimate the current ecological status of Lake Kotokel and its suburbs (Fig. 3). The hy-

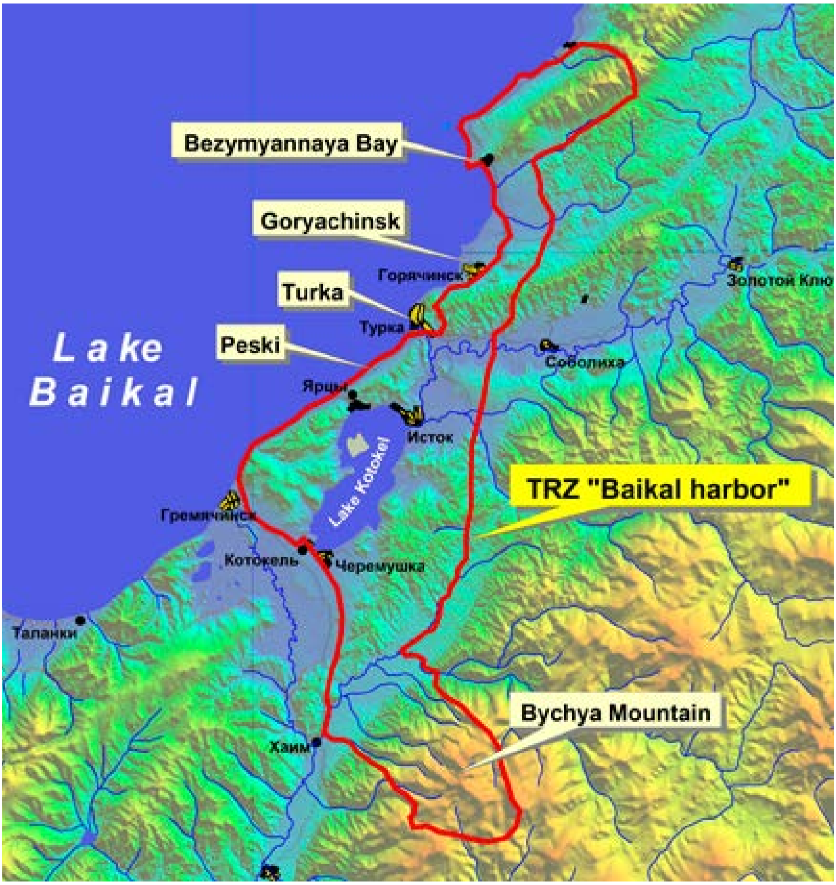


Fig. 2. Planned areas of the "Baikal harbour"

drochemical network was established to continue the geoecological monitoring at the locations of recreational facilities and prospective tourist routes.

To study the history of human activity and contemporary nature management the toponymic research was carried out. The analysis of the data obtained

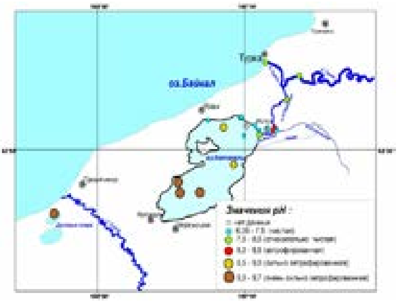


Fig. 3.Hydrochemical research on Lake Kotokel

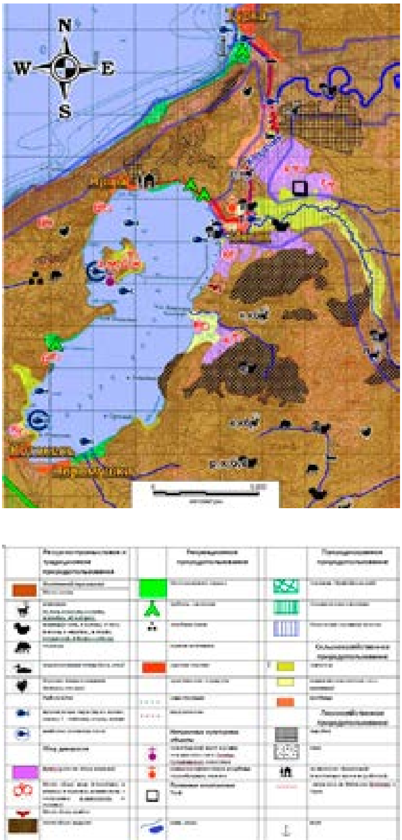


Fig. 4. Contemporary nature management of the Pribaikalsky District

(about 700 toponyms were analyzed and systemized) helped to create the toponymic dictionary. Also with the support of supplementary secondary sources, eg. maps, sketch maps, statistics, charts, historical books etc., contemporary and historical maps of nature management and traditional nature use were made (Fig. 4)

The map reflects the natural features of the area, fishing grounds, fishing and hunting objects and crafts, objects of natural and cultural heritage, etc. All of the above sites are also valuable recreational resources, their location creates the preconditions for the development of certain types of recreation in the area. The analysis of the map shows that the area continues to grow primarily resource-fishing and traditional types of nature management, due to its natural resource potential. Originally there were engaged in fishing, hunting, mining nuts and other wild plants, timber harvesting, carting. At present, these trades largely retained their importance in the economy of the area.

Special attention was given to the Old Beleivers (Semeiskiye) — the second largest ethnic Russian group in Buryatia. The Semeiskiye belong to the unique realm of Russian culture which developed under specific conditions that never repeated in other Russian ethnicities.

To assess the prospects for tourism development the sociological research was carried out. The evaluation of the opinions of local people and tourists about the quality of modern tourism infrastructure in the context of forming "Baikal harbour" was made. The data was interpreted and displayed in the form of diagrams.

As a result several ecological tourist routes were worked out available for foot, water, skiing tourism. The local nature is suitable for recreational purposes at any season. Also there are historical places connected with the history of the Republic of Buryatia and the aboriginal population: the Buryats, the Evenks, the Semeiskiye.

BARGUZIN DISTRICT

Zabaikalsky National Park was our place of research in the Barguzin District. The Zabaikalsky National Park was founded to protect and study the unique nature of Lake Baikal. Main aim was an expert estimation of the existing ecological paths and locations. To achieve it, the variety of techniques of data collection was used such as interviews, surveys, measurements, mapping etc. As a result the preliminary assessment of the recreational potential and the aesthetic evaluation of landscapes were made. The interviews with tourists and locals on tourism prospects were carried out. The topographic description of the routes was made together with the survey of hiking trails and recreational facilities. Some recommendations for their improvement were developed.

CONCLUSION

In the course of our expeditions we gathered the huge mass of data characterizing the different aspects of nature management and the contemporary ecological situation. The area of study has many attractive factors for developing different types of nature management. Special attention should be given to the traditional nature use and tourism. As a result the variety of recreational activities was developed in the areas of research.

Among the possible research priorities for the next field season the continuation of monitoring activities in the area of Kholodninskoye deposit, the study of the environmental situation in the area of Lake Kotokel, estimation of loads in connection with tourists visits in the TRZ "Baikal harbour", toponymic research.

REFERENCES

1. Avdonin V.V., Boytsov V.E., Grigoryev V.M. Deposits of metal minerals. Moscow.: Academic project, Triksta, 2005. – 720 p. (in Russian).
2. Puzanova T.A. Geochemical impact of Kholodninskoye lead-zinc pyrite deposit on aquatic landscapes of Northern Baikal. Proceedings of the international conference "Rational nature management: traditions and innovations". Moscow, 2013. P. 211–213 (in Russian).
3. The official portal of the central library of the Pribaikalsky District [electronic resource]. Available at: http://az-kozin.narod.ru.

T.A. Vorobyova, A.V. Evseev, N.I. Tulskaya
Department of Nature Management, Faculty of Geography, Lomonosov Moscow State University

Information support of radio-nuclides migration studies in the Russian arctic environment

INTRODUCTION

Numerous sources of artificial radio-nuclides are situated at the Russian North. Potential risk for natural environment and population health is connected with this fact. This stipulates the necessity of artificial radio-nuclides migration studies in natural environment components both close to their sources and in the region in general. Radio-chemical regionalization of vast northern territories enables to discover regional patterns of artificial radio-nuclides distribution conditions. The aim of this investigation is compiling of a small-scale radio-geochemical regionalization map for the territories of the White and the Barents Seas drainage basins which are situated within the limits of Murmansk, Archangelsk and Vologda regions, the Komi and Karelia Republics. Murmansk and Archangelsk regions have been chosen as test regions for regionalization methods development [1, 5] They have many common characteristics: severe climate with long winter and short vegetation period, heightened moisture content, vast bogged territories, location in three natural zones (from tundra to middle taiga), low biological productivity of ecosystems. But there are remarkable differences as well. Murmansk region has more differentiated landscapes, complicated geologic-tectonic structure, geomorphological heterogeneity. Less landscapes differentiation is typical for Archangelsk region. Its relief is mainly a slightly rolling type plain with a well developed river and lake systems. Differences in river basin structures are of principle importance in these regions.

METHODOLOGY

Methods of regionalization are based on river basins and geochemical arenas conceptions. The principal investigation method is cartographical. It enables to create cartographic data base which includes bio-climatic, geological, geomorphological, pedological-geochemical characteristics and differences in morphological structure of watershed basins of the studied area.

Radio-geochemical regionalization is based on geochemical arena conception i.e. territory of river and lake watershed system controlling distribution of pollutants migration with surface waters, accumulation within basin limits and their transit beyond them.

RESULTS

Regionalization works included several stages. At each of it a thematic map was compiled. These maps enabled to compile a conjugated map series. Integrated analysis and revealing of radio-geochemical regions were based on this map series. At the first stage of investigations rivers and lakes watersheds structure was analyzed. According to Yu.G. Simonov [2, 4] theory concerning morphological structure of river basins, matter withdrawal from watershed basins depends on river beds gradients, length of different sizes rivers, area and complicity of river basin and other "geometric" characteristics. Transit basins may be found where there is a balance of matter accumulation from slopes of the upper part of the valley and its withdrawal as well as "discharging" basins where material carried by the flow from the upper part is less then material carried away. "Accumulation" basins are also found: matter accumulation processes prevail there. It must be mentioned that each basin has separate transit, discharging and accumulation parts. All basins develop to a balanced transit state. Certain correlation among number, length, areas and gradients of different size water flows is typical for them. If one compares characteristics of the studied basins with modal it will be possible to evaluate them according to their accumulation-discharge features. Straler-Filosofov system was used to study river basins structure according to different thalweg order as well as their length, gradients, areas [2]. To be exact correlation of these characteristics within river basins of the upper level (the North Dvina, the Onega etc. for Archangelsk region, the Ponoi, the Tuloma etc. — for Murmansk region). Topographic maps present data for such analysis. This work enabled to compile a map of watershed river and lake basins, reflecting structural patterns of different level rivers watersheds.

Next stage was connected with evaluation of artificial radio-nuclides migration and accumulation activity. In order to receive data about geological and geomorphological river basins structures we performed an integrated analysis of the existing relief types and forms, its dissection, absolute and relative heights, features of underlying and bed rocks, slopes length and gradients. This analysis was completed by studies of landscapes structure differentiation, percentage of lakes and bogs, existence of specific for the study region processes (peat accumulation, karst phenomena). The initial information data base included geomorphological, geological, Quaternary deposits and landscapes maps. Their synthesis enabled to compile a map of migration and accumulation zones. This map presents differentiation of the territory according to various conditions and activity of possible processes of radio-nuclides redistribution.

A special attention was given to soils analysis revealing their stability in case of technogenic pollution i.e. capability to restore normal functional processes when technogenic impact is over. This is connected with self-purification processes and transportation of technogenic products from soils profiles or their converting to another form. Accumulation factors and intensity of artificial radio-nuclides transit from soils horizons and their accumulation at geochemical barriers were considered. A map of soils resistance to technogenic pollution was compiled based on soil cover, Quaternary deposits, geochemical-landscape maps analysis. Close soil groups according to geochemical resistance both to heavy metals and radiation impact were revealed based on M.A. Glazovskaya method [3]. The previous information about rivers basins watersheds structure, migration and accumulation activity, geochemical soils resistance gave an opportunity to reveal three types of geochemical arenas at the study area.

Open arenas include river basins watersheds with prevailing processes of intensive migrating matter discharge beyond the territory. Semi-open arenas include river basins watersheds with prevailing slow transit of migrating matter part of which is accumulated within territorial limits. Closed arenas include rivers and lakes watershed basins with prevailing sedimentation of migrating matter from surface waters and its accumulation inside the arena. Lakes systems basins, water reservoirs and rivers flowing into them, as well as river basin with no direct contact with seas are situated within these arenas.

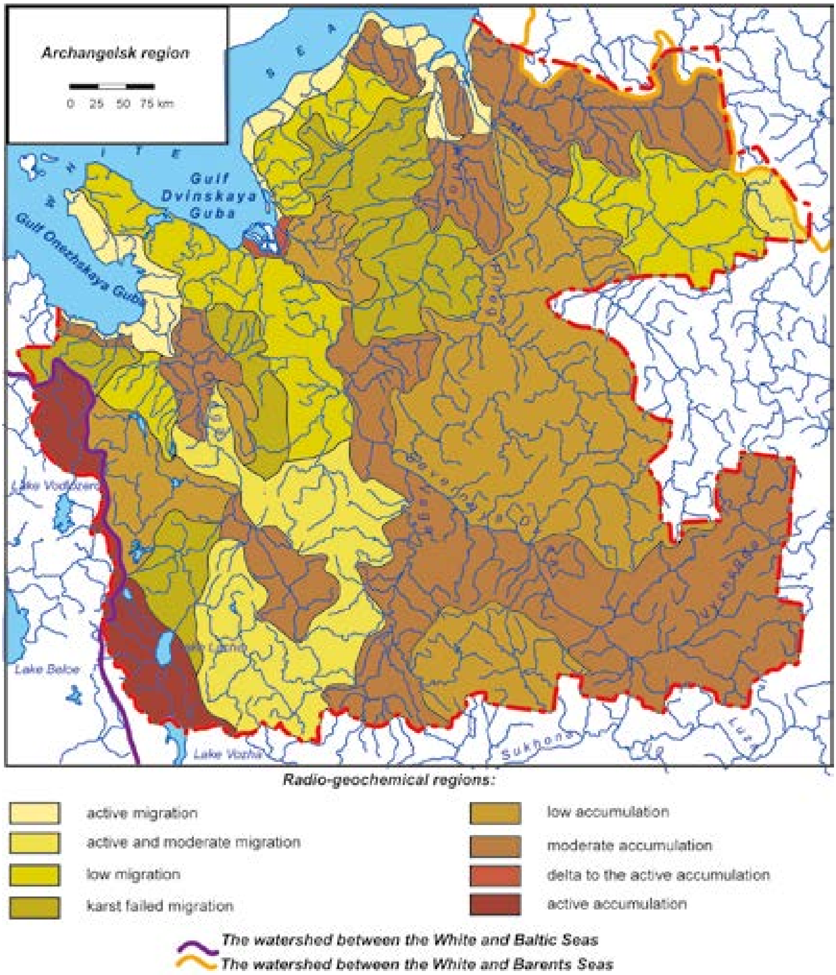


Fig. 1. Radio-geochemical regions of Archangelsk region

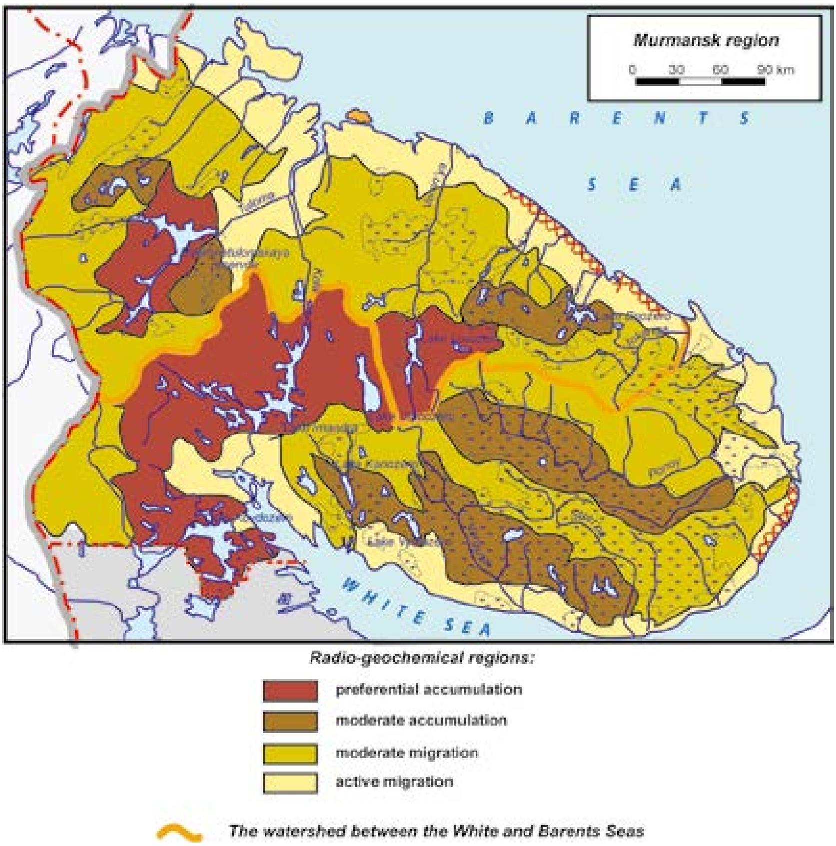


Fig. 2. Radio-geochemical regions of Murmansk region

Each arena was differentiated according to intensity of possible processes of radio-nuclides redistribution. Basins regions with prevailing accumulation, with accumulation and slow or moderate migration, with migration processes and slow or moderate accumulation, with mainly migration processes were detected. Integrated analysis of watershed basins maps, maps of matter migration and accumulation, geochemical soils resistance to technogenic impact and geochemical arenas enabled to reveal radio-geochemical patterns and compile a map reflecting territorial differentiation according to patterns of artificial radio-nuclides distribution [Fig. 1, 2].

CONCLUSION

They include regions of discharge, accumulation and different transit types where artificial radio-nuclides correspondingly are withdrawn, accumulated or balanced accumulation and transit type exists. A special attention in territorial planning of economic activities must be given to regions with potential artificial radio-nuclides accumulation. Studies of artificial radio-nuclides concentrations in different environmental media were performed in several regions. The received data demonstrate their accumulation in relief depressions. Their redistribution within soils profiles was not found.

The compiled map enables to reveal patterns of artificial radionuclides distribution, evaluate enables to reveal patterns of artificial radio-nuclides distribution, evaluate ways of their transit and give a forecast of locations with maximal potential accumulation.

REFERENCES

1. Borisenko.E.N., Velichkin V.I.,Vorobyova T.A. et al. Ecological-geochemical regionalization of the European Russian North. Doklady Earth Sciences, 2007, Vol. 415, No 5, pp. 711–713. DOI: 10.1134/s10283334X0705011X.
2. Ecological and geographical analyze of territory of administrative region. Ed. by A.P.Kapitsa and Yu.G. Simonov. Moscow, 1984, p. 286 [in Russian].
3. Glazovskaya M.A. Methodological basis of estimation of soils ecological-geochemical stability to technogenic influence: methodologycal textbook. Moscow, 1997, 102 p. [in Russian].
4. Simonov Yu.G. ,Simonova T.Yu. River basin and basin's organization of geographical cover /Erosion of soils and channel processes. Ed.by R.S.Cnalov. MGU, Moscow, 2003, No 14, pp. 7–32 [in Russian].
5. Vorobyova T.A,, Evseev A.E., Tulskaya N.I. Cartographic-information support of radiochemical monitoring in northern regions of Russia. Geoinformatika, No 3, 2011, pp. 51–61 [in Russian].

D.D. Badyukov, I.Yu. Margolina, K.A. Chevel
Department of Nature Management, Faculty of Geography, Lomonosov Moscow State University

Methodical aspects of educational field studies in monitoring of aquatic ecosystems (Mozhai reservoir as example)

Education of future specialist in the field of Geoecology and environmental management consist of complex of theoretical and practical disciplines. After the second year of study students take park in the educational field monitoring studies of water ecosystems.

The term «environmental monitoring» is very wide, but for study at the reservoir we select the part argumentation connected with observation system, because it is this observation system defines of receiving spatial-temporal data. This observation system, including location sample station, frequency sample, accurate measurement, list of parameters, have to responsible for result of research.

Determine of the rational network of observations is related with spatial discreteness or frequency of sampling time, linked with two main questions: (a) an authentic reflection of present changes and b) economic benefit. These two questions are closely interdependence, but they are solved by different methods. In particular, this is connected with various economy sectors, for which, clearly, should established its own specific regulations on frequency of sampling, taking into account their specific water quality requirements.

The leading one has to recognize the question, a reflection of changes in water quality, which largely determine cost of researching. To some extent it can even define the size of such cost.

The observation system mostly defines by source of contamination and types (composed) of contamination. And some timed chemical reactions.

A survey of water quality in water bodies depending on the intended use and factors affecting the water quality characteristics (temperature, transparency, oxygen content, pH, nutrient content and others) can be considered in terms of the conditions of optimization of the method of survey of the reservoir, in particular, in relation to choice of position measurement points (stations), reflecting the typical picture of the properties of water, measured characteristics, time and frequency measurements necessary for making a correct idea about the true condition of the water quality in the reservoir.

The issues of location of monitoring stations are mostly solved by researching water body with subsequent statistical analysis of observations data. Water area, where will be organized monitoring station must meet the following requirements:

1. at the selected point should be a good mixture, and the spatial heterogeneity of the water quality characteristics should be minimal both vertically and horizontally; it doesn't existence small-scale heterogeneity.

2. Temporal variations of water quality parameters (hourly, daily, seasonal, annual) in the area of location of observation points must be the most representative for the all reservoir.

In our research we do not consider the assessment of the necessary frequency of observations, because of time-conditions of realization of field educational study, which is not allowed to estimate time component of the variability of water quality in the reservoir (Mozhaisk reservoir). Thus, the observation of the pre-defined parameters of water quality is held all over the reservoir waters with known spatial heterogeneity.

The aims of field studies are:

- to master the methods of field researchers be portable and laboratory devices, including physical and chemical methods of investigations of surface and groundwater;

- to master express methods for environmental monitoring;

- to analyze the results of the measurements.

On the department of environmental management the educational field studies are devoted to monitoring of water ecosystems, and based on the Krasnovidovo educational scientific base of Moscow state University (Moscow region). The object of study is Mozhai reservoir, located in 100 km to the West from Moscow. This reservoir was created for supporting Moscow by drinking water and it's the largest reservoir in the cascade of Moscow-river reservoirs, its length from NW to SE is more than 50 km, water volume is 235.18 mln. m3.

Field Studies consist of three parts:

- the part of the researching on the boat,
- the part of the laboratory research,
- the part of analyzing results of water samples.

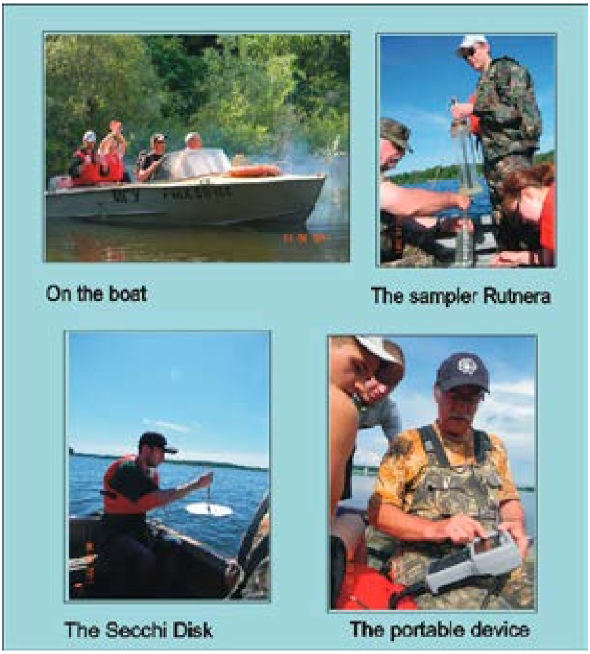


Fig.1. Researching on the boat

At the first part (Fig.1) students participate in water routes on the water area of the reservoir. They have to master the methods of sampling and field studies of surface water on the pre-defined stations. Location of the station is determined by GPS navigator. Routes pass on a boat «Progress» with the engine «Neptune-23», equipped with means of safety on the water. of the students are divided into teams, where each of them is responsible for own set of instruments for the selection and study, during the field part of studies. The depth of researching levels through 1 meter, temperature, dissolved oxygen, pH (acidity), mineralization are measured by using multiparameter portable equipment for researching water on the depth (Probe YSI model 650). The existence and depth of the layer of temperature gradient (thermocline) is determined according to the received data of temperature. Equipment for sample on the deep layers (the sampler Rutnera) is used for sample from layers hipolimnion and epilimnion. These samples will be used for laboratory researching.

Fig.2. Laboratory research

The laboratory part (Fig.2) is aimed to obtaining practical skills in the work of hydro-chemical laboratory, including methods of sample preparation and physical-chemical methods of laboratory research work.

Dissolved oxygen is determined by titration method (Winkler's method), phosphorus (gross and mineral), nitrates, ammonia are determined by photometric method, concentration of petroleum products is determined by fluorometric method; ionometry method are measured acidity, salinity and concentration of chloride-ions are determined by potentiometric method. Students are managed to explore water samples in laboratory in the day of sampling. It allows the students timely manner to correlate the results of the sample's studies with the place of selection and, at the later part to analyze the received data. As the result of the realized educational program, every student participates in all kind of research and analysis during studying.

At the finished office part of studying (Fig.3) it's realized surface temporal analysis data of the water and boat parts researching. Then based on analyzing data report is composed. During a period from 2007 to 2013 was accumulated spatial-time series of data of hydrological and hydrochemical parameters. Annual time of studding is constantly the first part of June; it allows us to recognize the trends of changes in the study parameters for a long time period.

The results of Mozhai reservoir researching, from 2007 to 2013, show that there is a water area spatial heterogeneity of all studying parameters.

Weak water exchange, a large longitudinal asymmetry, large depths and elongated shape of reservoir are influence on temperature distribution. It's a significantly feature of this reservoir within large reservoirs in the same climatic zone.

Measuring of the vertical profile around the reservoir has shown that already in June layer of the temperature jump (thermocline) is formed. This layer is detected at the depth of 3-4 meters which determines the vertical separation of the entire water column into layers, and thus changing the hydrochemical characteristics of the layers. The temperature of the water surface is detected in 19-240C which is depended from the climatic characteristics of the year, at a depth of 10 meters and more water temperature is near 100C. There is a reduction of dissolved oxygen concentration in water with depth also. There is a special attention to measurements of dissolved oxygen because of it is ecologically important indicator and depends on a range of factors. The highest values of it are recorded in the surface water layer and accounts for approximately

13 mg/l. Reduction of dissolved oxygen concentration decreases with depth and at the layer of 3-4 meters, in the layer of temperature jumping, it is noted biggest gradient of concentration reduction. It proves the division of water masses reservoir on separated masses. On the deepest stations at deep of about 13-15 meters the concentration of dissolved oxygen does not exceed 3-4 mg/L.

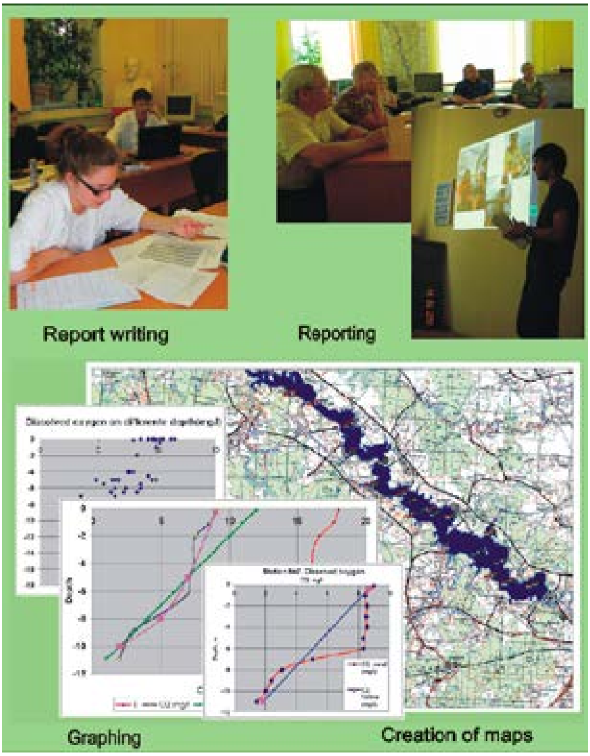


Fig. 3. Analyzing results of water samples

At the time of the annual research the blue-green algae, which lead to eutrophication process, developed slightly, and they are not able to have significant effect on dissolved oxygen in water. Insignificant growth of blue-green algae is confirmed by the measurements of clarity by portable equipment (disk Seki). This characteristic is practically the same and it's about 90-95 sm.

The value of total mineralization of water depends on mainly the genesis of the water masses. Rainfall and snowmelt waters form the surface water mass, so the value of total mineralization is small and it's approximately 100 mg/L. At the same time the deep water masses are formed by high mineralized underground waters, so the value of its mineralization is more than 200 mg/L.

Concentrations of biogenic elements determined in the form of phosphorus gross (mineral and organic), nitrite in form of nitrogen and ammonia nitrogen, associated with falling domestic sewage in the reservoir.

The average concentration of phosphorus gross is 0,085 mg/L. There is a quite increase in the phosphorus concentration from upper to bottom layer, i.e. in the upper layer a small amount of phosphorus goes to photosynthesis, further phosphorus is absorbed by plankton and it presents in many chemical substance.

The maximum concentration of gross phosphorus (0,201 mg/l) was recorded near settlements (Pozdnyakovo, Zaretskaya, Sloboda). The result of the research of nitrogen shows that concentration of nitrate and ammonium nitrogen increase with depth almost everywhere. Probably it's due to destruction prevails over the gross primary production at these biogenic elements don't use as food for organisms. Concentrations of NH4 increases more due to it is mostly formed exactly by destruction.

The average concentration of nitrite nitrogen in selected samples is 0.015 mg/l. The average value of ammonium nitrogen in the reservoir waters is 0.53 mg/l.

Researches of oil pollution show that over a long period there is a gradual increasing of oil products concentration in water. It's connected with rising number of motor boats and growing area of settlements not far away from the reservoir coast line.

Average values at the surface layers water are 0,020-0,040 mg/l, they fall with deep to 0,010 - 0.005 mg/L. Due to prohibition to use of motor boats in the May - June (protection of fish spawning grounds), this source of contamination is not recorded.

So during educational field studies students obtain practical skills of researching contamination of water body and intensify the knowledge from theoretical courses.

THE 1ST RUSSIAN-JAPANESE COLLABORATION SEMINAR: TWO DAYS IN MOSCOW

Common picture in the foyer on the 18th floor of the MSU main building with N. Kasimov

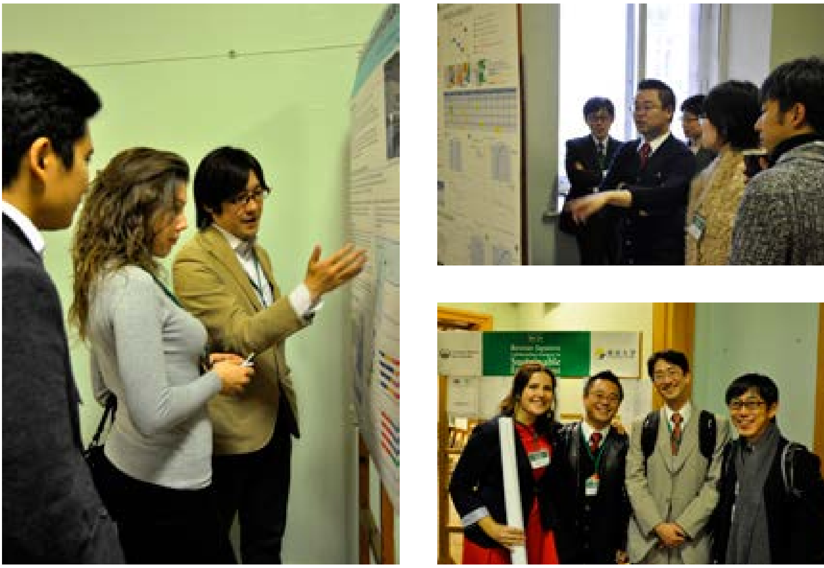
Opening session: Prof. Toshio Koike and Academician Nikolai Kasimov speaking

Opening session: Dr. Kiichiro Hatoyama and MSU Vice-Rector, Prof. Nikolay Syomin

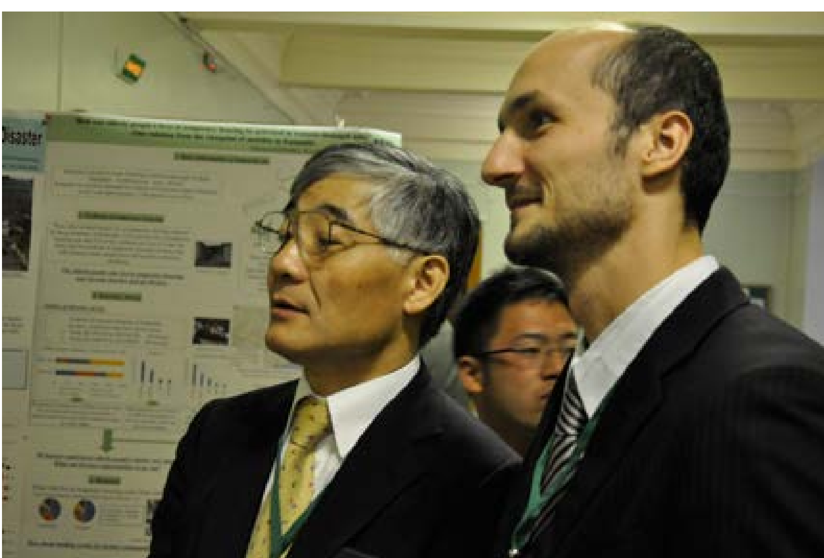
Speaker Prof. Elena Golubeva

Speaker Prof. Wataru Takeuchi (right) and Japanese students (left)

Japanese speakers: Prof. Makoto Shimamura (left) and Prof. Ryosuke Shibasaki (right)



Participants of the seminar during the Poster session



Japanese professors Tokio Toshio Koike and Petr Matous watching a poster exhibition

Speaker Dr. Alla Pakina addressing to the audience on the 2nd day of the meeting

Russian and Japanese participants at the meeting hall on the 1st day

Photographs by Ekaterina Makarova

Contents

RUSSIAN CONTRIBUTION

Scientific publication

ENGINEERING FOR
GREEN DEVELOPMENT
Proceedings of the 1st Russian–Japanese Collaboration Seminar
for Sustainable Environment

ISBN

Editorial Board:
Kiichiro Hatoyama, Yu.L. Mazurov, A.A. Pakina

Project manager: Oleg Zverkov
Design and prepress by Assa Valois

Edition of 500 copies