ENVIRONMENTAL RISKS FOR SOCIOECONOMIC DEVELOPMENT

PROCEEDINGS OF THE 3rd RUSSIAN-JAPANESE (2nd STEPS) COLLABORATION SEMINAR FOR SUSTAINABLE ENVIRONMENT

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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 3rd (2nd STEPS) Russian-Japanese Collaboration Seminar for Sustainable Environment held in Moscow, Russia, 8-10 August 2016. The book is intended for researches, high-school teachers and students, all other readers interested in the engineering for green development and close fields.

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The 3rd Russian-Japanese (2nd STEPS) Collaboration Seminar for Sustainable Environment

International Scientific Seminar
held in Moscow, Russia, 8-10 August 2016

ORGANIZED BY

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

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- A. Klishina (coordinator),
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- O. Garmaeva, R. Mamedov, and O. Zverkov

ENVIRONMENTAL RISKS AND FUTURE WE WANT.
Preface and Acknowledgements

Five years ago, in early 2013, a Memorandum of Understanding was signed in Tokyo between two divisions of the Tokyo and Moscow universities specializing in the field of environmental management. In the autumn of the same year, Moscow hosted the first seminar on sustainable environment, convincingly demonstrating the broad prospects for the cooperation that had begun.

Over the years since that time, a stable partnership of the parties on the problems of environmental sustainability has been formed. Within its framework, seminars and publication of collections of their works continue, students and postgraduate students are being exchanged, the number of participants is growing, their geography is expanding, and new directions are emerging. The development of the partnership was supported by the government of Japan in the form of the STEPS program, aimed at enhancing the cooperation of the University of Tokyo with the leading Russian universities. The Russian-Japanese project on sustainability of the environment has proved its viability, it continues to develop.

The project of cooperation between the Tokyo and Moscow universities is aimed at the future, on the rationale for the contours of the “Future we want”, the future that our countries need. This was especially pronounced at the 3rd Russian-Japanese seminar on environmental sustainability, held in August 2016 at Moscow State University. Its theme was defined as “Environmental Risks for Socioeconomic Development”.

Defining the topic of the next seminar, its organizing committee proceeded from an understanding of the growing importance for both our countries, as well as the desire to integrate the efforts of the international scientific community to minimize natural and environmental risks. With such a statement of the issue, all the participants and guests of the seminar agreed. This, in particular, was said at the opening of the seminar by the Dean of the Faculty of Geography of Moscow State University Prof. S.A. Dobrolyubov, head of the Department of Nature Management, Member of the State Duma of the Federal Assembly of the Russian Federation, Prof. M.V. Slipenchuk, president of the International Geographical Union prof. V.A. Kolosov, as well as the representative of the Japanese Embassy in the Russian Federation, Mr. Onishi Kazuyoshi.

The seminar was held in August, during the teacher and student holidays. Nevertheless, it aroused undoubted interest among professionals, as evidenced by the completely filled audience where the meetings were held. The participants of the seminar, as a rule, reacted lively to the contents of the reports, asked pressing questions. Very vividly passed and the poster session, held in great recreation on the 18th floor of the Geographical Faculty. Exchange of views and discussions continued outside the seminar rooms.

Throughout the workshop, its participants repeatedly noted the inevitability of the manifestation of environmental risk factors in development, both in the past and in the future. Natural disasters are almost impossible to prevent. But they can be foreseen. And you can adapt the society to their manifestation, reducing the three most unfavorable consequences of their manifestation. Often, reliable systems for monitoring disasters are expensive. But even more expensive are carelessness and irresponsibility.

Japan has accumulated a valuable experience in minimizing and overcoming natural and environmental risks. This experience demonstrates the amazing results of reducing the number of victims and victims during the manifestation of hazardous phenomena. In addition, it demonstrates clear trends in reducing unit costs for ensuring public safety and economic activity.

A similar situation is inherent in Russia. In our country there is a huge variety of natural conditions and natural phenomena, as well as environmental risks of the consequences of economic activity. At the same time, thanks to the achievements of geographical and related sciences, natural and environmental risks have been well studied, and a monitoring system has been established. Developed in the Soviet period, urban development standards reflect the imperatives of natural and environmental constraints in resettlement and economic activities.

True, in recent decades, many of these achievements have been lost. However, at present the situation is radically changing. The state is increasingly articulating the policy of territorial development of the country, in which priority is given to the regions of Siberia and the Far East, where our neighbor is Japan. In Russia, the understanding is growing that the success of the development of these regions will largely depend on the adaptation of their population and economy to the external conditions of development, on the skills to overcome the adverse effects of natural and environmental risks, and on the ability to perceive and comprehend the neighbors' experience in dealing with such issues.

The seminar 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. H. Kato, Prof. S. Sato and Dr. K. Hatoyama.

It is very important that this seminar was supported at all stages of preparation and holding with the Moscow university administration and the Faculty of Geography, including Dean of the faculty Prof. S.A. Dobrolyubov, Deputy Dean Dr. S.R. Chalov and Prof. M.V. Slipenchuk, Head of the Nature Management Dept, whom we also sincerely grateful.

We also consider it necessary to note the excellent work on preparing and holding our seminar the whole Organizing Team including Ms. A. Klishina (coordinator), Dr. E. Glukhova (secretary of the Editorial Board), Ms. O. Garmaeva (University of Tokyo), Mr. R. Mamedov, and Mr. O. Zverkov, a wonderful person who, to our great regret, passed away shortly after the seminar.

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 among professionals.

This proceedings is published in the declared in our countries cross-year of Japan in Russia and Russia in Japan. Its appearance is our common contribution to strengthening cooperation between Russian and Japanese scientists, to bringing our cultures closer together, to deepening mutual understanding between our peoples. Its publication is a real testimony of the interest of students and young scientists of Japan and Russia to better know each other, to make more active use of the geographical neighborhood factor in the interests of a sustainable and prosperous future for our countries.

Yuri MAZUROV
Coordinator of cooperation from Russian side
Professor, Department of Nature Management,
Faculty of Geography,
Lomonosov Moscow State University

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

Dear Japanese and Russian participants of the seminar, dear guests,

Let me open our next, the third Russian-Japanese seminar on environmental sustainability. It is devoted to research of risks of adverse natural phenomena for the population and development of the economy. The topic of natural and environmental risks is especially relevant nowadays. It is they who become more and more clearly the real limits of growth, the real limitations of development, the problem for the sustainable development of civilization. This is especially true for our countries, for Russia and Japan. Therefore, the integration of efforts in this area of representatives of science of our countries is so positively perceived in Russia and Japan.

This is exactly what was discussed yesterday during our meeting with the Japanese delegation at the State Duma of the Federal Assembly of the Russian Federation. As one responsible for the development of inter-parliamentary contacts with Japan, I once again note with satisfaction the interest of both sides in expanding our cooperation in all areas, including scientific cooperation. Successful scientific cooperation is possible only in a favorable general political climate. But this climate is created as a result of the growing activity of all participants in international cooperation.

I believe that the cooperation of our two universities is making its modest but very real contribution to building trust and mutual understanding among the peoples of our countries. In essence, our cooperation implements a scheme so understandable in the modern world: sustainable academic cooperation - sustainable relations - sustainable development. Our cooperation, this is, thus, promoting the implementation of Goal 17 of the recently adopted UN Sustainable Development Goals - Partnership for Sustainable Development.

I do hope for a similar perception of our cooperation and the Japanese side. This is evidenced by a grant from the Government of Japan received by the University of Tokyo for the development of the STEPS program. The participation in the opening of the seminar by Mr. Onishi Kazuoshi, a respected representative of the Embassy of Japan in the Russian Federation, can also be considered evidence of this, for which we are sincerely grateful to him.

I am sure that the seminar starting today, like the two preceding ones, will become an important event in the professional contacts of specialists of our countries in the sphere of managing the interaction between man and nature. The guarantee of this is the participation of the leading Japanese scientists in this field, recognized in the world of professionals from the University of Tokyo, the first Japanese university and still retaining leadership in the system of higher education in Japan. Let me express my sincere gratitude to Professor Shinji Sato and Dr. Kiichiro Hatoyama for providing such a vivid representation of Japanese scientists in our next seminar.

Another important prerequisite for the success of the opening seminar is the participation in it of a number of leading Russian scientists in the field of environmental management and sustainable development. They represent not only the chair of rational nature management, but also a number of other subdivisions of the Faculty of Geography of Moscow State University, as well as other scientific and design centers of the Russian capital.

It gives me special pleasure to welcome in this audience the dean of the Faculty of Geography of Moscow State University, Corresponding Member of the Russian Academy of Sciences, Professor Sergey Sergey A. Dobrolyubov. Being also the head of the department of oceanology and one of the leaders of this scientific direction in our country, he will present today a paper on achievements in this important field of science. I would like to take this opportunity to thank Prof. Dobrolyubov for participating in this seminar and for his continued support of our Russian-Japanese project.

I would also like to greet our special guest, the President of the International Geographical Union, Professor Vladimir A. Kolosov, one of the most famous modern geographers in the world. His participation in our seminar is a clear sign of support for precisely this vector of development of modern geographic science, a vector aimed at integrating the achievements of geography proper with adjacent areas of knowledge. This is the direction of development of our science, which increases the demand for its results in the development of society.

In conclusion, I would like to wish all the participants in the seminar bright speeches and memorable, fruitful discussions. My special wishes to the youngest participants of the seminar, Japanese and Russian students and post-graduate students. Many of them for the first time take part in such a responsible scientific event. I would like their performances to be the beginning of a successful academic career of our university shift. I also hope that the cultural program of the seminar will successfully complement its scientific component. And together they should, in the opinion of the organizers, form a firm commitment to our cooperation and an even greater interest in our country and its scientific potential.

Sergey DOBROLUBOV
Dean, Faculty of Geography, MSU, Dr. Sc. (Geography),
Member of the Russian Academy of Sciences

The Faculty of Geography at Lomonosov Moscow State University was established on June, 23, 1938. The Director of the Research Institute of Geography, S.M. Lutskiy, was appointed to head the new Faculty. The Faculty had the Departments of Physical Geography, Physical Geography of Foreign Countries, Physical Geography of the USSR, Economic Geography of the USSR, Economic Geography of the Capitalist Countries, Cartography and Geodesy, and also the Research Institute of Geography.

Nowadays the Faculty of Geography is the largest scientific and educational center of geography in the world. There are 1 000 undergraduate students and 200 PhD students studying in the Faculty. The Faculty consists of 15 departments, 8 research laboratories and 4 field stations with total 800 employees. Among them there are: 100 professors, 300 PhD, 1 Full Member and 4 Members of Russian Academy of Sciences, distinguished scientists, laureates of State and Government Prizes of USSR and Russia in the field of education, science and technology, laureates of the Lomonosov and Anuchin Prizes and many more. Approximately 30% of all dissertations in the field of geography in Russia are defended within the Faculty.

STUDYING

The Faculty of Geography has 150 government-sponsored places for entrants and in addition about 80 vacancies for students who pay for their training (on the basis of a contract between a student and the university). For Russian applicants, the admission is based on the results of General the State Exams. The average competition level is 5-6 applicants into place. The Faculty hosts the MSU Geographic Competitions (Olympiads) for high-school students, annually drawing in up to 1,000 participants. In addition, the Faculty takes part in the organization of All-Russian and International Geographic Competitions. The winners of these Olympiads enter the University without the exams.

To qualify for the admission to Bachelor and Master programs, foreign students must meet some general requirements. Students must have an appropriate secondary school certificate and be proficient in Russian. Once a person has been accepted at the Faculty of Geography he or she is eligible for a number of services offered by Lomonosov MSU such as accommodation, visa and registration support etc. The Faculty of Geography of the MSU trains specialists of the highest caliber. The curriculum offers 2 levels of training. The training for the Bachelor's Degree lasts for 4 years, the Master' Degree requires 2 additional years.

The training for Bachelor's and Master's Degrees is carried out in the 5 main directions: «Geography», «Hydrometeorology», «Cartography and Geoinformatics», «Ecology and Environmental Management», «Tourism».

SCIENCE

A number of distinguished scientists contributing in establishment and developing of geography were working at the Faculty. Several main themes, most required in the recent conditions, can be marked out from the scientific work carried out at the Faculty:

1. Prognosis of the regional climate change using the XXI century scenarios of the Global Circulation Models;
2. Hydrological estimates and forecast, securing the hydro-ecological safety;
3. Diagnosis and prognosis of the extreme natural phenomena in sees;
4. Monitoring and estimation of the dynamics of the cryosphere;
5. Evolutionary-geographical methods of the climate change estimation;
6. Geomorphology-engineering analysis;
7. Geoinformatics cartography technology and remote sensing of the Earth surface;
8. Estimation of the social-economic and ecological consequences of the National innovation projects realization;
9. Landscape planning, estimation of the influence on the environment, the state of the natural and anthropogenic landscapes;

10. Monitoring and estimation of the biodiversity, medial geography research;
11. Integral estimation and prognosis of the ecological conditions in the regions and cities of Russia;
12. The technology of the ecological optimization of the nature management;
13. Engineering of the recreational territories.

An important subject entirely related to the aims of the geographical research "Conservancy and Sustainable Development of the Regions of Russia" is included into the Programme of the MSU Advancement up to the 2020. State Committee on the High Technologies and Innovations approved in 2011 the technological platform "Technologies of ecological development", which was initiated by the MSU, as the form of private-state partnership in mobilization of the possibilities of the state, business and scientific community and as an instrument of the formation of the policy in science, technology and innovation. This project is already used for shaping the most interesting technologies such as remote sensing data use, the ecological situation in regions and cities of Russia, integrated geochemical assessment, monitoring and control of the natural hazards. The Ministry of Education and Science uses the experts of the platform for determination of the themes of the scientific project calls for the Federal Target Programmes.

Important scientific results are related to the realization of the Russian Government "megagrant" 2010–2014. A "Natural Risk Assessment Laboratory" was founded at the Faculty headed by German oceanographer professor Peter Koltermann. The main results of the Laboratory activity were related to the estimation of the Natural hazards, which could become more or less active in dependence on the climate change in XXI century. The specialists of the Laboratory implemented models allowing to provide a prognosis of rivers run off change to the middle of the XXI century, change in cyclonic and storm activity.

In 2014 a new "Arctic Environment Laboratory" was funded at the Faculty, with the aim of the detailed integral research of whole the complex interconnection between the ocean, land and the cryosphere in the Russian Arctic.

In addition to whole spectrum spectrum of field geodesic meteorological and sampling equipment, the Faculty owns modern instruments for laboratory investigations. The ecology-geochemical research facilities are equipped by devices allowing inorganic analysis (graphite furnace and flame atomic absorption spectrometers, optical emission, X-ray fluorescence and luminescence spectrometers, spectrophotometer), separation and organic analysis.

The researchers of the Faculty registered more than 10 patents in the field of geography in the last few years. All of them have commercial potential.

The Faculty annually organizes not less than 10 National and International conferences and symposiums in the fields of geography and the human-environment interaction.

Annually, the researches of the Faculty publish about 40 textbooks and about 30 scientific monographs and collected papers, 600–700 scientific reviewed papers also in World leading scientific journals. 7-volumes fundamental work "Geography, Society and Environment" was published to the 250-years anniversary of the Moscow State University.

TRADITIONS

The Faculty is famous for its traditions. The principal one is to maintain the contact between the Faculty and its alumni. From the earliest scholars of the Faculty to the newest graduate, every alumnus and alumna is a part of the Faculty's. Graduates arrange their meetings annually. In 1998 the "Association of Alumni of the Faculty of Geography of the MSU» was established. Its main goal is to provide student bursaries, help veterans, arrange anniversary celebrations, and to participate in a variety of cultural and sports events.

The humanity has entered the XXI century. The technological progress continues and our nature changes with its pace. The role of geographical training is now not only to preserve nature, but also to create and maintain friendly environmental conditions for the purpose of sustainable socio-economic development. This has become the main research and educational task of the Faculty of Geography of the MSU.

Onishi KAZUYOSHI
Embassy of Japan in the Russian Federation

Ladies and Gentlemen,

Thank you for your kind invitation to the Third Russian-Japanese and the Second of STEPS Collaboration Seminar for Sustainable Environment. This STEPS program by Tokyo University is being conducted in the framework of Re-Inventing Japan Project by Ministry of Education, Culture, Sports and Technology. I am honored to be given the opportunity to speak on behalf of the Embassy of Japan in Russia and would like to thank all the organizers and participants who are contributing to this important Japan-Russia bilateral event in scientific cooperation.

Science is becoming more and more important in the world of diplomacy. The Ministry of Foreign Affairs of Japan has held intergovernmental joint committees based on cooperation agreements on science and technology with many countries, including Russia. At present there are various scientific issues Japan is involved in such as the ITER project, the International Linear Collider, nuclear power, the advancement of space technology and activities, global environmental issues and polar research to name a few.

Fortunately or unfortunately, I personally have had limited experience in the field of science in my diplomatic career. The most serious experience was that of the Fukushima nuclear accident in 2011 which taught all of us in the fields of science and government many important lessons about the relationship between science and diplomacy. At the time of the incident, I worked in the team at the Ministry of Foreign Affairs which dealt with the International Atomic Energy Agency (IAEA). Following the incident, the Ministry had to give the whole international community all the information available regarding the incident with maximum speed, accuracy and transparency. Risk communication for foreign citizens in Japan was another huge challenge and scientists and engineers had to clearly explain the existing risks to ordinary people.

In relation to environmental sustainability, it is important that countries such as Japan and Russia work together and share our scientific knowledge to make the best decisions for the future. This is not only to make the best decisions for our own countries, but for the world as a whole. Though we may live in different places with borders designed as limitations to the geographical and political space in which we live, nature does not take heed of these 'lines.' When natural disasters occur and climate change affects weather patterns the results of such occurrences transcend borders.

When we discuss global environmental risk within the context of diplomatic conferences, it is indispensable for us diplomats to have up-to-date knowledge on the subject matter under discussion and recent scientific findings. For example, when holding discussions on the topic of fisheries and sustainable resource management, Japan and Russia jointly decide on catch quotas and joint scientific research plays an important role as the basis for agreements between our governments. More than 10 years ago, I worked as a young interpreter for scientists in the fisheries industry. I had to remember many technical terms related to fishery and sustainable resource management. A term I still remember is the word "scale" or «чешуя», which I had never used in the work of diplomacy before or since. In any case, the understanding of common terms and scientific findings is knowledge that should and must be shared by all countries, so that it can provide a basis for common interests and a point from which the best decisions can be reached. In this sense, exchanges among scientists are extremely important.

Once again, I would like to express my sincere thanks for allowing me the opportunity to saying a few words here today. I am very happy to see that so many of you involved in the field of both scientific and environmental studies have gathered here to share your various findings and I wish you great success in this seminar and with all your future joint endeavors.

Thank you for your kind attention.

Vladimir KOLOSOV
President of the International Geographical Union,
Head of Department of World Economy, Faculty of Geography,
MSU, Dr. Sc. (Geography), professor

Dear colleagues, dear friends!

Let me please to cordially welcome you on behalf of the International Geographical Union (IGU), one of the oldest global international associations uniting geographers of 90 countries.

The topic of the third Russian-Japanese seminar on sustainable development, which is being opened today, fits perfectly into a number of major international initiatives and programs. It corresponds to the priorities of the United Nations — primarily the Earth Charter adopted as a result of six-year discussions and affirming the fundamental values of a just, sustainable and peaceful global society in the twenty-first century, the goals of the United Nations Decade of Education for Sustainable Development.

The study of the risks of natural and man-made disasters is a very important part of the most ambitious in the history of the research program "The Future of the Earth", created by a joint initiative of the International Council for Science (ICSU) and the International Council for Social Sciences (ISSC). Geography is well represented in this program. Our seminar will promote more active participation of the Russian and Japanese geographical communities in the projects of the program.

On the initiative of the International Geographical Union, this year was proclaimed by UNESCO as the International Year of Global Understanding. Its goal is to bridge the gap between the national levels of political decision-making, in particular, to prevent the consequences of natural and man-made disasters and the global nature of society's development and natural changes.

Studies of natural and anthropogenic risks are the activities of one of the leading commissions of the International Geographical Union, which for many years is headed by our Japanese colleague Professor Sh. Haruyama. We highly appreciate the contribution of Japanese geographers to the activities of our union. In 2013, the IGU Regional Conference in Kyoto was a great success, gathering about two thousand geographers from many countries of the world. I am confident that Professor Yukio Khimiyama will be elected the next president of the IGU at the International Geographical Congress to be held this month. His works are well known in Russia, he visited many times in our country, including within the walls of Moscow University.

The exchange of ideas at international seminars and conferences, participation in joint projects and educational programs is one of the main driving forces of world science. International meetings of geographers always take place in an atmosphere of mutual understanding and warm friendly communication. I wish the participants of our meeting fruitful work and new creative successes.

SESSION 1
"Global environmental risk"

Sergey DOBROLYUBOV, Victor ARKHIPKIN,
Galina SURKOVA, Peter KOLTERMANN
Arctic Environment Laboratory, Faculty of Geography,
Lomonosov Moscow State University

Modelling natural risks in the Russian seas

INTRODUCTION

Coastal zones are characterized by extremely high concentration of the World's population (producing >70% of the GWP). Integration of the coastal structures into the economy goes far beyond coastal regions, stresses on the economy and life conditions of the coastal zones crucially impact on the economy and life conditions in the inland regions. All these make coastal zones highly vulnerable to natural hazards with the key concerns being that sea level rise or changes in maritime storms cause flooding resulting in inundation and subsequently land loss. Responses to sea level rise have implications for water resources, and the ecological balance in the coastal zone with its ocean part and the neighboring land part. Increasing population pressure on the coastal zone — more people moving to the coast because of enhanced economic development through increased use for transport infrastructure, tourism, industry settlements — increases the risk and vulnerability. The Russian coastal zones are characterized by strongly different conditions implying large differences in the nature and character of extreme events. This requires very different approaches to the risk assessment of natural hazards in the marginal Arctic coasts and the inland sea coasts in the Baltic, Black, Azov and Caspian seas because approaches relevant for one area may not necessarily be effective for the others.

Marine storminess represents the core of the direct local ocean impacts and originates from the off-shore winds. According to Gulev and Grigorieva [8], during the last several decades there has been a tendency of growing mean and extreme significant wave height (SWH) over the North Atlantic and North Pacific with a maximum of 10-12 cm per decade. Furthermore, in the coastal areas the trends are typically higher than in the open ocean regions, being of up to 20 cm per decade. Importantly, wave extremes typically grow faster compared to the mean values. For instance, for the Barents and Black Seas 99th percentile of SWH was nearly doubled during the last 5-6 decades, while the mean values increased by 20-25%.

Climate model projections show that the midlatitudinal hydroclimate extremes will likely intensify and become more frequent for the 21st century under all emission scenarios [11]. These projections, being quite robust on average, exhibit, however, a very large spread and give little confidence in particular coastal regions. This is not surprising given the large number of mechanisms involved. Even in the advanced climate models such mechanisms as regional water vapor recycling and changing cyclone life cycle are poorly resolved. Thus, scenario climate projections require regionalization or downscaling to regional scale. Importantly, the downscaling is just partly a resolution issue — on small scales there are conceptual drawbacks in large scale climate models. Moreover, realistic adaptation of these models to specific coastal areas requires extensive use of observational data for validation purposes.

To identify and fill the gaps in our understanding the mechanisms and quantifying the intensity of extreme hazardous events in the coastal zones of Russian Federation the Natural Risk Assessment Laboratory (NRAL) were established at the Faculty of Geography, Lomonosov Moscow State University in 2010. During 2010-2016 NRAL implemented a comprehensive research programme of ocean-related extreme events in costal zones, centered on understanding their nonlinear nature and multifactor character. We developed a comprehensive catalogue of climate extremes over coastal zones of European Russia and performed high resolution diagnostic and modelling studies of different types of extreme events resulting in natural hazards, such as extreme wind wave storms, extreme precipitation and associated flash and river flooding, extreme temperature conditions and abrupt changes in the local geochemical balances. In particular, we understood that extreme wind waves may not necessarily follow mean climatological values of wind and wave height and may exhibit strong increases in magnitude even when the mean values are relatively stable, as in the Barents and Kara Seas [7].

Our studies clearly demonstrated that most of the coastal hazards are associated with the compound nature of climate extremes, quantified through hydrological modelling using high resolution models of wave modelling [1] and non-hydrostatic atmospheric modelling. To build an effective system which allows for the synthesis of ocean dynamics and atmospheric dynamics — we implemented at NRAL most advanced wave models (WAWEWATCH and SWAN), high resolution regional ocean model ROMS and the atmospheric high resolution non-hydrostatic model WRF. Never before have all these highly technological numerical tools been employed in a synergistic and holistic way, even at leading operational and forecasting centers.

The present paper highlights some results of a modelling studies of storm waves in some seas near Russia during last decades based on the NCEP/NCAR reanalysis data [12]. The goal of this study was to assess modern climatic parameters of wind waves and storm surges in the Black, Caspian, Baltic and Barents seas and to determine their spatial, annual and seasonal variability.

DATA AND METHODS

Nowadays, numerical modelling seems to be the most appropriate method of generating wind wave data sets. The main advantage of this technique is its flexibility relative to the formulation of initial conditions, the calculated parameters and the resolutions — both temporal and spatial. Another advantage of modelling studies is the possibility to perform hindcast and forecast calculations using archived or forecast wind fields. Operational wave forecasting on different spatial scales is a state-of-the-art field in which numerical modelling is used.These models are relatively well developed and provide the wide range of configurations. However, for every individual region (the Caspian Sea, Baltic Sea, Barents Sea, Black Sea) the choice of the best configuration is an unresolved scientific task dominated by regional features.

A calendar of storm events was derived for the period 1948–2010 for this study. The numerical storm simulator SWAN (Simulating WAves Nearshore) was used, a third generation wave model that was developed at Delft University of Technology. It computes random, short crested wind-generated waves in coastal regions and inland waters [4]. The model is based on the wave action balance equation (or energy balance in the absence of currents), with sources and sinks. It uses typical formulations for wave growth by wind, wave dissipation by white-capping, and four-wave nonlinear interactions Wind forcing data was extracted from NCEP/NCAR reanalysis [12] at the 6-hourly intervals available (0000 UTC, 0600 UTC, 1200 UTC and 1800 UTC). The spatial resolution of the SWAN numerical grid was about 5 km. An overview of numerical simulations is described in [1,2]. For our study, days were chosen when modeled wave height was 4 m or more. The threshold of 4 m is based on the state standard for safety in emergencies [3], which specifies waves of 4 m or more in the coastal zone and 6 m or more in the open sea as hazardous. 412 storm cases were identified for the Baltic Sea, 137 cases for the Black Sea and 94 for the Caspian Sea between 1948 and 2011. Sea floor topography (0.05 × 0.05 degree, rectangular grid) and surface wind speed and its direction are used as model inputs. The wind forcing data set was extracted from NCEP/NCAR reanalysis for the 6-hourly values available at 1.9×1.9 degree. Supercomputers “Chebyshev” and “Lomonosov” of the Moscow State University were used for the numerical experiments.

In contrary to the Black, Caspian and Baltic seas, we need to include swell from the North Atlantic for the analysis of the White and Barents seas. In this paper, we present the evaluation of the effect of the swell generated either in the North Atlantic or in the Barents

Sea, on the waters of the White Sea. It turned out that the effect from the North Atlantic swell on the White Sea is negligible (height up to 0.2 m) for the area.

For the climate projection of storm events we used daily sea level pressure (SLP) fields (0-90°E, 30-80°N) generated by the coupled atmosphere-ocean circulation model of Max Plank Institute ECHAM5/MPI-OM [17] within the framework of CMIP3 project [14]. It consists of models for the atmosphere (ECHAM5) and the ocean (MPI-OM). Global ECHAM5-MPI/OM SLP datasets were taken from the open-source CMIP3 archive at the Program for Climate Model Diagnosis and Intercomparison (PCMDI) [http://www-pcmdi.llnl.gov] for the 1960-2000 and 2046-2065 (SRES, emission scenario A2 [15]).

As shown in [17], ECHAM5-MPI/OM appears to closely reproduce daily mean SLPs and the frequencies in circulation types, especially for the late autumn, winter and early spring periods. This justifies the use of the model because the majority of the storm activity in the Black, Baltic and Caspian Seas is observed in the cold season.

Our approach of atmospheric circulation classification for storm events relies on the understanding that storm waves are mainly the product of wind speed and direction, which determine the value of the flux of momentum from the atmosphere to the sea. Storm wave parameters also greatly depend on the sea size, its depth, bottom relief, coastline configuration etc. But these factors are not results of atmospheric processes on as short a time-scale as one storm. It is the surface wind that plays the most important role in individual storm forcing. Fortunately, the pressure is the most reliable meteorological parameter reproduced by reanalyses and by climate general circulation models, and so a straightforward expansion of the study to model data is possible. SLP has already been used successfully in previous classification procedures, e.g. [10, 18].

The steps of our study were the following: to classify SLP grids accompanying storm events (from now on referred to as storm SLP); to extract the main features of circulation patterns for every type; to evaluate the frequency of every type for the modern climate and possible changes in frequency in the future. The circulation types are obtained by cluster analysis (k–means approach, e.g., [11]) preprocessed by Empirical Orthogonal Function (EOF) analysis, e.g., [16] to reveal few leading modes determining the most part of variance. These techniques of EOF decomposition and k-means cluster analysis, together or in combination with other techniques, are widely used in circulation type classifications, e.g., [5, 18]. Firstly a dataset consisting of 30 daily SLP grids was prepared for every storm from the calendar, including 15 days before and 15 days after each storm day. After EOF decomposition of daily SLP grids, the first three eigenvectors were retained, describing more than 70% of the variability. Therefore, high frequency perturbations were filtered out. EOF fields of sea level pressure for storm days (according to the storm calendar of the sea) were used as input variables to classify circulation patterns. Definition of circulation types was carried out using the k-means cluster analysis. In this study, cluster centroids (ensemble mean of cluster members) were constructed for each circulation type by averaging the SLP grids of all days that belonged to the same circulation type.

The same procedure was also applied to the model data for the period 2046-2065, i.e. the correlation was calculated between daily model SLP and reanalysis SLP fields from the storm calendar. Before this correlation procedure, the model data were interpolated on the reanalysis grid.

RESULTS AND DISCUSSION

Storm events (with $H \geq 4$ m) modeled by SWAN were included into our storm calendar to classify the synoptic patterns that accompany Black, Caspian, White and Baltic Sea storms. For example, time series of annual storm frequency for the Baltic Sea (Fig. 1) demonstrated noticeable interannual and decadal variability. The relatively stable regime of 1950s and 1960s was replaced by a positive trend in the 1970s which, while briefly interrupted at the end of the 1980s, continued on until the first part of the 1990s. We also revealed an increase in storm activity in 1979-1989, maximum in 1992-1994, sharp decrease till 2000 and a gradual increase until 2010 for the White Sea. No valuable in the amount of storm situations were observed in this basin. The alternation of relative calm and stormy periods as well as

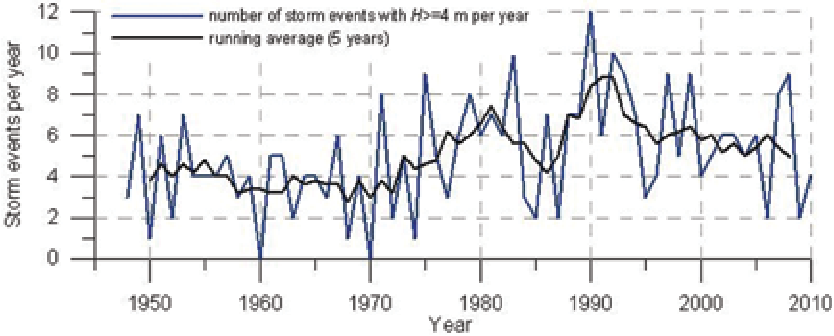

Fig. 1. Time series of storm events (H ≥ 4 m) in the Baltic Sea from SWAN results.

the increase of storminess in approx. 1960–1975 is a typical feature not only for the Black Sea, but also for other European seas, e.g. the North and Baltic Seas as shown by Matulla et al. [13].

Four main circulation types of SLP daily fields were revealed for the Baltic Sea (Fig. 2). Types 1, 2 and 4 have several common features, the main one being the dipole structure of SLP with negative

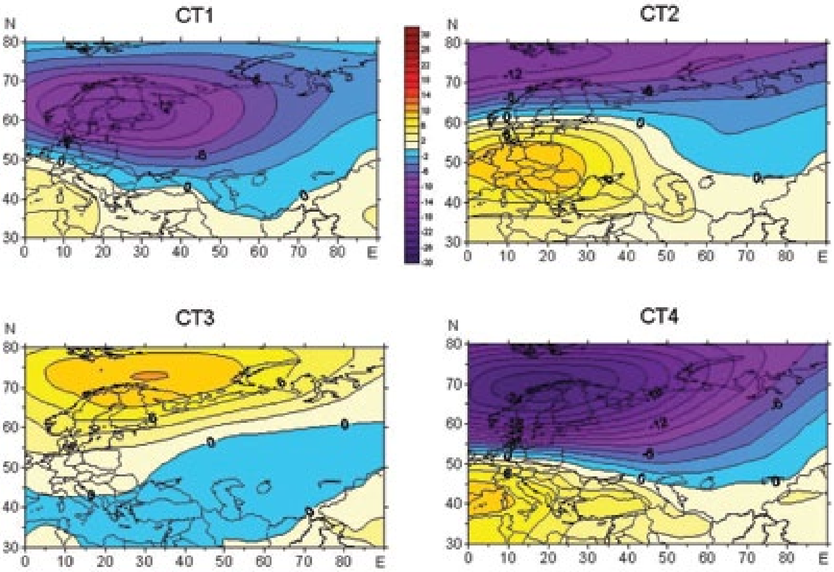

Fig. 2. Patterns of the four wintertime SLP circulation regimes for the Baltic Sea, anomalies from 1961–2000 (hPa).

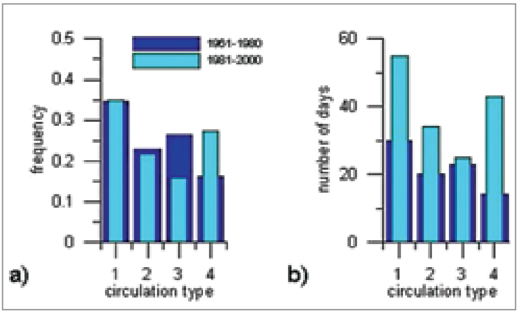

Fig. 3. Relative (a) and absolute (b) frequency of storm days in the Baltic Sea with wave height H ≥ 4 m, circulation types as in Fig. 2.

anomalies in the North and positive in the South. Despite likenesses they differ clearly in the position of their negative anomaly centers which shows the diversity of prevailing tracks of Atlantic mid-latitude cyclones. Types 1, 2 and 4 exhibit the influence of westerly air flow and cyclones moving with them towards the Baltic Sea along different trajectories. In case of CT 1, the center of cyclones is located over the Baltic Sea, for CT 2 it is over the Norwegian Sea, and for CT 4 it is over the North of Scandinavian peninsula. Circulation Type 3 is meanwhile completely opposite to others. This regime is often referred to as Scandinavian blocking and is characterized by a strong positive height anomaly over Northern Europe.

Storms in the Baltic Sea occur mainly in winter whereas summer is relatively calm. The main trend for the two time periods 1961–1980 and 1981–2000 was an increase in storm numbers, especially under the CT 4 weather regime with its high cyclonic activity. The comparison of CT regime for two periods, 1961–1980 and 1981–2000 revealed both an increase of the storm activity in the second period and a redistribution of storm frequency (Fig. 3). Further analysis showed weakening of CT 3 anticyclonic influence for the storm activity and at the same time, an increase of cyclonic CT 1, CT 2and CT 4 importance.

Within the variety of the atmospheric circulation governing the climate of the Black Sea, there are two main types of sea level pressure field derived by cluster analysis and associated with SWAN storm days (Fig. 4). For the first circulation type CT 1 (57% of events), the trough moves to the Black Sea from the eastern Mediterranean Sea, and often forms an independent local cyclone over the Black Sea.

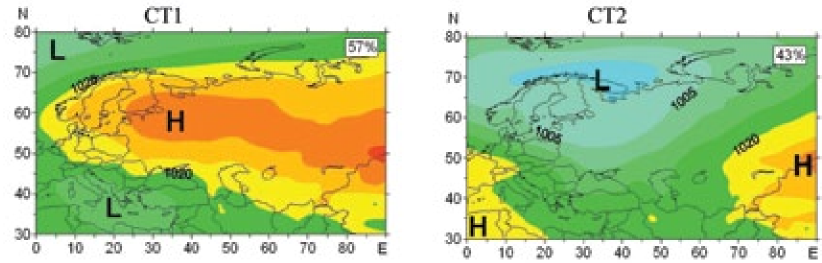

Fig. 4. Patterns of the two wintertime SLP circulation regimes (hPa) for the Black Sea.

The second type CT 2 (the other 43% of events) is characterized by a low pressure center over the Barents or Norwegian seas. The leading edge of the trough develops quickly and trails southeast rapidly from a northern low pressure center. When this cold air reaches the Black Sea in winter, a local cyclone may be generated.

These two circulation types are the most effective for the formation of storms. The configuration of the pressure field is such that the high wind flow has the largest distance over the open sea to accelerate and to induce storm waves. In these cases, storms cover a large part of the sea. Both observations and modeling in previous studies, e.g., [21, 22, 23] agree that the number of storm events in the Black Sea does not increase by the end of the twentieth century and may even reduce. The same tendency is seen in SWAN results (Fig. 5). Analysis of CT frequency shows that the proportion of the two CTs is redistributed slightly between the periods 1961–1980 and 1981–2000, with the frequency of CT 1 events becoming higher than CT 2 in the latter period.

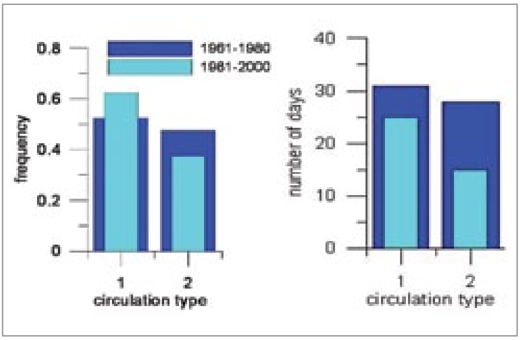

Fig. 5. Relative (a) and absolute (b) frequency of storm days in the Black Sea with wave height H ≥ 4 m, circulation types as in Fig. 4.

When comparing SLP fields of ECHAM5-MPI/OM and NCEP/NCAR for 1961–2000, the threshold for the correlation coefficient:

$r \geq 0.95$ were chosen. Previous paper [39] showed that $r \geq 0.95$ is enough for ECHAM5-MPI/OM and reanalysis results to have good agreement in the number of days with wind speed of 15 m/s and more, which is considered to be the threshold for storm-wave development in the investigated seas.

To analyze possible changes in storm SLP frequency in the future, we used ECHAM5 results from modeling the A2 SRES emission scenario [15], the most negative variant of human impact to the climate including high greenhouse gas emissions, non-effective land use, fast population growth etc. SRES A2 scenario has the highest temperature increase by the end of the 21st century, about 3.5° [11]. According to the ECHAM5-MPI/OM results, projected mean global temperature will increase by about 1.5°C by 2050 and by 4°C by 2100 relative to 1980–1999 [11].

Storm activity in the Black Sea will be strongly reduced by the middle of the 21st century, and so the tendency of the previous decades will continue: number of storm days will reduce from 250-350 cases for CT1 before 2000 to 200 in 2045-2064 and from 100-150 cases to less than 50 for CT2. According to an IPCC report [11], the multimodel ensemble mean SLP projection shows SLP increase over the Mediterranean Sea and Black Sea, especially between December and February. This may explain why storm activity is projected to weaken in our results. The same reduction of storm activity is expected for the Caspian Sea due to pressure increase over its surroundings.

CONCLUSION

This paper shows the results of a hindcast study of wind waves on the Black, Baltic, Caspian and White seas based on a continuous numerical calculation for the period between 1949 and 2011. The large time span of this period makes it possible to obtain reliable statistical and extreme parameters of wind waves, as well as to assess the evolution of the wave climate. A storm events calendar was prepared based on numerical experiments with the wave model SWAN and only storms with a significant wave height of 4 m or greater were chosen. Additionally, an assessment of interannual variability of storms on the Baltic, Black, Caspian and White seas was carried out. It was shown that by the end of the 20th century the storm activity in the Baltic Sea had increased, while Black and Caspian seas revealed negative trend and the White Sea absence of any trend. It was also found that the frequency of circulation types was redistributed in 1981–2000 compared to 1961–1980. This result provides an important foundation for the statistical climate projection of storm activity in future research.

The results reported in this paper could be further applied in research with the use of other data sets and methods such as meteorological hindcasts having a finer temporal and/or spatial resolution, unstructured numerical grids and coupled models permitting the calculation of both waves and hydrodynamic parameters. The latter are expected to be especially useful for studies of the characteristics in coastal areas, bays and straits.

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Flooding risk management in urbanized coastal zone

FLOODING OF COASTAL CITIES BY TSUNAMI AND STORM SURGE

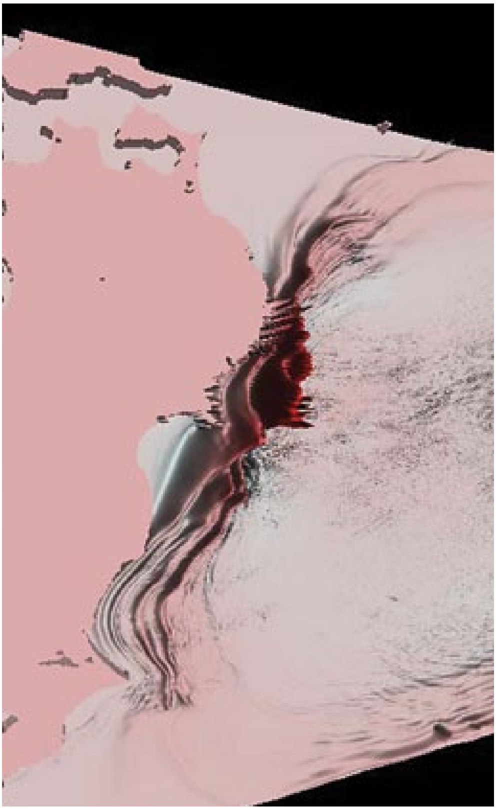

Fig. 1. Numerical computation of the 2011 Tohoku Tsunami (28 minutes after the earthquake)

In the last decade, coastal zone experienced devastating damage due to historic mega-tsunami, e.g. 2004 Indian Ocean Tsunami and 2011 Tohoku Tsunami, and giant storm surge, e.g. 2015 Hurricane Katrina and 2013 Typhoon Haiyan. Since most mega-cities are located on the coast, it is important for human community to develop a better relationship with hazardous sea nature. Fig. 1 represents the scale of the 2011 Tohoku Tsunami simulated on the basis of numerical computations. This article describes the state of the art of the coastal disaster mitigation.

PROTECTION BY STRUCTURE AND DAMAGE REDUCTION BY EARLY EVACUATION

Disaster mitigation for tsunamis and storm surges is a major challenge faced by Japan, which has suffered many coastal disasters and will continue to do so, when the country tries to enhance resilience of its coastal areas where the country's population and assets have concentrated. It is difficult to predict in detail how high tsunamis will be because their height greatly depends not only on the magnitude and characteristics of earthquakes, but also on the geography of the seabed or coast. Storm surge is better predicted compared with tsunami, but highly variable due to the track of typhoons and nearshore bathymetries. Tsunamis and storm surges happen less frequently than floods and storm waves, and compared to earthquakes, which cause damage almost instantly, it takes longer time for tsunamis and storm surges to reach and affect the coast after they develop off the coast.

Disaster mitigation for tsunami and storm surge has been implemented by combining structural (hard) countermeasures and non-structural (soft) countermeasures. The structure-based countermeasures are represented by seawalls and breakwaters. The non-structure-based countermeasures include relocation of residential area to higher places, early warning, and evacuation. Estimating the scale of storm waves, storm surges, and tsunamis that will reach coastal areas requires study on how waves develop in the spatial scale of tens of kilometers. The Seacoast Law in Japan requests, therefore, that the Prefectural Governors work with the central government to take measures for coastal disaster prevention. For example, in Japan the height and structure of seawalls, which are an example of structural measures, are determined by the Prefectural Governors in their role as coastal managers. Before these are determined, not only the highest water elevation of tides and run-up of storm waves, but also the design tsunami height and the storm surge level are taken into consideration to determine the specifications of seawalls, so that seawalls will be high enough to prevent sea water that is as high as the highest water elevation and design height from overflowing the walls to the land.

On the other hand, in order to consider what precautions should be provided against other disasters, such as fire and earthquakes, it is more practical to take account of conditions of nature and society that are specific to local communities and districts; therefore, such precautions are considered at a smaller level, like cities, towns, and villages, than that of coastal management by the prefecture, in accordance with the Basic Act on Disaster Control Measures, which is a basic law for provision of such precautions. The coastal disaster mitigation strategy is drawn up as part of local disaster prevention plans which are arranged by the Mayors of cities, towns, or villages, and is aimed at providing an evacuation program in the event of high water level that cannot be blocked by seawalls. Even land areas protected by seawalls cannot be perfectly protected, and buildings and houses there will be flooded if high water level due to tsunamis and storm surges overflow the seawalls into those areas. However, it often takes some time for such a high water level to reach the coast after an earthquake or a typhoon developed, so quick evacuation can save more human lives. Non-structural measures aimed at disaster reduction to prevent loss of human lives and reduce damage to assets, and are different from structural measures, which are taken to prevent inland flooding and are aimed at disaster prevention. To implement disaster reduction based on quick and well-organized evacuation, it is important for each resident in a community to maintain awareness of disaster prevention and for the residents of the community to help each other. It is important, therefore, to understand the role and limitations of seawalls, which are recognized to be public support, and translate the concept of community support and individual support into detailed action plans. It was also pointed out even before the 2011 Great East Japan Earthquake how important public support, community support, and individual support were, because the experiences of the 1993 Okushiri Tsunami, the 2004 Indian Ocean Tsunami, the 2005 Storm Surge due to Hurricane Katrina, etc. had indicated that tsunamis and storm surges caused by these hazards were too large to be prevented by seawalls alone.

Fig. 2 is a schematic diagram and represents a concept of a comprehensive disaster prevention program that combines structural and non-structural measures. The horizontal axis represents the scale (height) of a tsunami (or a storm surge, but hereafter explained only for tsunami), while the extent of damage is represented in the negative direction on the vertical axes. Because the extent of damage caused by a tsunami accelerates as the tsunami becomes higher, the damage when serious as the tsunami develops high waves, and the extent of the damage is represented by an upward convex curve. To take structural measures that provide constructions like seawalls, the scale of the tsunami to be blocked by the measures is determined based on data that includes the record of the largest tsunami, as shown in the figure, and examination of how the run-up of storm waves or storm surges will behave. Then, constructions, such as seawalls that are designed based on the previously mentioned information, will be set up along the coast to prevent tsunamis from flooding the land.

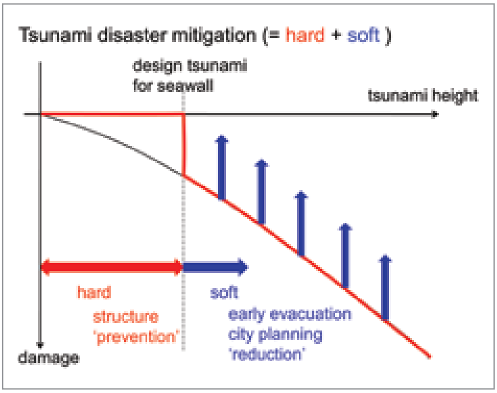

Fig. 2. Conceptual diagram of tsunami disaster mitigation composed of structural and non-structural measures

Seawalls, however, are designed against an external force that is not large enough to overflow the levee crown of the walls; the walls cannot be expected to be effective against and safe from a tsunami that is higher than they are. It is the philosophy of the comprehensive tsunami mitigation that, in the event that water flows over the seawalls and causes a flood, non-structural measures with a focus on a quick and smart evacuation should be taken to minimize the damage caused by the tsunami. Structural measures include constructing seawalls to prevent the land from being flooded, and these deserve to be called disaster prevention, while nonstructural measures should be regarded as disaster mitigation because they are aimed at saving more human lives and reducing the extent of damage when urban areas are flooded.

TWO LEVEL HAZARD FOR DISASTER MITIGATION

When the 2011 Tohoku Tsunami devastated many coastal communities, Town Fudai and other areas in northern Iwate Prefecture were protected by seawalls as high as the tsunami, which successfully prevented the tsunami from flooding over the land. However, in northern Fukushima Prefecture and in many areas further north, the tsunami was several meters higher than the seawalls there and wrecked them. Even in areas where the seawalls survived, it was difficult to confirm clearly whether the seawalls reduced the damage of the tsunami. In contrast, in southern Fukushima Prefecture and areas further south, the overflow depth of the tsunami over the seawalls was approximately 1–5 m, and a clear relationship between how seriously the seawalls were broken and how much damage was developed on the land was observed in these areas. For example, some seawalls along the Nakoso Coast in the south end of the Fukushima Prefecture were hit by a tsunami with approximately 1-m overflow depth, but were not destroyed, resulting in minor damage to the land area. Most low walls in another area a few hundred meters away that were hit by the tsunami with an approximately 3-m overflow depth were ruined and could not prevent a large-scale flood. In addition, many coastal areas of Minami-Soma City suffered large-scale flood damage, but the extent of the damage tended to be smaller in areas with a lower percentage of totally destroyed seawalls; it was also confirmed by this fact that seawalls, if not totally broken, effectively reduced the amount of overflow.

In addition, the fact that the Tohoku Tsunami flooded some evacuation places led to a recognition of how important it is to set in a detailed and scientific manner the scale of the tsunami allowed for to plan structural and non-structural measures. Although the tsunami, which was far larger than the set conditions, tore down many seawalls, the walls that were not destroyed completely are reported to have lessened the flood damage caused by the tsunami, as observed in the examples of Nakoso and Minami-Soma cities, and the effectiveness and limitations of structural measures will be quantitatively explained soon by scientific analyses. Based on these findings, an idea is being introduced to set the scale of tsunamis in two

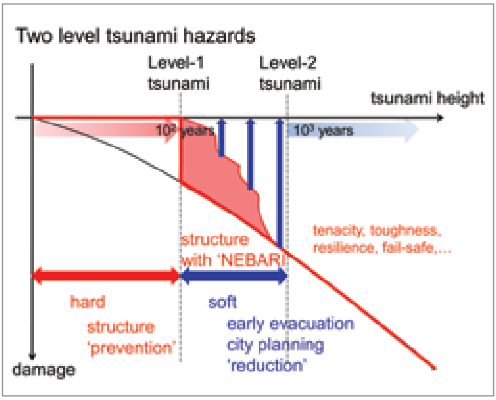

Fig. 3. Conceptual diagram of tsunami disaster mitigation based on two level tsunami hazards

levels, as shown in Fig. 3, Level-1 tsunamis are those that occur once in about one hundred years, and are used to design structures like seawalls, and Level-2 tsunamis are those that occur less frequently, or once in one thousand years, and are used to draw up evacuation plans. In addition, a tenacious structure with a "nebari" concept that is also effective against tsunamis exceeding its design height is also being considered. Every effort is being made to combine detailed, practical non-structural measures and resilient structural measures to save human lives and reduce damage to assets.

OPTIMAL COMBINATION OF HARD AND SOFT COUNTERMEASURES BASED ON RISK MANAGEMENT

As described in the above, it has been decided to promote preparations against tsunamis, by setting the two tsunami levels based on their frequency and by combining structural and nonstructural measures. Seawalls are designed against Level-1 tsunamis, which occur once in one hundred years or so. This means that only the frequency of tsunamis is considered to decide the height of seawalls. This approach to setting the height of seawalls is reasonable to some extent to secure a common extent of safety, when most coastal low-lying areas are used as places of residence, as in the case of Japan. The extent of safety in communities can be raised by measures other than seawalls, and it is recommended to take account of such conditions to design the height of seawalls. As one of the ways to enhance safety against tsunamis, it is effective to change the way lands are used, through relocation of communities to uplands and regulation of the use of low-lying coastal areas, for example. Provision of education in disaster prevention and evacuation drills to more people will raise the rate of successful evacuation and lead to a reduction of casualties. It is important to have a framework to consider both conditions of nature comprehensively, such as characteristics observed in the event of earthquakes and tsunamis, and social conditions that have an impact on the optimal design height of seawalls.

A risk analysis is an effective means of examining such conditions comprehensively. Fujima and Hiwatashi (2013) studied Town Toi in Shizuoka Prefecture to assess the residual risk of the town and, based on the assessment, proposed a method to determine the optimal height of seawalls. The risk analysis performed to consider preparations against tsunamis is to analyze the damage expected to be caused by, as well as the incidence of, a virtual tsunami in the future, for example in the next fifty years in an area forecasted to be flooded by the tsunami, and calculate the expected value D of the risk in the area.

$$D = \int_0^\infty d(H, h_c)\, p(H)\, dH$$

Values H and p(H) represent the height of an approaching tsunami offshore and the probability of the tsunami as high as H reaching the area, respectively. Values hc and d(H, hc), respectively, represent the heights of seawalls and financially calculated amounts of the damage expected to be caused by the tsunami. This function anticipates that the amount will be increased as the height of the tsunami H becomes higher and will be decreased as the height of the seawalls hc becomes higher. The above formula calculates the expected value, which is an amount of the damage anticipated in the area over the period subject to study. The expected value of the damage is not normally zero in Japan, where its population and assets gather in flat, low-lying coastal areas, because there is a finite probability that a tsunami will overtop seawalls and affect the coastal communities; seawalls do not free the country from a risk of flood caused by tsunamis. The purpose of various measures taken against tsunamis is, therefore, to reduce the residual risk.

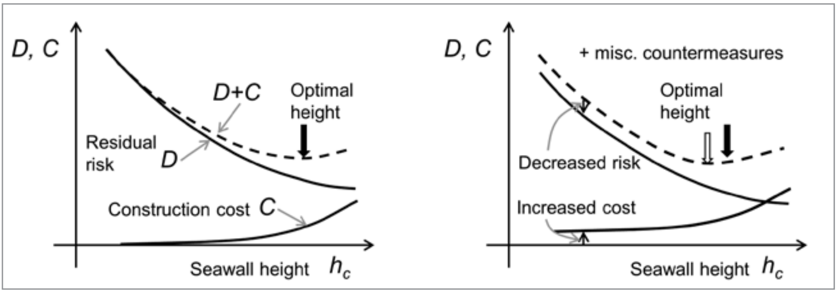

Fig. 4. Optimal seawall height determined by the risk analysis

Fig. 4 is a graph in which heights of seawalls hc and financial costs/benefits are respectively plotted on the horizontal and vertical axes, and gives an example of the residual risks and construction costs. Residual risks will decrease and construction cost will increase in proportion to the height of seawalls. Since the sum of residual risks and construction costs is the total social cost to be borne over the period by the community, such a height of seawalls that minimizes the total cost will be the most reasonable height.

This approach to determining the height of seawalls analyzes not only the incidence of tsunamis, but also the amount of damage that depends on the amount of assets and house types in the community, and is thought to be more rational than the current method, which considers only the incidence of tsunamis to determine the height. As indicated by Fig. 2 and 3, damage caused by tsunamis can be decreased not only by seawalls (structural measures) but also by non-structural measures, such as relocation of communities to elevated places and faster evacuation. If the amount of the residual risks that can be reduced by taking measures other than the construction of seawalls is quantitatively evaluated, such other measures can be implemented in addition to the construction of seawalls and can minimize the residual risks comprehensively. In this way, it will be possible to determine an optimal combination of measures. For example, according to Fig. 4, building seawalls as high as hc and taking other additional measures will increase cost but further reduce residual risks. If the effectiveness of the measures to take is allowed for and the height of seawalls are determined so that D+C will be minimized, it will be possible to reduce the height of seawalls and mitigate damage.

To analyze which measures to choose to have an optimal combination as explained above, it is necessary to sort out data on the incidence of tsunamis and other basic data of damage, including breakage of seawalls, and changes in the way land is used over the period subject to study. Since conventional design of seawalls did not consider how seawalls are broken by tsunamis flowing over the walls and how effective the walls are in mitigating damage, there are scarcely any such studies and analyzes available for reference. To promote such measures that will save more people from tsunamis, it is necessary to evaluate not only the ability of seawalls to withstand overtopping, but also to assess a combination of structural and nonstructural measures comprehensively from various perspectives, including those of social equality, economy, and risk management, and carry out the measures smoothly.

Reducing residual risks of tsunamis and improving resilience of coastal areas call for a preliminary disaster assessment program aimed at encouraging a certain manner of land use and a comprehensive coastal management system that collectively deal with measures against tsunamis; our upcoming task is to interdisciplinarily discuss and study how to implement such a program and system.

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Experience of the global environmental trends study in the European Union and its application for Russia

INTRODUCTION

Leading international organizations and agencies regularly prepare a series of outlooks and scenarios, considering the change of the environment, environmental management perspective, environmental policy with different horizons of prediction. The OECD Environmental Outlook to 2050: The Consequences of Inaction (2012) examines two major scenarios towards 2050 under present trends of socioeconomic developments: without new policies and "if we act" [1].

The European Environment Agency (EEA) analyzes global megatrends relevant for the European environment with the forecasting horizon up to 2050. "A State of the Environment Report. Assessment of Global Megatrends" is published every 5 years by EEA, to assess the European environment's state, trends and prospects in a global context. The EEA reports clustered megatrends into 5 groups: social, economic, technological, environmental and political. The experts pointed out that in the absence of response global megatrends can violate the stability of Europe and the world but they also could provide opportunities [2]. Among the environmental megatrends for Europe in 2010 State of Environment Report the following trends were mentioned: the decreasing stocks of natural resources, including mineral and water; increasingly severe consequences of climate change; increasing environmental pollution load; loss of biodiversity are of the greatest importance.

In 2015 an updated assessment of global megatrends for Europe [3] focused on the same issues presented in Report of 2010. The latest report covers a broad range of topics, setting out trends that are likely to influence and shape Europe' future, and their possible environmental implications. Europe has two main clusters of response options to global megatrends: 1) shaping global change in ways that mitigate and manage risks, and 2) adapting to global trends.

In 2015, the following 11 mega-trends of world development were identified as the most important for Europe [3]:

1. Diverging global population trends;
2. Towards a more urban world;
3. Changing disease burdens and risks of pandemics;
4. Accelerating technological change;
5. Continued economic growth;
6. An increasingly multipolar world;
7. Intensified global competition for resources;
8. Growing pressures on ecosystems;
9. Increasingly severe consequences of climate change;
10. Increasing environmental pollution;
11. Diversifying approaches to governance.

The monitoring of global trends and their impact on Russia previously was done under the title “Russia in the Surrounding World” and published in 1998–2011 Yearbooks with the series the articles on crucial environmental issues and policy, demography, socio-economic issues, environmental education, green economy, etc.

Under the global trend, we understand a modern, breakthrough, and actively developing phenomenon (or process) that can have a significant impact on the various sectors including state of the environment. The vision of global trends allows better respond to the challenges of the future, to determine the strategic planning priorities, including those in the field of environmental management and policy.

The objective of this study was to identify, analyze and rank the impact of the global trends that can shape the state of Russian environment in the medium and long term. The process resulted with a set of global trends (or “Grand Challenges”) that create windows of opportunities and threats for Russia.

MATERIALS AND METHODS

Based on the analysis of sectoral documents, strategies and scenarios of Russia [4–10], key world forecasts [11-14] and the other information sources, global trends with an environmental focus were identified for Russia.

The major methods for identification and analysis of global trends for Russia were bases on the various foresight approaches: bibliometric and patent analysis, in-depth interviews, expert panels, focus-groups, literature reviews. The important statistical data was taken from the "National State of Environment Reports" annually prepared and published by the Ministry of Natural Resources and Environment of the Russian Federation [15].

The next step was the ranking of trends on their impact on Russia. It was conducted on the basis of questionnaires of experts. The questionnaire was sent to more than 150 experts from the leading scientific organizations in the field of environment and nature management, as well as to some universities. More than 70 responses were received. Among the experts who took part in the survey were employees of the Institute of Geography of the Russian Academy of Sciences, the Institute of Ecology and Evolution named after A.N. Severtsov, Faculty of Geography, Lomonosov Moscow State University, Tver State University, Smolensk State University, State University of Management, Technological Center of RusNano and a number of other organizations. The revealed trends were ranked on the basis of expert evaluation for a number of indicators:

- The degree of influence on Russia: 1 — creates threats, 2 — creates opportunities;
- The power of influence on Russia: 1 — weak, 2 — strong, 3 - very strong;
- Russia's ability to influence the development of this trend: 0 — can not affect, 1 — limited, 2 — can significantly affect.

RESULTS

A total of 36 trends relevant for Russia were identified (Table 1), including 10 economic, 6 social, 3 geopolitical, 8 scientific and technological, 9 trends in the field of environmental change.

#	CATEGORIES OF THE TRENDS	GLOBAL TRENDS
1.	ECONOMIC	1. Green economic development and "green growth" in the developed countries of the world
		2. Formation of a global market for alternative energy sources
		3. Introduction of economic instruments for solving environmental problems at the international level
		4. Growth in global demand for food
		5. Increasing global competition for mineral resources
		6. The growth of oil and gas production on the shelf of the Arctic Ocean, accelerated development of the Arctic
		7. Growth of oil production from oil sands and oil shales
		8. Reducing the availability of fresh water and increasing competition for water in transboundary river basins
		9. Expansion of environmental protection activities
		10. Increased costs of adaptation to climate change
2.	SOCIAL	11. Growing urbanization and the increase in the proportion of urb an population
		12. Increase in morbidity and mortality from environmental pollution
		13. The spread of diseases caused by climate change to new areas
		14. Growth of the population living in water scarcity conditions
		15. Growth of population migration due to environmental causes and climate change
		16. Growing ecological awareness of the society
3.	GEO-POLITICAL	17. "Redistribution of the Arctic" due to resources accessibility (raw materials, transport, environment-forming, etc.)
		18. Fostering interaction between environmental science and politics
		19. Multilateral cooperation on sustainable development issues

4.	IN THE FIELD OF SCIENCE AND TECHNOLOGY	20. Development of alternative energy technologies,including for the biofuel production
		21. Development of technologies for the environmentally safe disposal of waste and detoxication of toxicants
		22. Development of technologies for recycling and reuse of wastewater
		23. Effective technologies for assessing the state of ecosystems (landscapes) and the marine environment for reducing environmental risks
		24. The spread of environmentally friendly transport
		25. Development of the materials with new properties (including energy-saving ones) and technologies of green construction
		26. New technologies for development of non-traditional and hard-to-recover hydrocarbon resources
		27. Development of geo-engineering technologies (for climate management, carbon capture and storage)
5.	ENVIRONMENTAL	28. Climate change, including the increase in the intensity of hazardous and extreme hydrometeorologic processes
		29. Increase in the intensity of unfavorable geological-geomorphological, erosion-channel processes and processes in the cryosphere
		30. Distribution of new pollutants in the environment, including micro- and nanoparticles
		31. Reduction of biodiversity due to climate and land use change
		32. Outbreaks of abundance and invasion of alien species
		33. Sustainable reduction of primary (virgin) forest areas
		34. Increase of protected areas
		35. Overfishing and depletion of fish stocks in the seas
		36. Increasing impact on coastal ecosystems

Table 1. Global trends that can shape the state of the environment of the Russian Federation Discussion

About half of global trends (17 out of 36) create threats to Russia's environment. Among the most serious trends for Russia, the largest number refers to environmental trends, one — to geopolitical trend ("redistribution of the Arctic" due to the access to resources), four — to social trends (increased incidence due to environmental pollution; the spread of diseases caused by climate change; the growth of migration due to environmental causes and climate change; urbanization growth and the increase of urban population) and three — to economic trends.

Threats create the following economic trends: the growth of oil production from oil sands and oil shale; the formation of a global market for alternative energy carriers; increasing world competition for mineral resources. It should be noted that in the "Strategy of economic security of the Russian Federation for the period until 2030", the main challenges and threats also include "a change in the structure of the world demand for energy resources and the structure of their consumption, the development of energy-saving technologies and the reduction of material consumption, the development of "green" technologies (paragraph 12, point 6) [9]. Approximately the same number of experts assessed the risk of threats and opportunities for the following trends: reduced availability of fresh water and increased competition for water; costs increase of adaptation to climate change.

Among the trends of economic development, creating opportunities for Russia, were listed: greening the economy and green growth; growing global demand for food; introduction of economic instruments for solving environmental problems at the international level; the growth of oil and gas production on the shelf of the Arctic Ocean and the accelerated development of the Arctic; expansion of environmental protection. The trend of ensuring environmentally oriented growth of the economy and introduction of environmentally effective innovative technologies is declared as a strategic goal of Russia's State policy until 2030 in the field of environmental development [7].

The number of unresolved environmental problems in our country was the reason for attribution of environmental trends to the threats rather than to potential opportunities for Russia. This result of the survey corresponds to the official position: for example, the Strategy for the Economic Security of the Russian Federation for the period up to 2030 (2017) refers to the significant impact of factors associated with global climate change, capable of causing food and fresh water shortages, access to renewable resources, including resources of the Arctic and Antarctic zones, the Arctic Ocean water area (paragraph 10 "Challenges and threats to economic security") [9]. Of environmental trends, only one opportunities for Russia, i.e. an increase of protected areas.

Expert assessments of the impact of global trends of scientific and technological development on Russia largely correspond to the priorities of the national environmental policy. The experts stressed the importance of developing technologies for the environmentally safe disposal of waste and detoxication of toxicants; recycling and reuse of wastewater, and the creation of effective technologies for assessing the state of ecosystems (landscapes) and the marine environment. The importance of the last trend is due to the need to improve the effectiveness of environmental monitoring, forecasting of natural emergency situations, as well as responses to climate change. These technologies can multiply improve the technical and economic indicators of information and analytical support of environmental protection and environmental safety.

Among global trends that can have the strongest effect on Russia in the coming decades, there are the growth of oil and gas production on the shelf and the development of the Arctic; depletion of strategic mineral resources; "Redistribution of the Arctic" due to the access to resources; growing global demand for food; depletion of fish stocks in the seas; reduction of primary forest areas; climate change, etc.

Russia can influence the implementation of trends from all 5 groups, while a significant and limited impact can be traced only for 15 trends. To the smallest degree, Russia can influence the following trends: distribution of materials with new properties (including energy-saving ones) and technologies of green construction; greening the economy and "green growth"; development of alternative (ecologically efficient) energy technologies, including biofuel production; development of technologies for recycling and reuse of wastewater; the spread of environmentally friendly transport; development of geo-engineering technologies. Most of them belong to the category of scientific and technological trends, which, unfortunately, reflects a low scientific reserve in these areas. It is obvious that Russia needs to regularly monitor environmental development in the framework of global trends (as it is done in the European Union), to identify progress or deterioration of the situation by some parameters to adjust its environmental policy.

CONCLUSION

Studies of the global trends is particularly important for environmental management, which differs from the other sectors because of the long planning horizons, multidisciplinary decisions, inability to obtain quick and clear economic results.

Expert analysis of global trends allowed to identify the main threats and opportunities for environmental development of Russia. It serves as the basis for determining the priority thematic areas of applied research, identify promising directions in the field of environmental management and safety, contributing to the solution of key issues and responses to the challenges.

PROSPECTIVE DIRECTIONS OF RESEARCH MAY INCLUDE:

- long-term, global, and strategic risk assessment of global trends with special reference to Russia's environment;
- development on the basis of foresight methods a list of specific actions to be taken in the short and medium term to achieve a "desirable future" in the field of environment and policy processes in accordance with the threats and opportunities that Russia has.

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Hydrological risks under climate change

STUDIES FOR RISK ASSESSMENT OF CLIMATE CHANGE ON HYDROLOGY

Climate change is one of the important issues for sustainable environment. Especially, the impact on water is a serious issue. Various studies have already conducted, and many results are obtained. Fig. 1 illustrates the structure of studies in this field. Observation is the base of hydrology and climatology. Not only the filed observation, but also satellite observation give fundamental information of our analysis. Also, the result of climate simulations

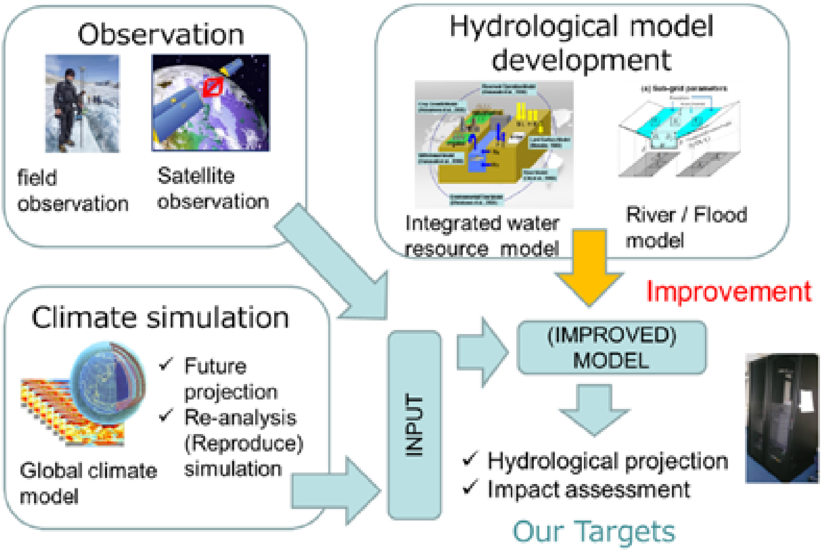

Fig. 1. The schematic figure about the structure of the study in the field of impact assessment of climate change on water

are important for us. As you may image, it is impossible to observe all area in earth, developing a good model is a key issue. And, the advantage of model is that it can give us the information about future. We are using the knowledges obtained from these observation and climate simulation studies as an input. Hydrological model is a main tool to study global hydrology. Various models have been developed, integrated water resource model considers the water withdrawal, dam and environmental flow. River routine and flood model is a key to assess the impact of climate change. We are using and sometimes improving these models to project hydrological impact.

Field and satellite observation gives us fundamental information about present hydrology. Based on these observed dataset, simulations of climate and hydrology are conducted. Climate models simulate historical and future climate. The output of these models are the bases of hydrological simulations for the assessment of climate change. Temperature and Precipitation is most important variables for the hydrological simulations. In addition to these variables, other variables are required in some hydrological models (e.g. wind speed, humidity, air pressure, radiations etc.). The hydrological simulation is composed of land-surface scheme and river routing scheme. The most important output of land-surface process for river routing scheme is runoff. River discharge is simulated by integrating runoff, the accuracy of runoff estimation is therefore so important. However, runoff is not able to observe directly. The accuracy of land-surface and river routing scheme is validated by the observations of river discharge. To project future hydrology appropriately, the availability of observation dataset of river discharge is an essential matter. Recently, due to the increasing interest in climate change, the number of developing models are increasing all over the world. Because the aim of the development in each model is not consistent, the increment of models can contribute to understand climate change and its impact on hydrology. The increment of models arises another issue about the spread of projection derived from the difference of models. It is significant to study about the difference among models. It is necessary to explain about the difference among models and develop a method to evaluate models.

THE UNCERTAINTY IN THE FUTURE PROJECTIONS OF HYDROLOGY

Uncertainty is a key issue to project a future appropriately. The uncertainty of future projection is derived from various factors. Here, we consider about the spread of projection as a source of uncertainty. Fig. 2 illustrates the combination of sources of the spread in future hydrological projections. The Global Climate Models (GCM, this is sometimes referred as General Circulation Model) project a future climate based on the emission scenarios and ensemble settings. The emission scenarios define the level of climate change and ensemble is the simulation of which the initial condition or parameter is slightly changed.

The studies which consider the spread of projection derived from the combination of GCM, emission scenario and ensemble runs have already existed in the field of climate. However, the

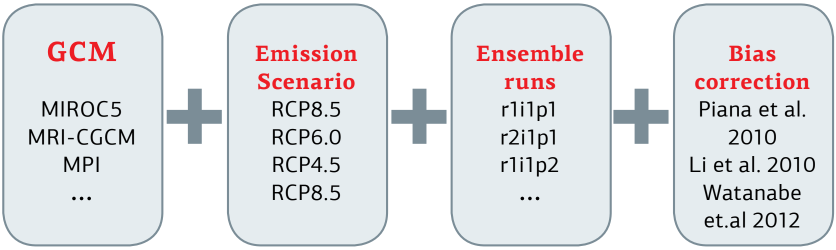

Fig. 2. The combination of factors for the spread in future hydrological projections

difference of bias correction method is significant in the field of hydrological projection. Bias correction of GCM outputs is necessary for hydrological simulation, and it has been mentioned in previous studies that the impact of bias correction on the result is significant. The impact of bias on future projections is not negligible, particularly for processes related to precipitation. Bias correction is performed frequently in assessment studies, and the development and comparison of bias correction methods has been the subject of many previous studies. Therefore it should be necessary to consider the spread of projection including the difference of bias correction

THE DEVELOPMENT OF RUNOFF BIAS CORRECTION METHOD

The projection of future runoff is important for assessing the impact of climate change on hydrology. The risk assessment of flood and drought etc. has been conducted based on runoff projections using hydrological impact models. The improvement of runoff projections can contribute to more appropriate assessments of river environments. Future projections are based on the output of GCM, and there are two approaches to the procedure used to assess the impact of runoff. In the first approach, runoffs projected by GCMs are used directly. In the second approach, runoffs simulated by land surface process models using climate forcing projected by GCMs are used for the assessment. In general, the outputs from GCMs need to be downscaled since the spatial resolution required for runoff assessment is finer than that of GCMs projections. Thus, in most assessment studies, land surface process simulations with finer spatial scale are conducted using downscaled climate forcing data projected by GCMs to obtain runoff projections rather than obtaining runoff projections from GCMs directly.

The procedures for correcting biases in GCM simulations (bias correction) are important. The impact of bias on future projections is not negligible, particularly for processes related to precipitation. Bias correction is performed frequently in assessment studies, and the development and comparison of bias correction methods has been the subject of many previous studies. Bias-correction methods for precipitation can also be applied to runoff. However, it should be noted that there are no observation datasets for runoff that can be used as a supervised dataset for bias correction. Thus, simulated runoff using a reanalysis dataset employed in a previous study was used. While many bias-correction methods have been proposed, bias-correction methods have not been applied to runoff correction. Despite the many studies conducted to investigate bias correction of climate variables, no method that is applicable to any assessment has been identified. The selection of method that is good for apply to runoff bias correction.

One of the criteria used to classify bias-correction methods is whether a method adopts a trend-preserving assumption wherein the signal of changes in GCMs output from an historical to a future period are preserved before and after bias correction. The trend-preserving assumption is reasonable for bias correction and has been used in previous studies because it is preferable to maintain the trend projected by GCMs rather than to change trends based on comparisons between GCM output and observation data during the typically limited period for which observation data are available. In addition, a two-pass assumption, i.e., that monthly variation in GCMs data is corrected and then daily variation is corrected using the corrected monthly variation, is adopted for the runoff bias correction. The advantage of this assumption process is that the trend of monthly variation obtained from GCMs outputs is not changed after the daily variation is corrected, while methods that correct daily variation directly generally change monthly variation after bias correction. For runoff in particular as well as other variables, the trend of future change in monthly scale projected by GCMs is more reliable than that in daily scale because, in many studies, the validation of GCMs is primarily focused on monthly scale, and reproducibility of outputs in monthly scale is more reliable than in daily scale. The efficiency of this strategy has been discussed.

The validation of runoff bias correction indicates the simple correction of monthly mean and coefficient of covariance can significantly reduce the bias of the GCM, and that the difference of methods is not negligible in the future projections. When methods are compared, results for bias-corrected runoff in a future period can be significantly different because the efficiency of bias-correction methods in an historical period is essentially the same. In particular, projections tend to have large differences if GCM outputs have significantly larger values than the reference data.

CLIMATE CHANGE IMPACT ON TOURISM

The impact of climate change affects various filed. Tourism is a field which may suffer some impact. Here, we consider the impact of climate change on tourism from the view of hydro-climate filed. One of the major impacts is the change of resources. Tourism resources, for example, tourism resources such as coral leaf or show, will change under global warming, and these changes affect tourism directly. Besides, resources to maintain tourism, for example, water resources will also change. These are indirectly affect tourism. In addition to the change of resources, the change of weather is also a significant factor. As expected, most of the tourist prefer the fine weather. And, previous survey indicated that the satisfaction level of tourist and weather are significantly correlated.

It is possible to project the change of tourist satisfaction from the change of weather under climate change using climate projections. To achieve this, a method to analyze the change which is important to consider the characteristics of future weather from the future projection data is required. One of the possible method is to estimate the change of fine day defined by cloud cover and precipitation. If the cloud cover, the ratio of the area covered by cloud (the value is 0 to 1), more than 0.9, it is referred to as cloud day. And if the rain is more than 0.5 mm per day, it is referred to rain day. Fig. 3 shows the future change in

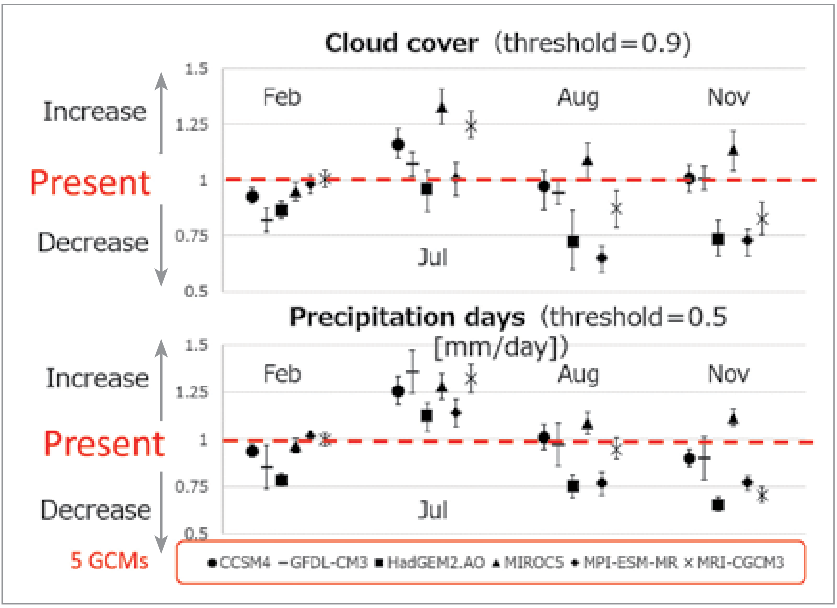

Fig. 2. The change of cloud and precipitation days. Vertical axis indicate the ratio of change. That is there is no change if the ratio is 0 (which is indicated by red dotted line). Each sign shows the result of each GCM. The error bar indicates the spread of projection.

Yaeyama islands, one of the tourist destinations in Okinawa, Japan, consists of several small islands located in the southwest part of Japan. The results indicate the increase of fine day in winter and decrease in early summer. These changes may affect the impact on the tourism in Yaeyama islands. A strategy to deal with these changes will be needed.

The study introduced above is an example that the climate projection is applied to various assessment fields. The probabilistic approach, used in the example above, enables simple assessments for issues associated with climate change. The trends in change are evaluated without considering the detailed relationship between climate and a target of assessment. This result can be useful for the impact assessment of climate change. The example of application shows that the developed method can effectively project the future main changes and uncertainty for the target of assessment considering the spread of projection derived from ensemble simulations.

TOWARDS BETTER UNDERSTANDING OF HYDROLOGICAL RISKS UNDER CLIMATE CHANGE

Studies which support the basis of risk estimation are explained above. Based on the observation and model development, the study for application is utilized appropriately. Because of the increasing interest to the climate change and its impact, the information about future projection has been increasing drastically. It is necessary to make more effort to the theory and practice for massive information about future projection. Since using all data is unrealistic, the importance of process to evaluate and select data will be very important in the era of the explosion of projection dataset. Some studies use the knowledge obtained in the filed machine learning, such approach is necessary for the assessment. Meanwhile, the basic information such as filed observation and satellite information, which needs long-term to obtain some scientific results, also is important continuously. Even though a good technology to analyze the information are obtained, the application of the information is basically depends on the data availability. Since the most important data is observation data, the effort for the observation should be continued. The collaboration between the researchers across fields seems to be more important.

SESSION 2
"Technologies to understand risks"

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Geo-information technology for drought monitoring and early warning system in Asia

1 INTRODUCTION

1.1 BACKGROUND OF THIS RESEARCH

In Asian countries, rice is the main staple food and the stability of the rice sector that is the largest employer in the agricultural economy is very important. However, it is widely known that rice production in South-east Asia is strongly influenced by annual and inter-annual changes in precipitation caused by El Nino Southern Oscillation (ENSO) and the Austral-Asia monsoon. Under El Nino, which is the warm phase of ENSO, South-east Asian countries have experienced a delay in the monsoon onset, a reduction of rainfall and the following severe drought season, these natural phenomena have a great influence on rice yields (Shofiyati, 2014). Statistically speaking, in Indonesia, historical data say that a 30-day delay in the monsoon onset and droughts in the planting season causes rice production on Java and Bali to fall by 1.12 million tons on average for the January-April harvest season alone (Rosamond, 2009). This fact implies that droughts, mainly in the planting season, are related to rice production.

Generally, droughts do heavy damage to the overall economy of the countries concerned. For example, from 1997 to 1998 severe droughts were caused in Southeast Asia and Australia by the climate anomaly of strong EL Ni-no, they led to not only a sharp reduction of agricultural produce but also large forest fires. As a result, the amount of damage of the whole world reached thirty four billion dollars (Hosoya, 2011). To cite another example, drought affected large areas of Thailand and Cambodia in 2004, even though total annual rainfall was close to the long-term average. Almost no rain fell in the last three months of the year, a period that is critical for rain-fed rice, resulting in a 30% fall in farm output (IWMI, 2012). To make matters worse, droughts 'impacts on rice cropping are getting more and more serious from year to year because of the influence of intensifying climate anomalies like El Ni-no and La Nina. For the reasons above, it is longed very much to develop a method to detect a drought and evaluate its impact on rice yield in advance for mitigating the influence of droughts and formulating appropriate agricultural investment policy (Jonai, 2012).

The definitions are categorized in terms of four basic approaches to measuring drought: meteorological, hydrological, agricultural, and socioeconomic (Wilhite, 1985). The first three approaches deal with ways to measure drought as a physical phenomenon. The last deals with drought in terms of supply and demand, tracking the effects of water shortfall as it ripples through socioeconomic systems. Meteorological drought is defined usually on the basis of the degree of dryness (in comparison to some" normal "or average amount) and the duration of the dry period. Definitions of meteorological drought must be considered as region specific since the atmospheric conditions that result in deficiencies of precipitation are highly variable from region to region.

In this sense, it is indispensable to devise a method to detect a drought and evaluate its impact on rice yield in advance. This study aims to build a rice crop monitoring system that provides the dryness of the paddy field and rice growth conditions in quasi-real time by developing vegetation and agricultural climate indices. Furthermore, this research also intends to estimate near-future rice production at sub-provincial level by utilizing the indices with experiential and theoretical prediction model. This method is expected to contribute to a regional agricultural planning policy for an investment in irrigation infrastructure.

1.2 OBJECTIVE OF THIS RESEARCH

The objective of this research is to develop satellite-based drought monitoring warning system for croplands in Asian countries. First of all, we search paddy fields by visual observation of satellite images for sub-provinces in Asian countries. Secondly, three types of vegetation and agricultural climate indices are developed to detect climatic drought by combining rainfall and land surface temperature retrievals, and monitor rice growth conditions from a bunch of satellite observations. Thirdly, with that monitoring data, the rice-planting patterns are analyzed at provincial level, especially focusing on the number of rice cropping in a certain year. After that, the performance of vegetation and agricultural climate will be investigated as compared with rice crop yield at the sub-province spatial scale, and finally it is possible to estimate rice production for each region with experiential forecasting model made by means of statistical analysis.

2 METHODOLOGY

2.1 DATA USED IN THIS STUDY AND AREA OF INTEREST

Fig. 1 shows a framework of meteorological drought monitoring in Asia. Five types of data are prepared including; (a) AMSR-E VV and HH polarization data in 23.8 and 36.5GHz to compute land surface

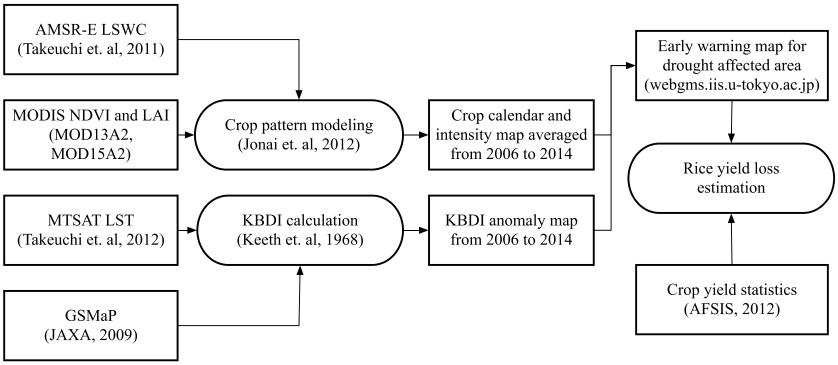


Fig. 1. Flowchart of a framework of meteorological drought monitoring in Asiain Asia

water coverage (LSWC) (Takeuchi, 2009), (b) MODIS normalized vegetation index (NDVI) 16 days composite product (MOD13A2) and leaf area index (LAI) 16 days composite (MOD15A2) to vegetation phenology of crop plants, (c) MTSAT IR1 and IR2 for land surface temperature retrieval (Oyoshi, 2010), (d) Global Satellite Map of Precipitation (GSMaP) and (e) crop yield statistics in ASEAN countries (AFSYS).

This study is mainly targeting the Asian countries which occupy 95% of strong on rice cropping in the world. Actually, the large irrigated areas around the Southeast Asian big rivers including Mekong is called as “rice bowls” of the region. In 2005 they produced half of the region’s production and around 8% of the global crop, though they constitute only 10% of the total land area. Moreover, most of the agricultural lands in tropical Asian countries are dominated by rain-fed system, which greatly have a close relationship to the timing of monsoon onset and precipitation in the main plantation season. IWMI report in 2010 also said that around 75% of crops are yielded from rain-fed agriculture. For the reasons above, these areas are very

[1] WebGMS - MTSAT/GMS (HIMAWARI) data processing on WWW http://webgms.iis.u-tokyo.ac.jp/

[2] Global Satellite Map of Precipitation (GSMaP) http://sharaku.eorc.jaxa.jp/GSMaP crest/

[3] Crop yield statistics in ASEAN countries (AFSYS) http://www.afsisnc.org/

suited for applying the rice crop monitoring method and expected to offer the best performance to find out correlation of droughts with rice production.

2.2 LAND SURFACE WATER COVERAGE (LSWC)

Land surface water coverage (LSWC) indicates the quantity of water content on land surface (Takeuchi, 2009). LSWC is calculated by integrating normalized difference water index (NDWI) and normalized difference frequency index (NDFI). NDWI is a satellite-derived index from the visible (VIS) and Short Wave Infrared (SWIR) channels derived from Moderate resolution imaging spectro-radiometer (Takeuchi, 2005), and it is sensitive to vegetation water content and open water. NDWI can monitor flood patterns at finer spatial resolution than AMSR-E at the expense of cloud contamination. On the other hand, LSWC is derived from the brightness temperature of vertical and horizontal polarization at 18.7, 23.8 and 36.5GHz. It is less affected by atmospheric conditions and not dependent on the soil temperature. LSWC provides a sensitive indicator of the presence of surface water and it has a good capability to distinguish the water surface and land surface.

2.3.NORMALIZED VEGETATION INDEX (NDVI) AND LEAF AREA INDEX (LAI)

Monitoring the distribution and changes of Leaf Area Index (LAI) is important for assessing growth and vigor of veg-etation on the planet along with Normalized Vegetation Index (NDVI). It is fundamentally important as a parameter in land-surface processes and parameterizations in climate models. This variable represents the amount of leaf material in ecosystems and controls the links between biosphere and atmosphere through various processes such as photosynthesis, respiration, transpiration and rain interception. LAI is one of the primary measures used in remote sensing and process-based models to characterize plant canopies. LA1 estimates are used for measuring the leaf reflective surface within a canopy. Until now excellent measurements of LA1 have been made for small-stature vegetation such as agricultural crops and plantations. In this study, we use this index for monitoring rice growth conditions.

2.4 GLOBAL SATELLITE MAPPING OF PRECIPITATION (GSMAP)

The research project "The Global Satellite Mapping of Precipitation (GSMaP)"started in 2002, which was sponsored by Japan Science and Technology Corporation. The high- precision and high-resolution global rainfall data are the most fundamental for the study of the global water cycle and water resources. The global rainfall rates with the uniform accuracy cannot be observed by any method other than the satellite remote sensing (Okamoto, 2005). At present, several satellites with the microwave radiometers, such as TRMM, Aqua, DMSP-F13, F14, and F15 are in operation. GPM project is a future plan of rainfall measurement with the core satellite loading dual frequency precipitation radars, accompanied by about eight companion satellites that also mount the microwave radiometers. Microwave radiometer data are expected to be the central data for producing the global maps of rainfall rates for the reason that they are used for the observation from satellite more frequently and have the wider observation swath width.

2.5 CROP CALENDAR AND INTENSITY MAPPING

First of all, we search paddy fields by visual observation of satellite photographs for 200 provinces each in Asian countries. Secondly, three types of vegetation and agricultural climate indices are developed to detect climatic drought by combining rainfall and land surface temperature retrievals, and monitor rice growth conditions from a bunch of satellite observations. At last, with that monitoring data, the rice-planting patterns can be analyzed at provincial level, especially focusing on the number of rice cropping in a certain year (Jonai, 2012).

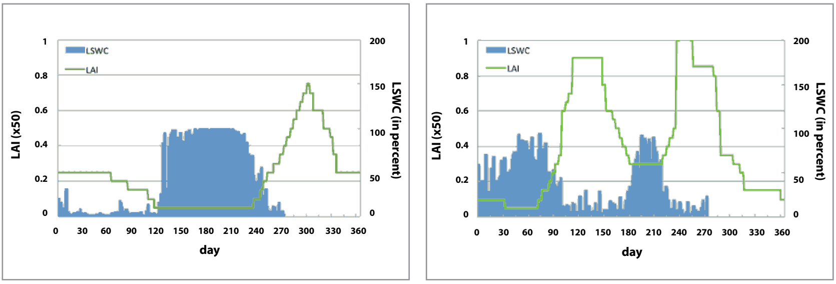
2.6 KEETCH-BYRAM DROUGHT INDEX (KBDI)

The Keetch-Byram drought index (KBDI) is a continuous reference scale for estimating the dryness of the soil and duff layers. The index increases for each day without rain (the amount of increase depends on the daily high temperature) and decreases when it rains. The scale ranges from 0 (no moisture deficit) to 800. The range of the index is determined by assuming that there is 8 inches of moisture in a saturated soil that is readily available to the vegetation (Keetch, 1968). KBDI is world widely used for drought monitoring for national weather forecast and a wild fire prevention. Our challenging in this study is to apply this index to meteorological drought monitoring in croplands.

3 RESULTS AND DISCUSSIONS

3.1 CROP CALENDAR AND INTENSITY MAPPING

Fig. 2 shows a cropping pattern analysis using LAI and LSWC. A peak value of LAI followed by LSWC is identified as a single cropping in (a) and two peak values of those in the same manner is identified as a double cropping in (b).the result of index calculation, especially for two of 200 provinces. Looking at the result of Irrawaddy, it can be observed that LAI approaches the peak after LSWC increased rapidly. This fact implies that after water content on land surface gets larger and deeper some vegetation grow. This is exactly what single-season cropping is conducted at Irrawaddy in 2011. On the other hand, in



(a) **Single cropping pattern in Irrawady river rice paddy in Myanmar.**

(b) **Double cropping pattern in Red river rice paddy in Vietnam.**

Fig. 2. Cropping pattern analysis using LAI and LSWC. A peak value of LAI followed by LSWC is identified as a single cropping in (a) and two peak values of those in the same manner is identified as a double cropping in (b).

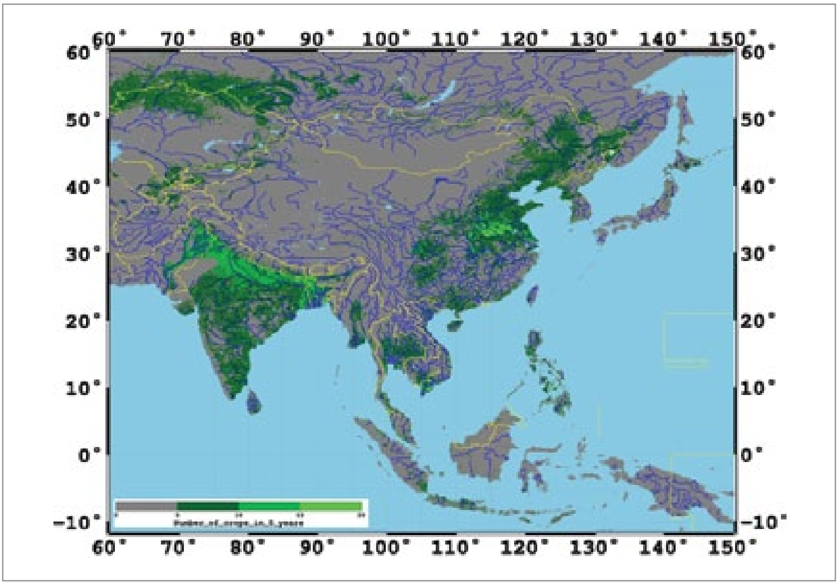


Fig. 3. Cropping intensity map in Asia Pacific region. The number of crops in 5 years from 2006 to 2010 are presented. The brightest color indicates triple cropping, brighter color double cropping and dark color single cropping respectively.

the graph of Red river, LAI peaks twice after the sharp increases of LSWC. Based on this result, it turns out that double-season cropping dominates in Red river.

Fig. 3 shows a crop-ping intensity map in Asia Pacific region. The number of crops in 5 years from 2006 to 2010 are presented. The brightest color indicates triple cropping, brighter color double cropping and dark color single cropping respectively. In this figure, when, where, and how many times rice is cropped in paddy field is shown. We can see that rice paddy field is widely scattered in Asia and heavily cropped at big river basin like the Indus, the Yangtze, and the Mekong River. Besides, we can see that double or triple cropping is done in Bangladesh and South China.

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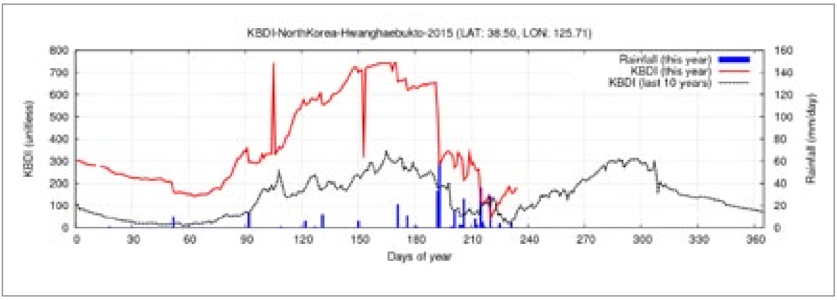
[4] NOAA national weather forecast office http://www.erh.noaa.gov/rah/drought/

[5] USDA forest service http://www.fs.fed.us/r8/fireprevention/currentDanger.php



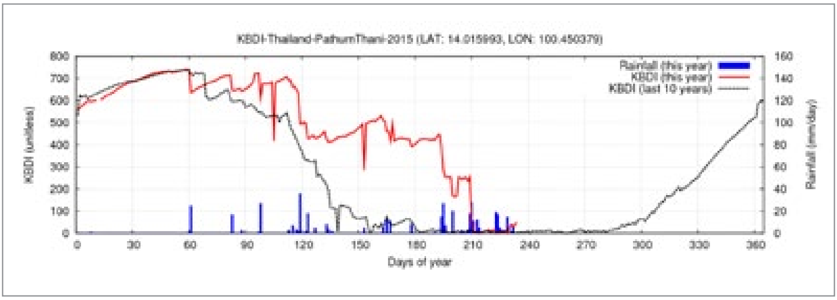


Fig. 4. Time series of KBDI and rainfall in 2015, and KBDI average values in the last 10 years in Hwanghae Bukto, Korea DPR and Pathumthani, Thailand.

3.2 DROUGHT AFFECTED AREA DETECTION IN 2015

Fig. 4 shows a time series of KBDI and rainfall in 2015, and KBDI average values in the last 10 years in Hwanghae Bukto, Korea DPR and Pathumthani, Thailand. In Korea DPR, KBDI values has been almost double of ordinary year starting from January to middle of July because of less rainfall and higher temperature anomaly. 10 years of average rainfall from April to June is 235 (mm) whereas only 74 (mm) of rainfall were observed in 2015 which accounts for 30% of ordinary year. In middle of July, two typhoons attacked Korean' peninsula and caused 200 (mm) of rainfall just in two days, however, it seems to be too late for farmers to plant new rice because rice plant requires 100 to 120 days to grow up and temperature goes down too cold in October to November in Korea DPR. In Thailand, KBDI in 2015 keep high value from January to May as usual, however, it keeps around 400 to 500 until middle of July because of less rainfall and higher temperature than ordinary year. Almost two month of delay in KBDI offset causes no sufficient water in croplands and farmers can not start rice cultivation activities or start it two month delayed in this year. Since rainy season from May to October is a major rice cropping season, rain-fed rice crops are very much effected by this drought anomaly.

Fig. 5 shows nation-wide drought anomaly map by KBDI in 2015 in Korea DPR and Thailand. According to this map, nearly 70% of major cropping area in Korea DPR is affected by more than 100% of drought anomaly in the last 20 years and 80% of major cropping area in Thailand is suffering from more than 50% of drought anomaly in the last 10 years. Detection of these area by geographical analysis could reveal.

3.3 DROUGHT EARLY WARNING SYSTEM AND CAPACITY BUILDING PROGRAM

Fig. 6 shows an web interface of satellite-based drought monitoring and warning system in Asia (DMEWS). The derived information is disseminated as a system for an application of space based technology (SBT) in the implementation of the Core Agriculture Support Program. The benefit of this system are to develop satellite-based drought monitoring and early warning system in Asian counties using freely available data, and to develop capacity of policy makers in those countries to apply the developed system in policy making. A series of training program has been carried out in 2013 and 2014 to officers and researchers of ministry of agriculture and relevant agencies in Greater Mekong Subregion countries including Cambodia, China, Myanmar, Laos, Thailand, Vietnam and Indonesia. This system is running as fully operational and can be accessed at http://webgms.iis.u-tokyo.ac.jp/DMEWS/.

4 CONCLUSIONS AND FUTURE WORKS

The graphs show that the dryness of paddy fields and rice growth conditions can be monitored in quasi-real by developing vegetation and agricultural climate indices. Moreover it is proved that rice-planting patterns can be analyzed at provincial level by the indices. With this information, we can take an annual rice yield apart to that

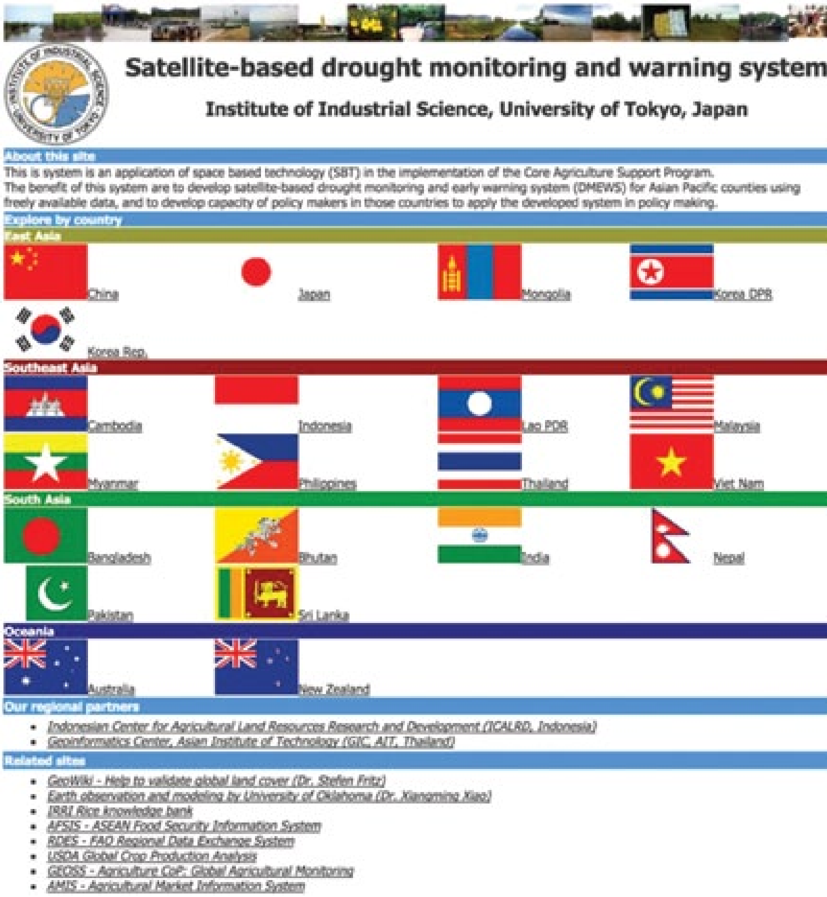


Fig. 6. Web interface of satellite-based drought monitoring and warning system in Asia (DMEWS) http:// wtlab.iis.u-tokyo.ac.jp/DMEW.

of each season. What to do next is to investigate the performance of vegetation and agricultural climate as compared with the rice crop yield. Actually, there are already some researches that investigate a relationship between rice production and LAI. However LAI is only a measured value, and LAI doesnt make it possible to evaluate near future rice production under droughts. On the other hand, we can estimate rice yields with drought index, KBDI, by inputting forecasted precipitation into the model. Therefore, KBDI is essential for evaluating droughts 'impact on rice yield in advance. In this study we mainly focus on KBDI and will investigate the relationship between the index and LAI, namely rice production.

ACKNOWLEDGMENT

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Renewable energy resources for green economy: case of Belgorod region

INTRODUCTION

Green economics as a new paradigm and a specific model of national economic development implemented in the strategies of development in many countries. The concept of green economics (GE) looks much realistic in comparison to the idea of sustainable development: its viability is substantiated by not only institutional background, but also innovations in technologies, first of all - in development of renewable energy technologies. According to the United Nations Environment Programme, green economy is one that “results in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities” [1]. Green economics (GE) brings into consideration not only the lack of economic resources which all the economies deal with, or the optional combination in production process and sustainable consumption, but also provides solutions in achieving sustainable economic model in changing world [7].

The International Energy Agency (IEA) defines renewable energy as follows: renewable energy is “energy derived from natural processes (e.g. sunlight and wind) that are replenished at a faster rate than they are consumed”. Solar, wind, geothermal, hydro, and some forms of biomass are common sources of renewable energy [5]. In its various forms, it derives directly or indirectly from the sun, or from heat generated deep within the earth. Today the share of renewable energy is close to 20% of total global consumption. As capacity continues to grow and prices for renewable energy and its equipment continue to fall, this share is likely to further increase. Along with measures to promote energy efficiency, the increase in renewable energy promises to provide many benefits to both the global economy and individual countries and regions [16]. By all indications, a new energy transition is occurring today. It is reasonable to predict that the share of renewable energy in the global power generation will grow exponentially in next decades. For example, the IEA has predicted that as much as 25% of the world's gross power generation will come from renewable energy sources by 2018 [5].

INSTITUTIONAL PREREQUISITES FOR GREEN TRANSITION

It is widely recognised that one of the largest difficulties for green development is strong dependency of most societies on non-renewable fossil energy supplies. This is particularly characteristic of the Russian economy due to large reserves of oil and gas, which provide most foreign currency earnings to the national budget. Despite this, the development of renewable energy recognized as a key indicator of the transition to green economy in Russia. In this regard, studies on renewable energy effectiveness are crucial to find solutions of environmental problems in Russia's regions and to promote principles of a green growth.

The development of energy efficiency programs in Russia is based on institutional prerequisites created in the period after 2000. According to [4], the energy intensity of the Russian economy has decreased in 6 times in comparison to 2005, but it is still 2 times higher than, for example, in China. In this regard, the study of possibilities to reduce an energy consumption due to decoupling effect is still actual. Perspectives for renewable energy use we investigated through the case study of Belgorod region — one of the most developed regions of Russia. The study aimed to assess environmental and economical effectiveness of different kind of renewable energy sources and also to identify their role in strategic development of the region.

Level of energy intensity or — in terms of “green” economy — carbon intensity of regional economy is one of the most representative indicators of “green” growth. The world's best practices of the green economy principles' implementation demonstrate that energy efficiency is a key criterion [2]. The institutional preconditions for transition to a green growth in Russia are quite weak, however, there are a number of programs, supporting activities on rising energy efficiency in the research area. For instance, following acts of Belgorod regional administration are aimed to promote "green energy": "The Concept of Bioenergy and Biotechnology Development of in the Belgorod region in 2009-2012" and the Decree of the Government of Belgorod region from 19.07.10 "On approval of temporary rules of calculation of economically justified regulated eco-tariffs for electricity produced at electric power facilities using renewable energy sources". The Federal Acts, such as Federal Low "On energy saving and increasing energy efficiency and on amendments to certain legislative acts of the Russian Federation" (2009) also create the basis for regional activity in the field.

CURRENT ECONOMICAL SITUATION AT BELGOROD REGION

Due to the geographical location of the Belgorod region, the main sectors of the regional economy are mining industry, developing on the resources of the world's richest Kursk magnetic anomaly, and agriculture, based on extremely rich humus soils — chernozem. Belgorod region is only 0.2% of the total area of Russian Federation, however, it ranks 26th in the list of 85 Russian regions. GRP structure is shown in Fig.1.

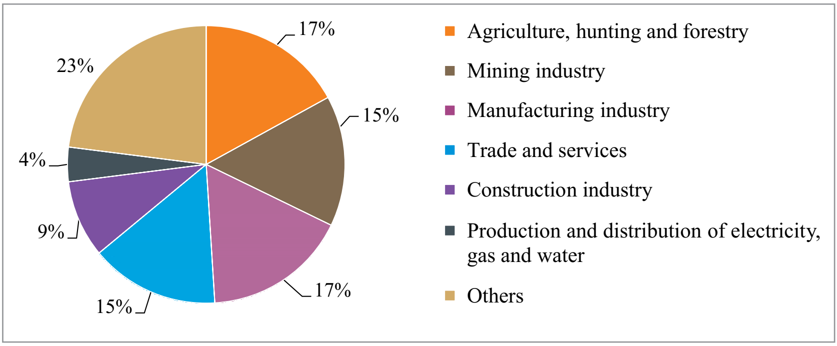

Fig. 1. GRP of Belgorod region

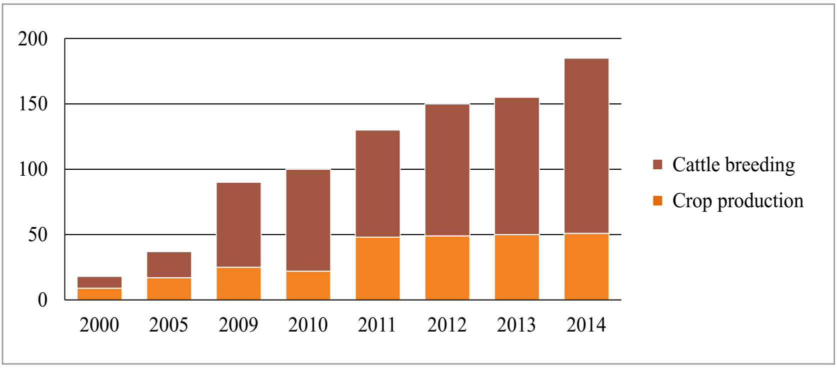

Fig. 2. Dynamics of agricultural production in Belgorod region

The analysis of GRP dynamics shows that the total share of the primary sector in regional economy is reducing during the last years due to increasing share of the services sector. At the same time the decline is typical mostly for the mining and metallurgical industries, while agriculture has shown a tendency to increase. The role of agriculture in the economic structure of the region has increased significantly over the last 15 years [13]. For the period from 2000 to 2014 the agricultural output has significantly increased (Fig. 2), both the livestock and crop production. The share of agriculture in GRP in recent years (2011-2014) also increased steadily, providing up to 17% of GRP and occupying the second position after industrial production (mining and manufacturing industries together). In 2015, the share of Belgorod region in Russia's total agricultural production amounted 4.5% [6], which brought the region to leading positions in Russia (the second place in the national economy after the Krasnodar region).

One of the key features of the regional economy is a lack of domestic energy production: the region produces only 6.3% of the required volume, and the rest comes from the neighboring regions where two Nuclear Power Plants (Kurskaya and Novovoronejskaya) are located. Domestic energy production is provided by local thermal power plants (TPP) and associated with attendant environmental impacts. The current regional development has caused several environmental problems, such as air pollution from TPP and transport in industrial cities (Stary Oskol and Gubkin cities), contamination of local rivers by agricultural waste, etc. [10].

PRECONDITIONS FOR ALTERNATIVE ENERGY DEVELOPMENT

As it is shown in a number of recent scientific works — both theoretical and applied — renewable energy use can be considered from point of view of not only environmental effectiveness, but also economical one [1; 10]. To evaluate perspectives of renewable energy development in Belgorod region we have analysed its natural prerequisites, such as the wind speed and the amount of solar energy, and compared GRP energy intensity in cases of traditional and alternative energy systems.

The area has sufficient resources to generate energy through local renewable sources: the amount of solar radiation varies within its boundaries from 1140 to 1200 kWh/m² per year (Fig. 3), which is comparable with the southern regions of Russia, where such stations are widely used. Wind resources are less promising, but also available to produce energy: the average value of wind speed is about 5.2 m/s [14]. A comparison of the potential of renewable energy sources in the Belgorod region and one of the European leaders in the field — Germany — showed that these variables are quite similar (Table 1).

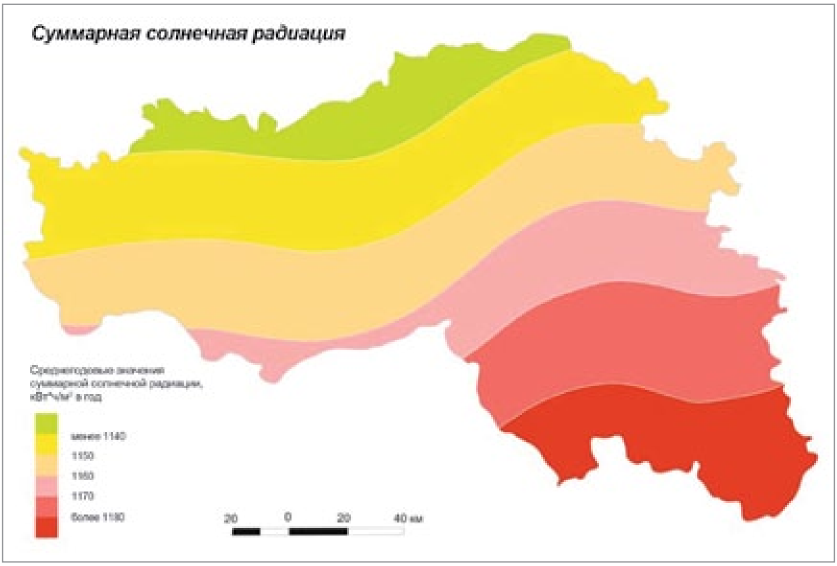

Fig. 2. Dynamics of agricultural production in Belgorod region

Belgorod region		Germany	
Geographic coordinates	Amount	Geographic coordinates	Amount
Solar radiation, kW·h/m2 per day			
53.5 N 34.07 E	2,87	53.8 N 7.2 E	2,87
48.5 N 41.07 E	3,39	47.8 N 9.2 E	3,37
Wind speed, m/s			
53.5 N 34.07 E	4,01	53.8N 7.2 E	8,01
48.5N 36.07E	5,87	47.8 N 9.2 E	4,57

Table 1. Comparative characteristics of renewable energy's natural potential in the Belgorod region (RF) and Germany

The possibility to increase the regional economy's energy efficiency we considered for two main types of regional industries: the most energy-intensive industries, which are presented by mining and metallurgical plants, and less dependent from energy consumption agriculture. The biggest industrial complexes — Lebedinsky and Stoilensky mining plants — are the part of the largest Russian manufacturers with a world name JSC "Holding company "Metallinvest" and SC "Novolipetsk metallurgical plant". According to internal data and annual reports of these companies, they pay great attention to improving energy efficiency and it is fully controlled in a frame of productive process. Due to high energy demand the transition to alternative sources at these plants is not economically justified. Several studies [12; 9] on the prospects of renewable energy implementation estimate their potential to cover the needs of large plants. As the potential of wind energy basically is insufficient, so more attention is usually given to solar energy. However, as it follows from previous studies, implementation of solar power plants in the region is also inefficient: their installation in industrial North of the region, where the main production is concentrated, will face the problem of dusting due to open-pit ore mining. Besides that, the area reserved for panels that traps solar radiation, must be comparable to the area occupied by career and tailing. The cost of such facilities will amount to hundreds of billions Russian Rubles, which is exceeds profitable investment. Taking into account a significant amount of energy, required to meet the needs of the Lebedinsky and Stoilensky mining plants — more than 5 billion kWh per year — solar power plants are not suitable to replace traditional sources.

Type of livestock	Number	Mass of excrements, kg/head/day	Total mass, tons/day
Pigs	3 977 100	4.5	17 897
Poultry	51 320 200	0.3	15 396
Cows	93 100	35	3 258
Other cattle	133 600	21	2 806

Table 2. Accumulation of organic waste from livestock in agricultural farms of Belgorod region

The next step was the analysis of statistical data [13] to calculate the volume of organic waste biomass generated in the agricultural sector of the region (table 2). Biomass resources in Belgorod region are represented mainly by livestock waste; crop production gives a waste mostly from grain and beet processing (straw and sugar beet pulp), which are used in animal husbandry as bedding and feed.

Reducing energy intensity of the regional economy is one of the main criterion of energy efficiency at the way towards sustainability. During the study project we have considered a possibility to produce energy through bio-waste recycling on example of individual farms. Taking into account the region's share in the pork production (now exceeds 28% of the total), it could be a suitable decision to increase energy efficiency and to reduce traditional fuel consumption.

The consequences of the large use of fossil carbon are twofold – first that supplies will come to an end; secondly that the end product — carbon dioxide — builds up and cause environmental damage [11]. Bio-energy development may not only to reduce carbon intensity, but also to provide opportunities for increasing welfare. It can generate employment and raise incomes in farming communities and provide a sustainable source of energy that is an affordable substitute for fossil fuels. Investments in bio-energy may increase harvests for both food and fuel crops.

The total volume of organic waste from farms in the Belgorod region (about 12.5 mln. tons of high-calorie mass per year) is enough for biogas production with amount needed to cover their electricity demand (721,1 million kW·h). Taking into account the different moisture, the volume of 12.5 mln. tons of organic waste will give

Fig. 4. Biogas station «Luchki» (Belgorod region) https://sdelanounas.ru/blogs/22478

about 250 thousand m³ of biogas per year. Recycling of all the livestock waste at the biogas stations in Belgorod region will let to produce about 2 bln. kW·h annually. If the share of energy dispatched to cover the own needs of the plants will reach from 25 to 50%, the total output of electricity will be about 1 bln. kW·h per year.

Today the Belgorod region has a great potential for agricultural production wastes's (especially livestock) recycling for energy purposes, and such facilities are already in operation in some farms of the region. In contrast to solar and wind stations the biogas station reveals quite high efficiency. Taking into consideration that renewable en ergy at all and biomass energy particularly is most often local by its nature [11], we concluded that the biomass resources have the greatest potential as a renewable energy source in the study area.

ENVIRONMENTAL AND ECONOMIC EFFICIENCIES OF BIOMASS UTILIZATION

Experiences of a number of developed countries show that their attempts to reduce ecological impact while maintaining economic growth — for example, by reducing GHG emissions in absolute terms within their territories — were not absolutely successful in the last decades. Unfortunately, life cycle emissions of final consumption, in fact, increased in many cases: production of emission-intensive goods has simply moved elsewhere [15]. That's why a key issue in this field is transfer of focus from production or consumption parameters to evaluation of efficiency. This idea fully corresponds to the principles of a "green" economy, which is a low-carbon, resource efficient and socially inclusive economy. In a case of Belgorod region the main attention must be given to development of innovative technological and management approaches. Such innovations can be considered as the most important benefit from environmentally oriented policy.

Environmental management effectiveness is one of the most complicated issues in modern environmental policy due to necessity to combine economic, ecological and social aspects as equal. Economic policy in Belgorod region must be aimed to provide not only an economic growth but also to achieve environmental and social effects for local population. Energy efficiency in the agricultural sector of Belgorod region's economy is very actual issue, since agriculture dominated in the territorial structure of land use (77% of the total area of the land fund), and a most part of the population (18.7%) is employed in agriculture. The energy intensity of the regional economy, we evaluated as:

$$E_{GRP} = \frac{EC}{GRP}, \qquad (1)$$

where $\boldsymbol{E_{GDP}}$ *is energy intensity (kW·h /RR),* ***EC*** *— energy consumption (kW·h),* ***GRP*** *— Gross Regional Product (RR).*

Evaluation of current energy intensity of the regional economy showed that the total amount at the area is 24 kWh/1000 RR. The difference between economy's sectors is quite substantial: in agriculture — 6 kWh/1000 RR, and in mining industry — 57 kWh/1000 RR. Reduction of energy intensity in industrial production is the most urgent task, however it can be solved in a framework of its modernization. Achieving lower energy intensity in agriculture is more realistic, since such experience is already done, and implementation of biogas stations is effective on a level of individual farms. Bio-waste utilization will result both in covering agriculture's needs in energy and decline in total energy intensity of the regional economy. The total energy consumption of GRP, while maintaining the volume of production, will decline by 4.2% (from 24 to 23 kWh for 1000 Russian Rubles). Changes in a structure of regional economy are always related to new projects, requiring careful consideration of all the consequences. This especially concerns changes in environmental and social spheres [8]. In a case of developing new facilities on bio-waste recycling at individual farms the proposed changes are mainly connected to construction and operation, and will cause an increase in employment of local population. Employees of different skills in various industries — from economists and engineers to unskilled workers — would be needed in the process of construction and further operation of facilities. During the operation staff of about 8 people will be needed for every of the biogas stations. In addition, the small business sector (building materials from local suppliers, transport services, etc.) will be engaged during the construction period. Thus, each station produces a number of new job places with different skills, which is extremely important for rural areas.

CONCLUSION

The analysis of perspective directions of the transition towards a "green" economy on the example of Belgorod region shows that the bioenergy use is accompanied by multiple effects through achieving goals on improvement energy efficiency and reduction of resources intensity while increasing employment. From this point of view, biomass utilization contributes to so-called "decoupling" effect, when the GRP growth rate exceeds the growth rate of energy consumption. Today the regional economy development is characterized by a high level of impact on the environment, and it is expected to arise in the future. The assessment of the biogas production's potential and its comparison with other renewable energy resources in Belgorod region has demonstrated that it can be considered as an effective way to reduce carbon intensity of the regional economy while covering energy demand.

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SPECIAL SESSION I

"Meteorological risks in Cryosphere — further collaboration with MSU, UTokyo & National Research Institute for Earth Science and Disaster Resilience (NIED)"

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The railway protection forest. A century long maintenance and the future outlook

The railway network in Japan has developed and maintained a nation-wide protection forest system for more than a century. The management and measurement of their disaster mitigation function against various natural hazards is undertaken according to the railway's administrative standards. The current goal of the railway protection forest system is to establish and maintain rational and natural protection forests at minimal cost.

Although the idea of using protection forests as protection from natural hazards has existed since feudal period, it was the railway authorities that brought the idea into practice in modern Japan. Japanese railways launched their plan to develop railway protection forests before the first national forestry law was enacted and have cultivated the woods since then, following their own administrative rules. These woods, which were established by railways and are designed to protect railways, have been termed “railway protection forests”.

Today, Japan has an approximately 25,000 km network of railway tracks, with an aggregate annual volume of 360 billion passenger-kilometers and 23 billion ton-kilometers of freight. The total area and wayside length railway protection forests amounts to approximately 11,000 ha and 1,500 km, respectively.

Railway protection forests are classified into 9 categories, depending on their protective functions: snowdrift, snow avalanche, sand drift, landslide, rock fall, flood, fire, wind, and water source (for steam locomotive).

The first railway protection forests were the 41 snowdrift protection forests that were placed along the Tohoku Line between Mizusawa and Aomori in 1893. This line started full operations between Tokyo and Aomori in 1890, but the transport along the line in winter was very unreliable because of heavy snow. Trains were frequently delayed, or even trapped for days, by snowdrifts. All trains on this line had to load emergency foodstuffs for passengers and train crews had to prepare for such events that the train was trapped in snow. Wooden fences, which were built along the tracks in localities with heavy snow, were ineffective as strong winds and flying embers from locomotives easily destroyed them.

Seiroku Honda, the founding father of railway protection forests in Japan and the first professor in silviculture at the Imperial University of Tokyo, devised a plan for snowdrift protection forests to protect railway tracks from blowing snow, after inspecting the afforestation sites developed by the Canadian Pacific Railway, which he had visited on his way home following academic studies in Germany. This marked the birth of the railway protection forest system in Japan.

Seiroku Honda founded the first protection forests in 1892, using German silvicultural methods and continued to work as the technical adviser in the railway ministry for about 30 years, training his successors. Snowdrift protection forests account for 90% of the total area of railway protection forests in Japan. They are sited mainly on Hokkaido Island and the northern part of Honshu Island.

Fig. 1. An example of a snowdrift protection forest in Hokkaido

Fig. 2. An example of a snowdrift protection forest in Honshu

The need to maintain forests on slopes susceptible to snow avalanches has been long recognized in Japan. This knowledge was integrated into the legal system and also realized in the historical practice of forest management in Japan; some feudal landlords designated part of their territories as snow avalanche protection forests, where cutting of the trees was strictly restricted.

Fig. 3. An example of a snowdrift protection forest in Honshu

After the opening of Tohoku Line, which connected cities along the northern Pacific coast between Tokyo and Aomori, construction of new lines began aiming to connect cities on the Tohoku Line and districts on the Sea of Japan coast through the snowy and mountainous hinterland of northern Honshu Island. Snow avalanche problems were encountered soon after these new lines came into operation.

For example, Ganetsu Line, which opened in 1914, experienced 75 avalanches in 1917 and some of these cases involved fatalities and injuries, and serious property losses. As the result of lessons learned from those repealed disasters, the railway authority designated slopes prone to snow avalanches avalanche protection forest areas and undertook the necessary afforestation measures.

Avalanche protection forests are considered the most indispensable and effective disaster prevention measure of all the types of railway protection forests because they mitigate or prevent the destructive and fatal potential of avalanche disasters. Ganetsu Line was affected by approximately 250 avalanches in its first 20 years, but experienced only 7 in the next 20 years, by which time the avalanche protection forests had reached maturity. Avalanche protection forests are sited mainly along mountain range lines in Hokkaido and northern Honshu Island.

There are a large number of sand dunes along the coast of Sea of Japan of Honshu Island. Trains on the newly opened lines passing through these areas encountered frequent disturbances such as derailments and blockages due to sand drifting onto the track. At first wooden fences were built along the lines to block sand drifts, but they were easily destroyed by gales and proved totally ineffective. Sand drift protection forests based on traditional forestry methods were adopted as an alternative measure and developed along the Uetsu Line in 1921. Aeolian movement of sand completely stops as soon as the sand dunes are vegetated, and the protective effects of sand drift protection forests are prompt and significant. Sand drift protection forests have also been established on the Hokuriku, Sanin and other coastal lines.

Landslides and rock falls are frequent natural hazards for railways in the mountainous regions of Japan, where the soil is unstable and precipitation is abundant. As more tracks were built in mountainous regions, forest cutting on mountain slopes above the tracks initiated many landslides and rock falls. These events prompted the railway to develop landslide protection forests and rock fall protection forests, which are now ubiquitous in Japan.

For more than 100 years, the Japanese railway network has made use of the benefits of protection forests in many other situations. Protection forests surrounding springs protected the water supply for steam locomotives, stations, offices and quarters before it was possible to import water by pipeline.

The afforestation method and afforestation system of railway protection forests are selected and adjusted to fit local conditions and needs. The snowdrift protection forests in Honshu are afforested with Japanese cedar *(Cryptomeria japonica)*, and in Hokkaido, with European spruce *(Picea abies).* Both of these species are evergreen, fast growing and tolerant of high planting densities.

The width of the strips necessary for effective snowdrift shelter in general is approximately 20 meters. Seiroku Honda prescribed the minimal width of snowdrift protection forests as 40 to 60 meters. This was to enable between a third and half of the wood to be cut (using patch cuts) and reforested without sacrificing the snowdrift sheltering function of the woods. This method has both prolonged the longevity of the woods and generated a financial return, making it possible to sustain the railway protection forests for more than 100 years.

Snow avalanche protection forests are also planted with Japanese cedar, which can grow even under heavy snowpack conditions. The renewal procedure of small patch cuts and replanting, as applied for snowdrift protection forests, is inappropriate for snow avalanche protection forests because the mountain slopes require continuous and dense forest coverage. Accordingly, avalanche protection forests are renewed by thinning and planting individual trees so that the protection function of the woods is constantly maintained. Sand drift protection forests are similar to avalanche protection forests in regards with their afforestation system, except that Japanese black pine *(Pinus thanbergiana),* which is suited to coastal soils and climate, is planted instead of Japanese cedar.

For more than 100 years, railway protection forests have been developed based on coniferous monocultures, enabling the maximum timber yield and revenue at cutting. In the past, railway protection forests have provided timber for railway sleepers, buildings and other structures. Sale of these products has provided the revenue needed for afforestation treatments. Currently, there is little cutting as the timber revenues that are generated do not cover the cost of the cutting. As the result, the ecological, functional and aesthetic conditions of railway protection forests have deteriorated. This is because the monocultures require constant silvicultural interventions, not only to establish seedlings, but also to tend the grown trees in order to maintain ecologically healthy stand conditions. These interventions are costly because labor costs have risen sharply over the last few decades.

Transformation of these planted protection forests to native vegetation communities, which are adaptable and require less nurture attention, is one of the possible solutions to this problem and will also impart an environmental friendliness to the railway. East Japan Railway Company introduced the concept of natural vegetation for railway protection forests in 1992. Although modern railway tracks may withstand many of the natural hazards they encounter without the protection of railway protection forests, we value them as helping our technology to coexist in harmony with the environment.

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Comprehensive Arctic geographical research at the Faculty of Geography Lomonosov Moscow State University

The Faculty of Geography is one of very few institutions in Russia offering the scientific degrees in cryospheric science. Evidently, this is because of the fact that the stuff of the faculty has extensive knowledge of Polar and mainly Arctic region. The interest to Arctic region increased considerably in the past few years and the reasons for that are as the following:

- Arctic region represents a mixture of various geopolitical interests;
- In Russia the region is considered as "practically unexplored resource for the Russian oil–gas industry";
- Exploration of Arctic is difficult, ecologically dangerous, with resulting high production cost, which requires specific scientific support to industrial development;
- Arctic is known to be the most vulnerable region to the ongoing climate change;
- Arctic is site of the large projects realization including the state-issued "The development strategy of the Arctic zone of the Russian Federation and national security for the period up to 2020".

For scientific community the increased interest resulted in number of calls from different scientific Funds, the Faculty of Geography was active participant with several successful projects. However, increased "price" of the projects required reconsideration of the standard specifically-focused approach, like just on separate topics of oceanology, climatology, glaciology, natural hazards, economical geography, etc., into combination of these fields. It is not yet what is named "system analysis", but serious step forward into that direction. Especially important was combination of social sciences and physical geography.

The first successful attempt of such comprehensive research was "Megagrant" named "Natural Risk Assessment Laboratory". Formally the Laboratory still exists, though, by the rules of the Ministry of Education, it has to support itself by self-organized external funding. As a result, it was transformed with the same core scientists into the Russian Science Foundation (RSF) funded "Arctic Environment Laboratory" as the result of successful application under the frame of the RSF "Laboratory establishing call". In addition, the team has several related to the Arctic topic smaller RSF, Russian Foundation of Basic Research (RFBR) and Russian Geographical Society grants. Same scientists can be members of several projects, while some, even invited from other scientific organizations, are involved into just one or two. Practically such construction represents an institution above the standard "State financed" research topics in MSU. It's can be rather difficult to be ruled but does provide interesting scientific results including funding opportunities for young researchers and students of different levels.

Fortunately, there is no need to construct all the databases and algorithms from scratch. A lot is constructed before, and new funding opportunities could be mainly used for inter-topical combinations and comparison. However, such combinations also need new developments. Thus, a system of data cataloging constructed inside the project by the team members from the State Hydrological Institute in St. Petersburg could be used in the project and hopefully would be used in future (Anisimov & Kokorev, 2016).

The main objects of investigation were, of course, mainly same as previous. For example, they were various climate parameters in this case related to particular social and economic application. They were called "socially-important characteristics" — about 50 of them, such as those used in agriculture (vegetation period, soil temperature, snow season duration etc.) or describing the Arctic Seas conditions (wind speed, etc.), calculated and presented as maps for the present time, middle and the end of the XXI century (Surkova, 2015).

If combined with the sea ice extent the wind becomes a component of storms and possible passability of the Arctic Sea routes (Myslenkov et al., 2015b). And it was also important to model the waves characteristics — length, frequency, or height (Myslenkov et al., 2015a). The waves regime is closely related to the surges formation in the mouths of the Arctic rivers, which was also investigated and modeled (Korablina et al., 2016).

Going to the land, the ice regime of Arctic rivers is very important for the Russia, both in terms of the winter roads and the flooding in Springs (Agafonova & Frolova, 2016; Lebedeva & Alabyan, 2016). The Arctic temperature data, when combined with the sea ice data can be related to the coastal line change (Shabanova et al., 2017).

Dynamics of the snow cover is another crucial parameter for exploration of the Russian Arctic. It is studied in close collaboration with international scientific community (i.e. Bokhorst et al., 2016).

Since any future projections of the state of the environment have to be related to the economic needs, whether this is the snow cover-dependent run-off or the building-construction requirements — the State Standards (CCP, 2011) are accounted for in ongoing Arctic investigations and the new ones are developed by the members of the team (i.e. CCP, 2018).

Permafrost and permafrost-free territories in the Russian Arctic are also in focus of the Faculty stuff both as the naturally-changing Arctic territory phenomena being also under the anthropogenic pressure (Romanenko & Shilovtseva, 2016a; 2016b).

At the top of all the activity are the considerations of the population and the economy, which is the most tricky part, but still manageable (Baburin et al., 2015; 2016). The estimations include GDP per municipal units from the State Statistics, there are some constructions related to extracting direct and indirect costs and losses. The population can be considered as the integral characteristics of the economic development, same as the temperature at 2 m level is the integral characteristic of the surface energy balance. The population differs from west to the east, reflexing the transportation possibilities and the environmental conditions. Interestingly, the population is closely linked to, for example, the permafrost distribution and even to the distribution of the accepted “types” of permafrost (Badina, 2017).

Evidently, the natural hazards are also part of the Arctic investigation. The active development requires preparedness to local specific for people coming from other regions. An example on the connection between the risk and the economic activity was not long ago described for the Sakhalin island (Qiu, 2014). A “remote” for the Central Russia region with low mountains brought the quantity of snow avalanche victims highest in the World. And the timing of the extreme quantity of accidents corresponds exactly to the time of the increased developing, first by Japanese, than by Russians.

In conclusion: The Faculty of Geography is very active in Arctic Research and open to collaboration practically in any scientific topic. However, the most interesting would be comprehensive research, such as those, described above.

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Snow and ice research in National Research Institute for Earth Science and Disaster Resilience (NIED)

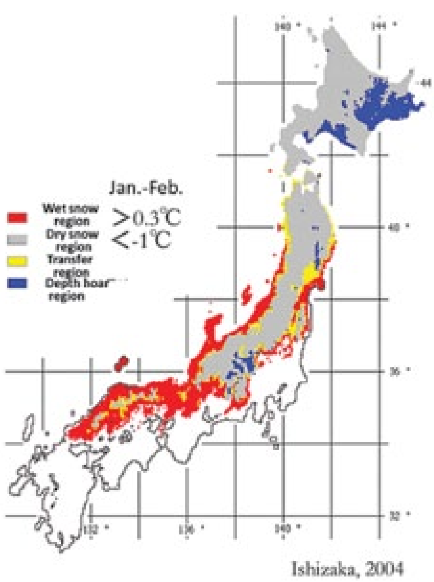

Fig. 1. Snow cover condition in Japan

BACKGROUND

In this paper, I introduce "Snow and Ice research in National Research Institute for Earth Science and Disaster Resilience (NIED)". Before explaining our works, I introduce Japanese snowy condition features. Figure 1 shows the snow cover condition in Japan. Japan has Japan has various snow conditions due to the long areas from 44 to 32° north latitude. In the northern part of Japan (Hokkaido Island), depth hoar develop very well like Siberia while in the central part of Japan (Honshu Island), snow is wet due to high temperature condition even though in the Midwinter.

As a background of these complicated snowy conditions, Japan has various disasters related with snow and ice as following:

Avalanches: we have every type of avalanches (surface layer avalanches with dry / wet, full depth avalanches, and slush avalanches). Every winter, several people, most of them were back country skiers, are killed by avalanche accidents. Moreover, a lot of roads, which are the main road to connect each town, were stopped due to high avalanche risk potentials.

Snow accretions: Snow falls in Honshu Island frequently occur around 0° C, thus power lines have sometimes problems due to snow accretion. In addition, snow falling from the bridges and traffic signs, they sometimes attack cars or human being on the road, are also severe problems.

Blowing snow: Strong blowing and drifting snow cause severe traffic accidents, and reduce quality of life and human activity (Especially in Northern Japan, Hokkaido).

They induce low visibility on roads. Moreover, snow cornices are developed by snowdrift on the leeward of slopes in the mountain sites and they frequently lead to avalanche release.

Other disasters: Landslides and flood resulting from snow melting are also severe problems. Snow road accidents are still serious problems, and recently accidents during snow removal are on the increase.

RESEARCH ON MITIGATION OF SNOW-ICE DISASTERS

In order to protect our lives and properties from snow and ice disasters, our institute has developed observation, forecast, and estimation techniques for such kind of disasters using advanced observation technologies and numerical simulations. Our institute has also implemented these technologies to our society for disaster prevention and resilience. To accomplish these aims, we have conducted the project with not only observation but also laboratory experiments, and also developed models based on these results. Hereafter, I will introduce the more detailed content of our project.

Subject 1: Measurement of spatial/detailed falling snow information:

Snow disaster types strongly depend on characteristics and/or amount of falling snow. Therefore, it is very important to obtain the correct information of falling snow characteristics. From these viewpoints, we have harmonized remote sensing techniques and ground observations. To get the information of verification data of the Doppler radar, we established the detailed precipitation and meteorological observation sites in the scope of the Doppler radar (Fig. 2). Using these ground observation data, we are now developing the algorism to obtain the accurate estimations of distribution and intensity of falling snow, and also precipitation particle types from the Doppler radar data.

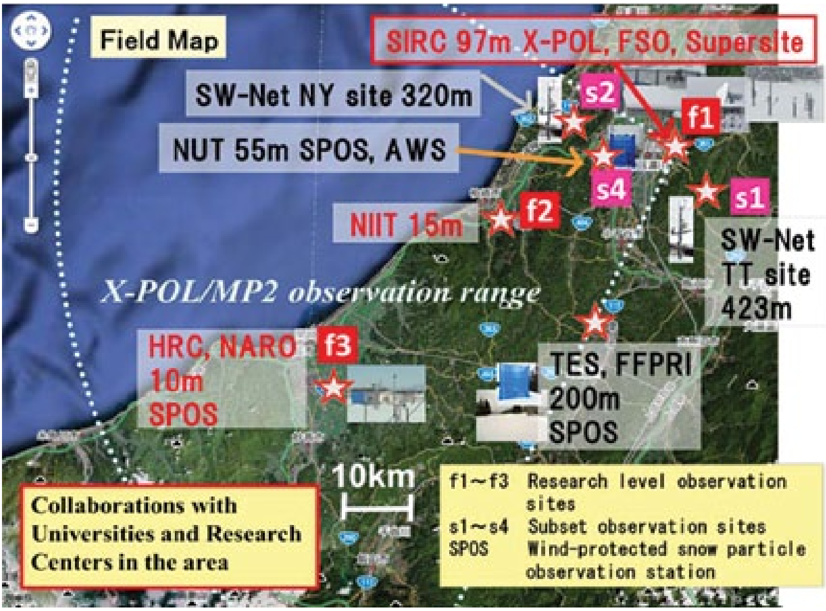

Fig. 2. Distribution of precipitation and meteorological observation sites in the scope area of the Doppler Rader

Subject 2: Development of numerical snow cover model

Deposited snow is ever-changing material with the meteorology condition and snow disaster risks change with them, thus the prediction of the snow characteristics using a snow cover model is essential for forecasting of snow disasters. Our main topics about this subject are: The first topic is the simulation of wet snow characteristics, namely, water movement in snow including not only uniform water transportation process, but also the preferential flow through water pass and physical properties of wet snow, such as, changes of viscosity or strength with water. These are very important because snow in most of Japanese areas is wet throughout the winter season. Second topic is the physics of new snow crystal because most of weak layers related with avalanche accidents in Japan are composed of falling snow crystals. For this study, we collaborate with the meteorology scientists studying falling snow (Subject 1).

Subject 3: Development of snow disaster forecasting system

We have developed the snow disaster forecasting system since 2004. Fig. 3 shows the schematic diagram of the snow disaster forecasting system. The system consists of three parts: One is the meteorological model, in which we forecast meteorological condition until the one day future. Second part is the numerical snow cover model (Subject 2), and third part is the forecasting models for each disaster: blowing snow model, avalanche forecasting model, snow road model and snow accretion model. These third parts have been independently developed, thus we can easily change these models when the model is improved.

The forecasting information based on the system has been tentatively offered to local governments, avalanche patrols and road management during the winter season and the information is used for more efficient hazard risk managements. On the other hand, the information of snow disasters, which were given by them, becomes very helpful data to improve the system.

Blowing snow model: Our developing model treats not only large scale, but also small scale. To improve the model, we have focused on the following issues:

1. Influence of snowflake collisions on snow surfaces on snow blowing.
2. Dependency of snow blowing on snow condition (dry/soft, hard etc.).
3. Basic physical elements of snow blowing based on the numerical methods, observations, and wind-tunnel experiments.

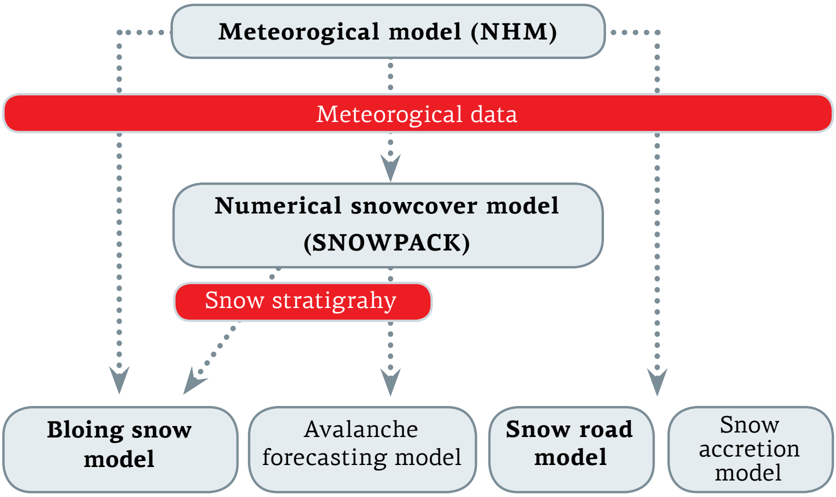

Fig. 3. The schematic diagram of the snow disaster forecasting system

The forecasting information using the blowing snow model is tentatively offered to the local government in the Northern part of Japan, Hokkaido Island.

Avalanche forecasting model: Our developing model is combined the snow cover model with the avalanche dynamics model. Thus, the model can forecast not only the timing of avalanche, but also the damage scale by predicted avalanche. Firstly, we predict the timing of avalanche using the numerical snow cover model (Subject 1) to simulate the weak layer characteristics (e.g. strength, location) in the snow cover. Then, we estimate the volume of avalanche resulting from the predicted weak layer. The avalanche scale is predicted based on simulation of the avalanche dynamics models, such as, Bingham fluid model or Titan 2D model, with the estimated avalanche volume.

Snow accretion model: This model treats the process from accumulation to falling the deposited snow. The model has been developed based on the snow accretion mechanism investigations with cold room experiments and/or observations. We have forecasted snow accretion throughout the winter season and the forested information is tentatively offered to the road management.

Our snow disaster forecasting model has been improved every winter and it becomes almost practical level now.

CRYOSHERIC ENVIRONMENT SIMULATOR AT SHINJO

The Cryosheric Environment Simulator (CES) established in 1997, is a large state-of-art facility for domestic and international cooperative use. CES can reproduce cryospheric environment including the snowfall similar to the natural one, where we can conduct many projects on basic and applied disaster mitigation studies and cryosoheric environment studies. Fig. 4 shows the schematic image of CES. The CES also has wind tunnel, solar radiation system, rainfall system and so on. In addition, the room temperature can be changed from -30 to 25 ˚C. Thus we can produce every condition in the cryosphere region using the CES. Recently, we have introduced two new equipments to advance the understanding of snow micro-physics at the CES: One is a cryogenic micro-CT with high resolution (Fig. 5a). Second one is a cryogenic MRI (Magnetic Resournance Images) (Fig. 5b), which is usually used in the medical field. The MRI can direct detail water existence in snow, which is difficult to get using the Micro-CT.

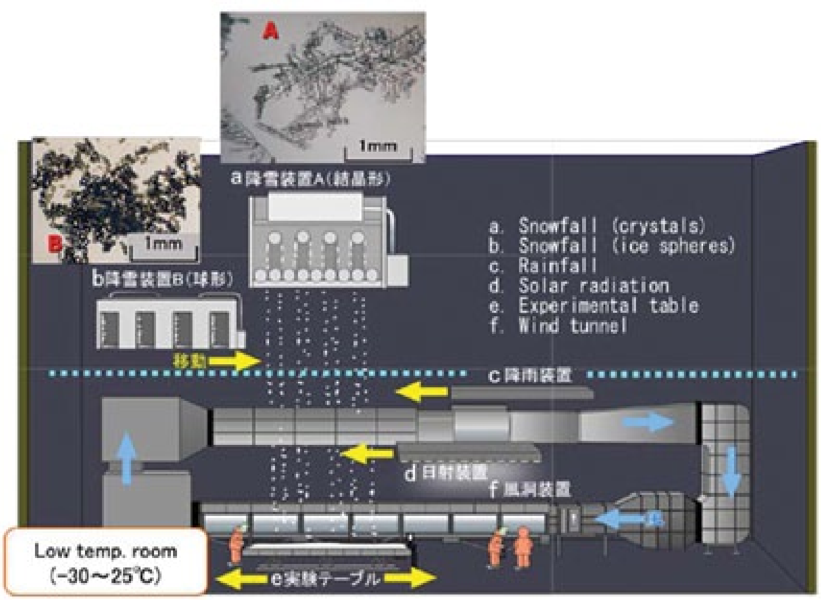

Fig. 4. The schematic image of CES

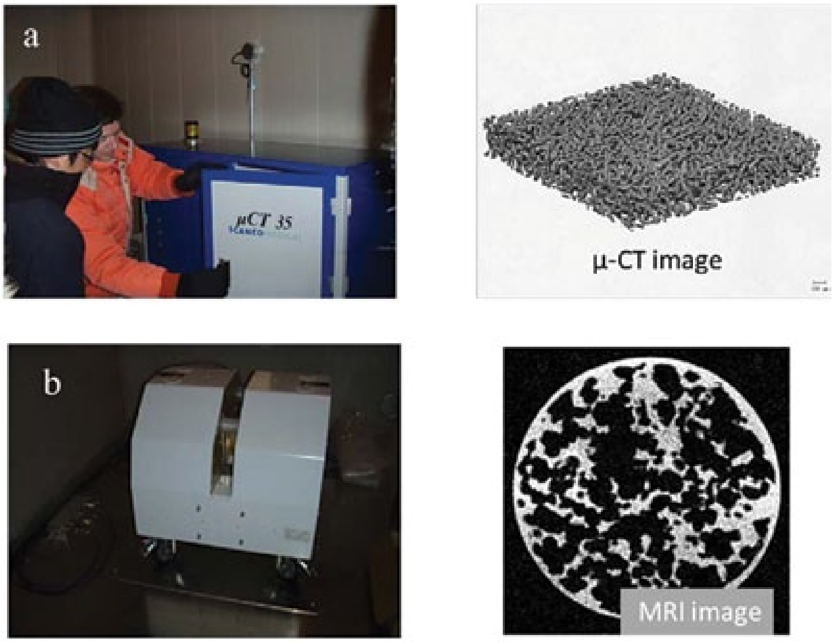

Fig. 5. New equipments for snow micro-physics:

a: Cryogenic μ-CT

b: Cryogenic MRI

Therefore, the CES is the highest level of the experimental facility for cryosheric environment study in the world.

INTERNATIONAL JOINT RESEARCH

We have worked with several institutes in the abroad based on the following international collaborations:

WSL Institute for Snow and Avalanche Research, SLF (Since 2014).

National Research Institute of Science and Technology for Environment and Agriculture, IRSTEA (Since 2016).

Xinjiang Institute of Ecology and Geography, Chinese Academy of Sciences (Since 2015).

It is our pleasure if we can establish the collaboration between Japan and Russia for snow science near future.

SESSION 3
"Urbanization risk management"

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Transportation management against natural disasters

Here, we would like to explain our research about transportation management against natural disasters that we have been studying in Kochi prefecture in Japan.

NEEDS OF TRANSPORTATION MANAGEMENT

In Japan we had experienced a huge earthquake and tsunami disaster in 2011 and it is still expected that another huge earthquake and tsunami disaster will come in several decades and attack different places with huge tsunami. To avoid large human damage, it is indispensable to develop a technology to support people's evacuation. Other than huge disasters, there exist various natural disasters in Japan (Fig. 1). For example heavy snow falls often causes heavy traffic jams even in the capital of Japan. To secure smoother transportation environment, it is also necessary to improve technologies to modify travel behavior under severe climate condition. Today we would like to focus the former topic.

TECHNOLOGIES TO SAVE LIVES FROM TSUNAMI

Figure 2 shows the basic concept of the technologies to save lives from tsunami disaster. Though it was prohibited to evacuate by car

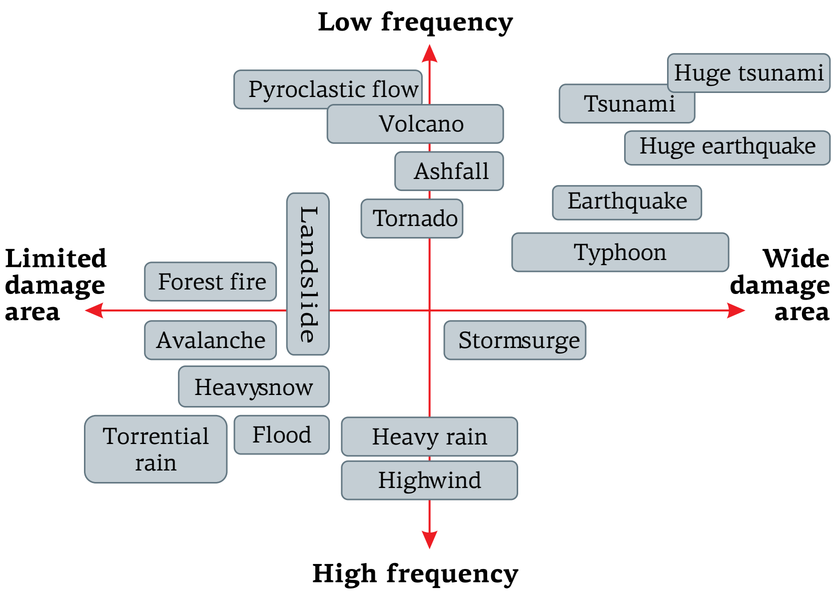

Fig. 1. Variety of natural disasters in Japan

in principle before the great earthquake and tsunami disaster in 2011, it was found that it can be possible to utilize car evacuation after the disaster. Therefore it is necessary to consider various transportation modes for evacuation. To guide people with proper transportation modes and evacuation routes, first of all, we need to monitor and understand the characteristics of regular traffic volume

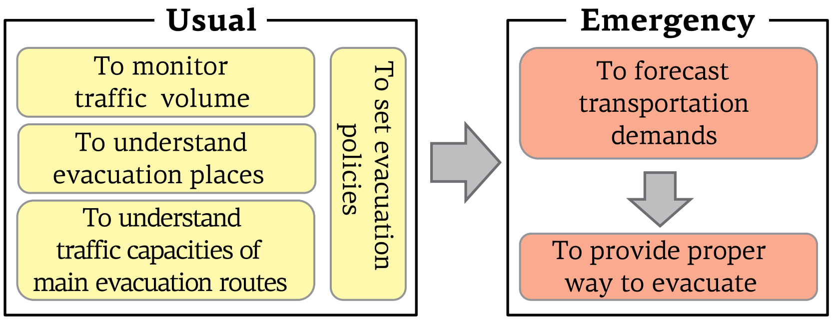

Fig. 2. Concept of technologies to save lives from tsunami

change, grasp where evacuation places are located, and recognize traffic capacities of main evacuation routes. We also need to create local evacuation policies.

Nowadays each municipality is required to prepare its evacuation policies using various transportation modes and each municipality has information of evacuation places including their capacity. It is possible to observe people's movement by analyzing GPS data due to the recent rapid technology enhancement, and there are various traffic simulation that can evaluate evacuation scenarios to understand traffic capacities of main evacuation routes. If we can prepare this knowhow from the usual stage, we can estimate transportation demands at any time at any place. Using all of those data, we can provide information about appropriate routes and modes.

RESEARCH EXAMPLE: A BASIC STUDY TO DESIGN TSUNAMI EVACUATION POLICY CONSIDERING CAR USE

Here, we would like to introduce one research example to help municipal government create an evacuation policy including evacuation by car, which we have been studying in Kochi prefecture in Japan. First of all, we considered that a tsunami evacuation policy should be created based on the following three-stage concept;

1. To check if there is an area in a region that we should consider car use for tsunami evacuation, and if "yes" then,
2. To calculate "Necessary Evacuation Velocity (NEV)" at each points in the area, and if NEV exceeds evacuees' walking velocity then,
3. To consider how to use car effectively in evacuation.

To check areas that need car evacuation, as a first stage, we introduced an indicator of "buffer length (lb)" using peoples' walking evacuation velocity (vwalk) as well as tsunami minimum arrival time (tmin), preparation time for evacuation (tp) and a factor of safety (α) as is shown in Fig. 3. If we know a border of expected tsunami inundated area that is usually predicted by the government, we can define area where you can evacuate on foot (WEA: walking evacuation areas) by drawing circles whose radius are lb from each point on the boundary and drawing an envelope curve. If some areas are remained by excluding WEA from the expected tsunami inundated area, we can call there areas as areas where car evacuation should be considered (CEA: car evacuation areas). If you notice that you have CEA in your region, it means it is better to start to think about car evacuation and to go to the next stage.

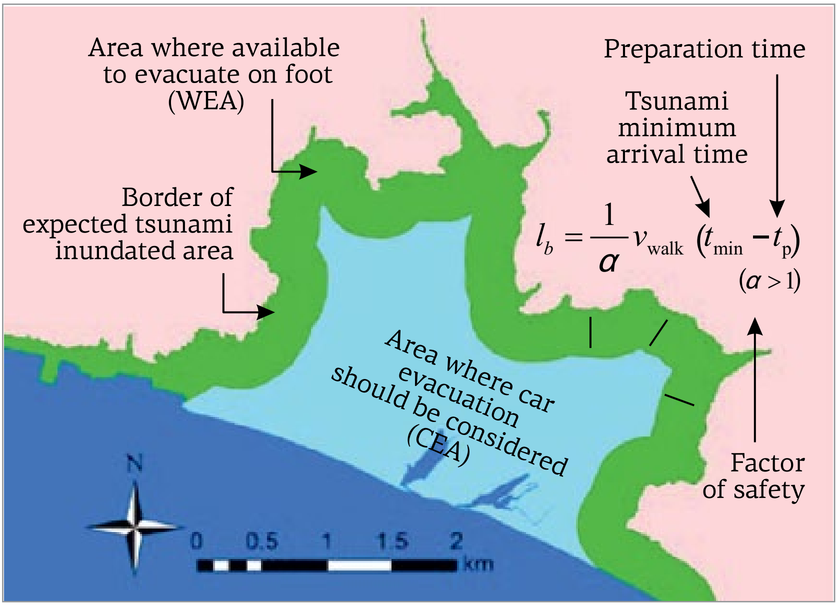

Fig. 2. Concept of technologies to save lives from tsunami

The second stage is to calculate necessary evacuation velocity (NEV) in CEA. Figure 4 shows the basic idea of NEV. If you set a horizontal axis as elapsed time after the earthquake and a vertical axis as distance from evacuation starting point in an evacuation route i, you can define a curve li(t) that denotes time evolution of tsunami arrival point. And if you know the evacuation goal and preparation time then you can find a minimum slope to succeed in evacuation; that should be NEV.

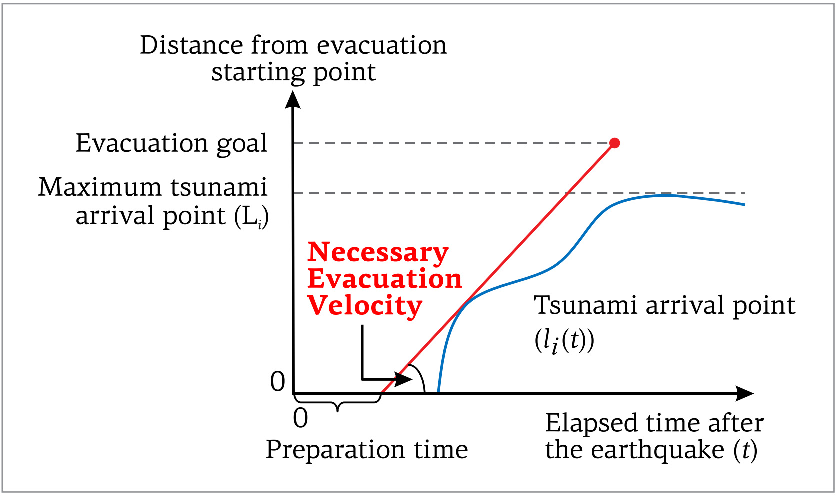

Fig. 4. The basic idea of necessary evacuation velocity

More precisely, if we define I as a set of all routes from a point in the expected tsunami inundated area to safe places, candidates of NEV in route i (эI) vi is illustrated as:

$$v_i = \max_{t>t_p} \frac{\alpha l_i(t)}{t - t} \quad (1)$$

There should be an ideal way and a practical way to select NEV. The ideal way can be shown as:

$$v^*_{\text{needed}} = \min_{i \in I} \left\{ \max_{t>t_p} \frac{\alpha l_i(t)}{t - t_p} \right\} \quad (2)$$

And the practical way can be shown as:

$$v^*_{\text{needed}} = \max_{t>t_p} \frac{\alpha l_{i^*}(t)}{t - t_p}, \text{where } i^* = \arg\min_{i \in I} L_i \quad (3)$$

Here, we chose the practical way because the ideal way is too complicated and hard to calculate in the reality for local municipality. Then if you can calculate NEVs in various point in an area, you can illustrate "tsunami risk contour" from the viewpoint of NEV (Figure 5). The concept was first proposed by So et al. (2010) and Daganzo et al. (2011).

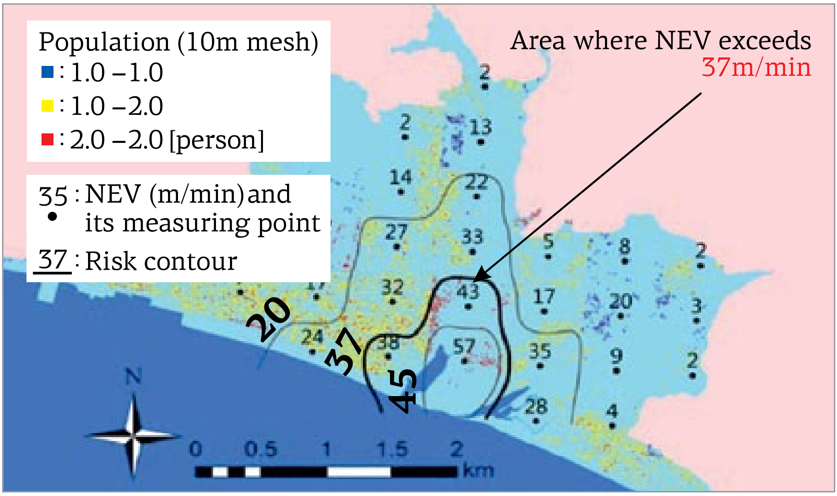

Fig. 5. Tsunami risk contour

When defining people's walking evacuation velocity as 37m/min then we can know where is really dangerous and evacuation policy for car evacuation is needed as the area inside the tsunami risk contour of 37m/min.

The third stage is to consider how to use car effectively in evacuation. Here we would like to suggest an index that would illustrate the severity of car evacuation, which we called "an index of minimum required number in one car." We defined this index by dividing a number of people that need car evacuation (P) by a number of cars that can go out of the tsunami inundated area within the time limit (Ncar) as is shown below. To calculate Ncar, one lane traffic capacity in evacuation q and a total number of lanes that cross the border of expected tsunami inundated area (nlane).

$$c = \frac{P}{N_{car}}, \text{where } N_{car} = q n_{lane} (t_{min} - t_p) \qquad (4)$$

If c exceeds 5.0 (regular loading capacity of a car), it is not realistic to apply car evacuation and it is necessary to consider other evacuation facilities, such as evacuation towers, evacuation steps on hills and so on. And if c is lower than 1.0, it is possible to apply car evacuation without any policy. However, if c is between 1.0 and 5.0 then it is necessary to set an evacuation policy to promote sharing car with neighbors.

1. To verify calculation results,
2. To combine with usual traffic volume monitoring,
3. To arrange traffic capacity data,
4. To develop algorithm to lead evacuees (to provide informa tion to car navigation systems or smartphones),
5. MeteorogicalTo collaborate with ICT-related entities, and
6. To communicate with residents, to arrange evacuation plan, and to conduct evacuation drills.

REMAINING TASKS FOR REALIZATION

This research focused mainly on how to set a car evacuation policy. To realize car evacuation in practice it is inevitable to consider following remaining tasks by discussing with real municipal government.

OTHER RELATED IMPORTANT TOPICS

There are also other important topics for research and methodology development. For example, this research activity introduced above has been discussed mainly for residents. It is obvious that most of the areas inundated by tsunami disaster are located on coastal areas where lots of strangers visit. Therefore it is also necessary to develop evacuation route guidance for strangers that don't know the area well. Pre-disaster road network reinforcement for evacuation should be also essential. Even if there is an excellent route navigation system, it is not workable under the unreliable road network. Those examples are direct measures to reduce victims.

Furthermore, of course there are some indirect measures. We need to design several evacuation scenario to analyze the effectivity of above-mentioned evacuation policy and the direct measures. Also promotion of housing relocation to higher places to reduce damage of tsunami disaster.

We hope this series of transportation management measure against natural disasters should be practically implemented immediately and introduced to the real municipalities.

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Development aid agendas in Japan: challenges in sustainable development

The following presentation provides a brief introduction and discussion of the challenges faced by Japan and the international community in its utilization of Official Development Assistance (ODA) as a tool for achieving sustainable development. Domestic policy details on the priority issues that address sustainability are presented, as well as a discussion on the evolution of sustainability as a global agenda within the development aid community. Examples of rising challenges in the financing and management of projects as a consequence of the sustainability agenda are introduced before the presentation concludes with a short discussion of the future of sustainable development in Japan and the international community.

INTRODUCTION: MOVING FROM THE MDGS TO SDGS

The international community has learned a multitude of lessons as it strives to meet the challenge of incorporating social, economic, and environmental aspects into holistic approaches to sustainability. As a result, the 8 Millennium Development Goals set to be achieved until 2015 have expanded into the 17 Sustainable Development Goals set for 2030 (Fig. 1). It is against this backdrop that members of the international community strive independently (locally) and collaboratively (globally) to attain the politically bold yet scientifically and technologically feasible solutions to lasting sustainable development.

OFFICIAL DEVELOPMENT ASSISTANCE AS A TOOL FOR ATTAINING THE SDGs

The Government of Japan disburses a considerable amount of funding to partner countries with developing and transition economies to help address their development challenges. Over the past decade the Japanese tax-payers have contributed an average of approximately 10 billion USD in Official Development Assistance (ODA) funding every year (Fig. 1, taken from the Ministry of Foreign Affairs Japan — MOFA)[1]. Official policy on such ODA is stipulated in the Development Cooperation Charter, drafted by the Ministry of Foreign Affairs Japan.

Fig. 2. ODA spending by the Government of Japan over 10 years (from MOFA, 2015)

[1] In contrast, the Russian Federation reported approximately 1.1 billion USD of ODA in 2015

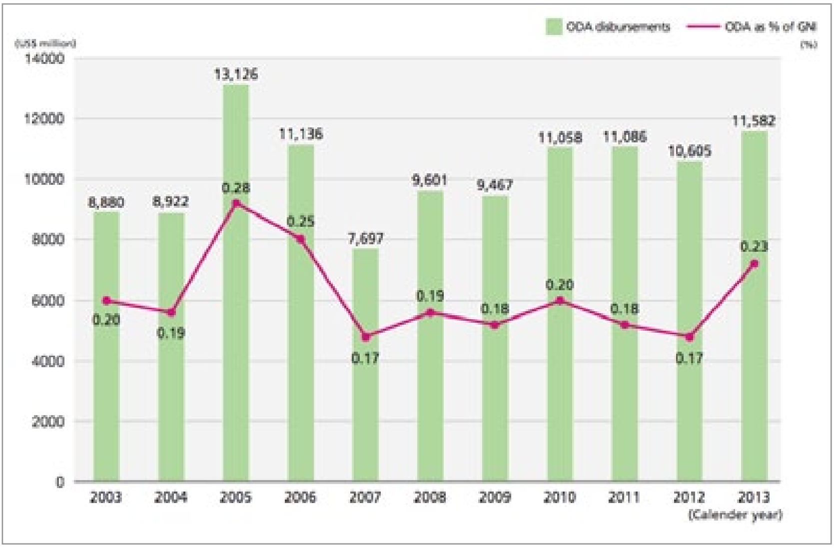

Fig. 2. ODA spending by the Government of Japan over 10 years (from MOFA, 2015)

In the Development Cooperation Charter (2015), the Government of Japan outlines its objectives for ODA. The main objective is for "securing peace, stability and prosperity of the international community" (p. 1), within priority areas which specifically include "building a sustainable and resilient international community" (p. 6, emphasis added). Citizens must then ask, what exactly does a "sustainable and resilient international community" entail? The charter further breaks down global challenges relating to sustainability into the following issues:

- Environmental issues & climate change
- Water issues
- Natural disasters
- Food crises and hunger
- Energy issues

These issues are outlined at the level of policy, but for actual funding, ODA resources are classified into a narrower range of functions. This is due to the fact that OECD countries have been using the "Rio markers" to classify funding for environmental purposes since 1998. For Japan, approximately 40-50% of ODA funding is tagged with the Rio markers and is thus classified as "environmental aid". Environmental aid constitutes ODA funds that are used specifically to address key environmental issues. In other words, ODA can be marked as addressing one or more of the following issues: biodiversity; climate change adaptation; climate change mitigation; and desertification. The operative words in the conditions of environmental aid are the marking of "one or more" of these environmental issues. As will be described later on, this creates complications for process overall.

SUSTAINABILITY AS AN AGENDA

While a strong movement is now in place that has helped the global community understand the urgent need for sustainability, development professionals and scientists did not always enjoy this level of support. The rise of sustainability as a global issue and agenda is no timid feat.

The following figures are the result of an N-gram analysis conducted on a free platform provided by Google (Google Books Ngram Viewer). This tool allows one to search for n-grams (a collection of n number of words) within an enormous corpus made up of the contents of books within the company's digital archives.

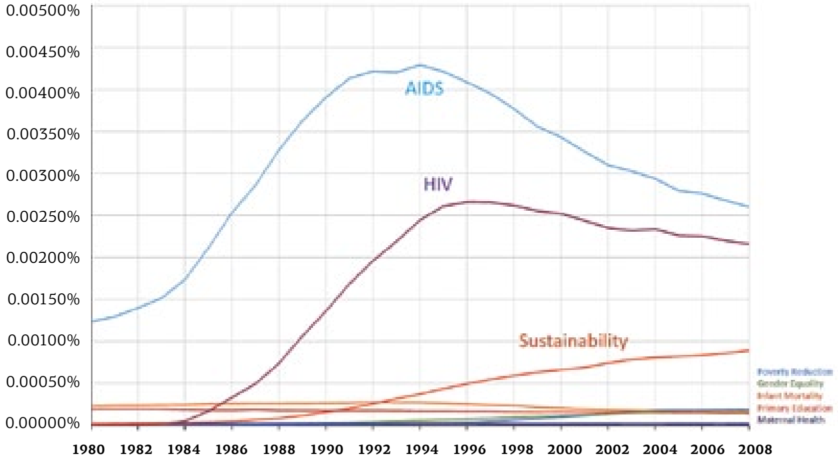

Fig. 3. Prevalence of development keywords from 1980–2008

A query of development key-words can reveal the shifting trends about the priority issues being mentioned and therefore considered within written documents over time.

Fig. 3 shows the growing emphasis of AIDS and HIV from the '80s to mid '90s as the global community came together to respond to the HIV epidemic in regions such as south-east Asia and sub-Saharan Africa. Relative mentions of AIDS and HIV seem to have peaked in the mid '90s as the graph reveals a steady decline in their mentions in the 2000s. In contrast, a steady increase in the mentions of sustainability can be observed all throughout this period.

Although there seems to be a steady decline in the mentions of AIDS and HIV in written texts, there is still an overwhelming emphasis on these issues within all texts contained within the corpus. The dominance of these two issues prevents us from observing some of the smaller differences and observations contained within other issues that congregate at the bottom of Fig. 3. In order to focus in on the key-words hidden here, the keywords "AIDS", "HIV", and "Sustainability" were removed from the query to reveal the relative differences in mentions among the terms: infant mortality, poverty reduction, primary education, gender equality, and maternal health, resulting in Fig. 4 below.

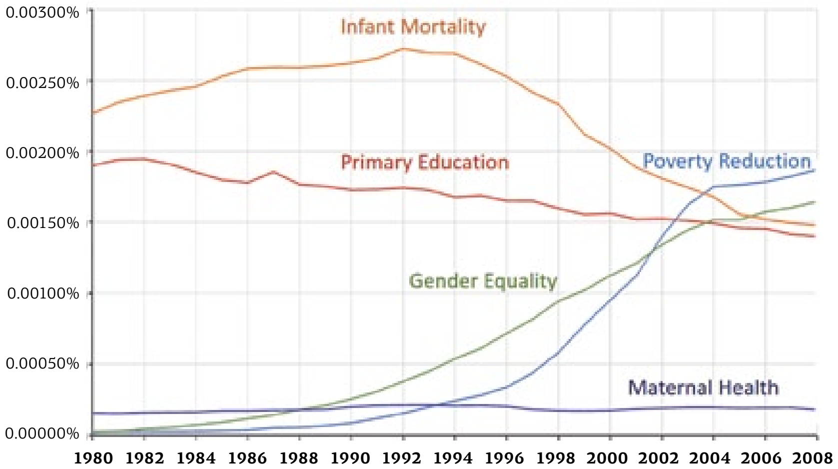

Fig. 4. Prevalence of development key words excluding "Aids" and "HIV"

The following figure (Fig. 5) places the keyword "sustainability" back into the query, and adds some more key issues such as "economic growth", "family planning", as well as environmental issues such as "climate change", "biodiversity", "desertification", and "clean energy".

What is interesting to note in Figure 5 is the relative decline of mentions of "economic growth" after 1995, while environmental issues such as climate change, biodiversity, and sustainability catch up in terms of the number of mentions. "Family planning" appears to have peaked in the '70s as various governments transitioned from focusing on population control to the consideration of reproductive rights and health.

The shifting figures outlined in Fig. 3-5 are a simplified yet intuitive reflection of the fluid nature of social transitions across global agendas. As countries, governments, and the development community identify emerging key issues, resources will again shift as priorities and challenges evolve for people and communities. When development agendas and priority areas shift, institutions and organizations must then fight for public sentiment, support, funding, and talent to address these issues. In like manner, sustainability is an agenda that has taken form for the international community.

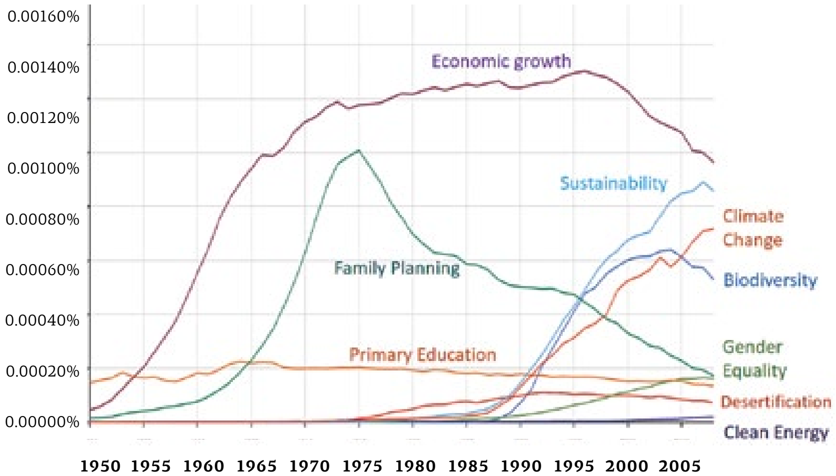

Fig. 5. Shifting prevalence of development keywords since 1950

CHALLENGES FOR SUSTAINABILITY WITHIN ODA

FINANCING CHALLENGES

Fluctuations among multiple agendas have a direct impact on the institutional policies, procedures, and practices of organizations tasked to implement development projects. Institutions within the development community are in many ways at fierce competition with one another for the limited resources and public sentiment that can be focused on address global issues. Furthermore, organizations are often evaluated based on their ability to attain goals, objectives, and metrics that are indicative of progress within agendas. Within the international community, for example, countries can boast their dedication and progress towards sustainable development by announcing their financial commitments to these areas.

Unfortunately, as countries try to reveal strong commitments and shed positive light on their activities, OECD studies have revealed that an immediate issue arises concerning double accounting. Across OECD countries, 60% of global desertification activities were also marked as biodiversity related. In addition, a total of 3.9 billion USD of global aid for climate change was marked both as mitigation- and adaptation-related finance through the use of the Rio markers. In Japan, this amounted to 300 million out of 7 billion USD being double-accounted (OECD, 2012).

PROJECT MANAGEMENT AND EVALUATION CHALLENGES

In addition to financing challenges of environmental projects that aim to contribute to sustainable development, the project-level ramifications of complications associated with sustainability are even more apparent. Double-accounting and financing consequences are relatively easy to identify and understand. However, practitioners involved in managing and implementing development projects are well aware of the fact that evaluating the "value" of a project and its "sustainability" (which are not the same) is a much more arduous challenge.

Through interviews with development industry stakeholders and government officials, our research group has identified a lack of consensus on sustainability issues which challenges project man-

Inputs	Activities	Outputs	Outcomes	Impact/ Goal/ Purpose
Resourses, financing	Production, marketing, education, sales etc.	Product/ results of the combined inputs	Product/ results of the combined activities	Impuct of the program

Fig. 6. Logical framework for project management

agers. These challenges are apparent in the literature as well. For example, certain projects have been labelled a "failure" for missing benchmarks developed to measure the Millennium Development Goals. Countries such as Burkina Faso are considered a "failure" in terms of achieving the MDG of universal primary education, despite the fact that it displayed the fastest enrolment increase within the region (Clemens et al., 2007). Where any practitioner would acknowledge significant growth as an indicator of success, idealistic policy goals can neglect the complexities associated with fundamental development challenges such as universal primary education.

These evaluation challenges are of course in no way unique to sustainability, but are rather the product of fundamental challenges that have long plagued evaluators and project managers (cf. Maemura, 2016). If one were to utilize the logical framework for project management (referred to as the Project Design Matrix in the Japanese development industry), projects can be organized into: inputs, activities, outputs, outcomes, and impacts/goals. A means-ends approach (use inputs and activities as a means to produce outputs, which act as a means to produce outcomes, and so on) of this nature organizes specific inputs and activities into higher-order objectives (Fig. 6).

Project managers, evaluators, and analysts see that the uncertainties arise as soon as one attempts to connect inputs and activities with outputs and outcomes, while even the best policy makers can often only hope that impacts will be made that are consistent with original policy goals and priorities.

SUSTAINABILITY FOR WHOM AND FOR WHAT?

What essentially can be seen at occurring within projects and programs, is that stakeholders view sustainability through a lens situated at the level in which they are involved. Fundamental gaps in understanding of project goals and the concept of sustainability are thus persistent across the industry where multiple organizations must collaborate to plan, implement, and evaluate initiatives. With varied roles, responsibilities, and organizational interests, these gaps invariably affect the manner in which sustainability is perceived. A simple way of framing the complexity associated with sustainability is to ask the question: Sustainability for whom?

When considering this question, one must recognize that various stakeholder interests add levels of complexity to the situation. For example, countries on the receiving end of aid programs often aim to achieve sustainability in terms of resources management, financing, or economic growth. Consultants and experts that implement development projects must consider how their technological knowledge is contributing to development goals, and organize their projects to ensure their activities are sustainable from an organizational perspective. Donor agencies alone can have multiple perspectives on sustainability: are diplomatic and political interests of peace and stability being served from a long-term and sustainable perspective? Can the program be repeated and support itself in terms of financial sustainability? Are the impacts contributing directly to environmental sustainability? As one can see, stakeholder interests play an enormous role in shaping our understanding of sustainability, yet rarely are such realities taken into account when presenting the public with descriptions and definitions of "sustainable development".

THE SUSTAINABILITY AGENDA AND BEYOND

By recognizing sustainability as an established agenda within the international community, we possess a useful lens into the fluid and evolving landscape of global challenges that have shaped development agendas over the past three to four decades. Furthermore, a deeper appreciation for the conceptual complexity of sustainability allows one to grasp the consequent challenges of gathering finite resources (input and activities) to produce measurable outputs that contribute to sustainable impacts. The 17 sustainable development goals in themselves suggest a bare minimum of 17 approaches or frameworks for the task of measuring or monitoring sustainability.

Going forward, countries with leadership roles in the international community such as Russia and Japan must continue improve their co-ordination and knowledge systems (Cash et al., 2003; Mitchell, 2003) through programs like the Students and Researchers Exchange Program in Sciences. Global citizens must learn from one another and effectively utilize their finite resources for achieving the SDGs. Decision makers and policy makers must identify comparative advantages, locate synergies, and eliminate redundancies. Scientists must continue to present facts that create evidence-based solutions for sustainability, as well as preparing to identify the next fundamental issue that challenges our planet so as to influence and create future agendas. It may seem a distance future for many, but scientists must ask themselves, what challenges will a sustainable planet face, and what will the next agenda be?

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Cities of Baikal region: environmental challenges of spatial development

INTRODUCTION

During the last 15 years, a process of intense development of suburbs could be observed in large cities of Baikal Region, especially, in Irkutsk, Chita, Ulan-Ude. This process became one of the serious urban planning problems and a new environmental challenge at the same time. City inhabitants move to suburbs combining occupancy in the city with the benefits of the rural lifestyle and better environmental conditions. The main factors of suburban development include the increase in the automobilization and population mobility levels, a wider range of distance occupancy opportunities and environmentally unfavorable living conditions in the city. It forms a significant traffic flow from the city to the suburbs, worsens the conditions of transport availability and creates environmental problems. In addition, current cities face the shortage of lands, suitable for complex building development. The urban fabric is conducted, mainly, through spot development, worsening habitability conditions of the urban environment.

In current conditions of the persistent population drift away from the northern territories of Russian Federation (Siberian and Far Eastern regions), one of the main factors keeping people at the same place is life quality, i.e. environmental suitability for comfort living. Life quality is determined by people's ability to use all the advantages of the territory where they live: to get enough fresh air, to use recreational space, to have available dwellings, corresponding to their needs and financial state, to exist in a bright picturesque environment of Baikal Region, to have a wide range of employment opportunities, i.e. to live in a "friendly" urban environment.

Irkutsk city was affected by suburbanization more than any other urban areas in Baikal Region. The solution of suburban environmental problems is inseparably linked with environmental safety support of Irkutsk, as living conditions in a city depend a lot on the state of its surroundings [1]. The special attention in this paper is paid to spatial development of Irkutsk. In 2016 year Genplan Institute of Moscow took part in competition on working out of strategy of spatial development of Irkutsk. Experts from St.-Petersburg, and also local town-planners of Irkutsk were other participants.

Nowadays the top target of Irkutsk stable development is improving of life quality by reducing harmful effects and improving environmental conditions, natural and man-made risk management, urban planning and design with respect to ecology, smart transportation and mobility, green industries and utilities. The residents of Irkutsk value unique natural landscapes and built environment, architectural design of buildings and spaces, stability and sustainability. A goal of urban planning is synonymous with sustainable spatial development in that decisions must not be made solely for an immediate result, but must be considered in light of its cumulative, long-term effects. So the strategy of spatial development of Irkutsk is working out for the period up to 2035 year.

According to the Russian legislation when we are preparing strategy of spatial development and other urban planning documents, the issues regarding the protection of the environment and nature must be taken into consideration. For this purpose there are a number of instruments laid down in various laws, which are integrated in planning processes and approval procedures. The key part of spatial strategy is the environmental assessment of Irkutsk city.

URBAN-PLANNING AND ENVIRONMENTAL ISSUES OF IRKUTSK

Irkutsk is a large industrial, scientific, educational and cultural center of Russia. It is a capital of Eastern Siberia and modern trade center, large transportation hub on the Trans Siberian railway.

Fig. 1. Cultural, historical and architectural heritage of Irkutsk city

Airport of Irkutsk delivers passengers from Moscow to Vladivostok, to international airports of Japan, China, and other countries. The development of academic science in a city is connected with activity of Irkutsk scientific center. There are nine research institutes of Russian Academy of Science located in Irkutsk: the Institute of Geography, the Energy System Institute, the Institute of Geochemistry, the Institute of System Dynamics and Control Theory, the Earth's Crust Institute, the Solar-Terrestrial Physics Institute, the Institute of Chemistry, the Limnological Institute (formerly located on Lake Baikal's shore) etc.

It goes without saying Irkutsk is a point of interest for tourists with its numerous museums and old architecture. There are 1048 objects of cultural heritage in the city [2]. Irkutsk has preserved its original look, combining shine of church domes, beauty of merchants' houses, monumentality of modern buildings and constructions (Fig.1). The majority of historical, architectural, cultural monuments, historically composed monuments have been preserved. The residents of Irkutsk city want growth to be sustainable and in keeping with the character of the community and Irkutsk's sense of place.

The special topics are Irkutsk and Baikal. The lake Baikal is a worldwide known and popular, and Irkutsk, 60 km from its banks, exploits the image of "the city on Baikal". Baikal does play the special role as a touristic attractor: a tourist has arrived in Irkutsk with such an understanding and sees that he or she can take a bus and go directly to Baikal. The important task of stable urban development is how to keep tourists in a city for 5-7 days with only 1-day trip to Baikal. As is known Baikal Lake contains one fifth of the whole world soft water: it is very important to protect the ecosystem of lake by reduction of recreational pressure.

Despite exceptional natural surroundings, living in Irkutsk city poses some ecological problems. So environmental assessment plays a key role in urban planning. Ecological information system (EIS) is an important base for correct decision making (Fig. 1). There are 4 main divisions in EIS:

- Information about Environmental risk (Seismic intensity, Flood, Landslides, Karst-suffosion process);
- Zones with special limit for use (Sanitary protection zones, Water protection zones, Zones of sanitary protection for sources of potable water, etc.);
- Environmental conditions (Air pollution, Soil contamination, Pollution of water Noise, vibration, etc.);
- Sources of pollution (Industrial Plants and fabrics, Heating and Power Plants, Landfills and dumps, Utility facilities, Airports and terminals).

The most important task in urban planning is to determine the environmental restrictions for long-term development of the city (Fig. 2)

The urban-planners prefer to use the results of comprehensive assessment, reflected on special maps. We use some approaches for this purpose. Ecological simulation (Fig. 3) is an essential tool to identify problem's areas, ranging territory on environmental quality, study environmental requirements for long-term development of the city.

Especially high levels of air basin contamination are noted in winter — when the central heating system is overloaded and the atmosphere

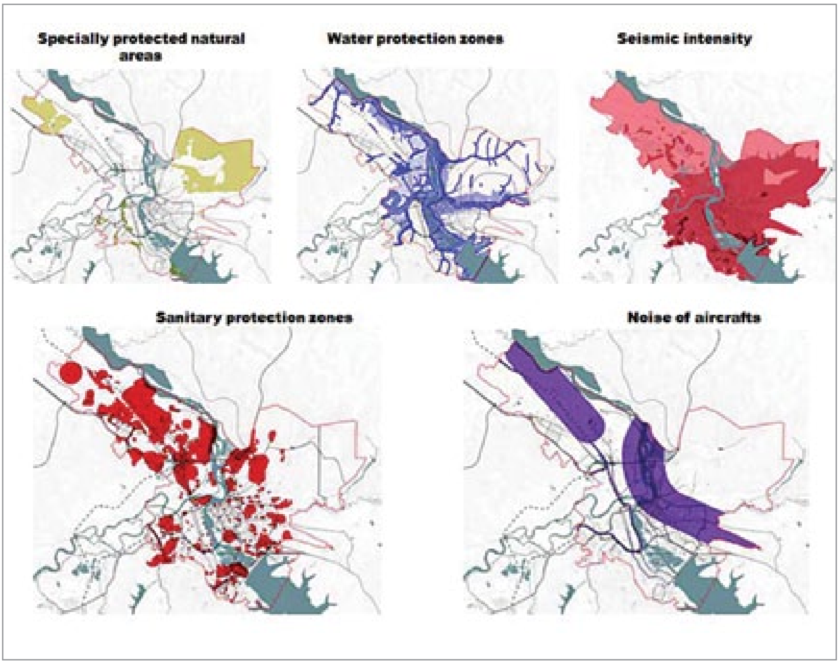

Fig. 2. Environmental restrictions for urban development

is not fully able to self-cleaning. The highest level of urban territory contamination is seen, according to the wind rose, in the direction of northwest to southeast. Emissions of fuel and energy enterprises make 96% from the volume of stationary sources of emissions. Despite reducing of industrial production in recent decades, intensity of influence of air pollutants on Irkutsk citizens tends to grow. It is caused by increase of number of wheeled transport (the annual tendency of increasing number of cars takes place) and fuel and energy sector development. It results in redistribution of emissions density from specific (previously common for industrial sector) to non-specific ones (fuel power industry and transport) with increase of common level of air pollution in the city [3].

The results of the comprehensive ecological assessment are shown on the Fig. 4. Cartography methods are based on the territorial landscape conditions, results of environmental impact assessment (air pollution, soil contamination, noise and vibration, sanitary status) geochemical rates, atmosphere self-cleaning potential. Quality characteristics are determined by empirical studying, mathematical simulation and expert ranking of factors from minimal to maximal result. The dark color reflects the most serious environmental situation..

STRATEGY OF 6 TOWNS

The conception of spatial development of Irkutsk elaborated by Genplan Institute of Moscow is based on strategy of 6 towns. Irkutsk is situated on three rivers: Angara, Irkut, Ushakovka. The city proper lies on the Angara River. The two main parts of Irkutsk are customarily referred to as the “left bank” and the “right bank”, with respect to the flow of the Angara River. The Irkut River, from which the town takes its name, is a smaller river that joins the Angara directly opposite the city.

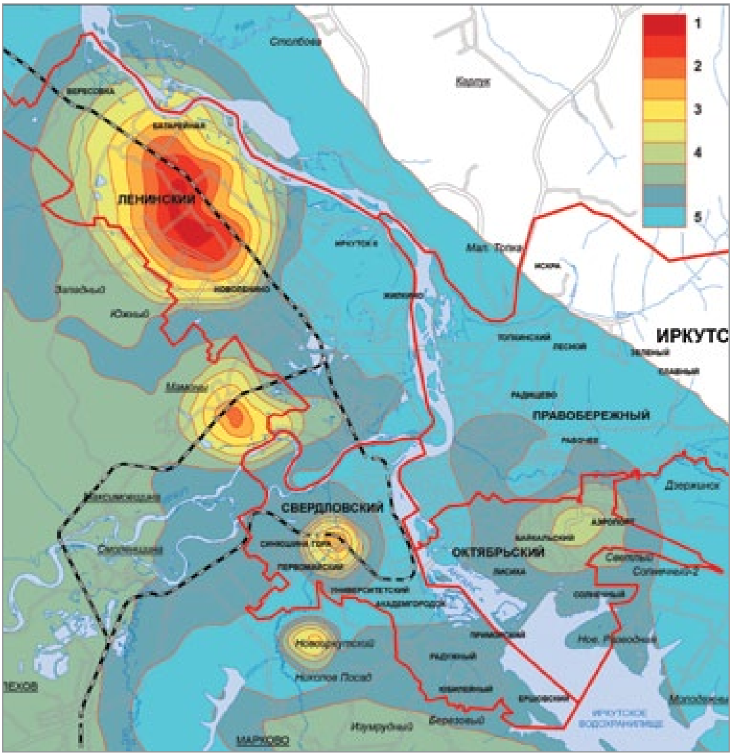

Fig. 3. Ecological zoning of Irkutsk city and suburban areas according to the levels of air pollution [2]. *The levels of air pollution:* ***1*** *— the most high,* ***2*** *— high,* ***3*** *— medium,* ***4*** *— low,* ***5*** *— the lowest.*

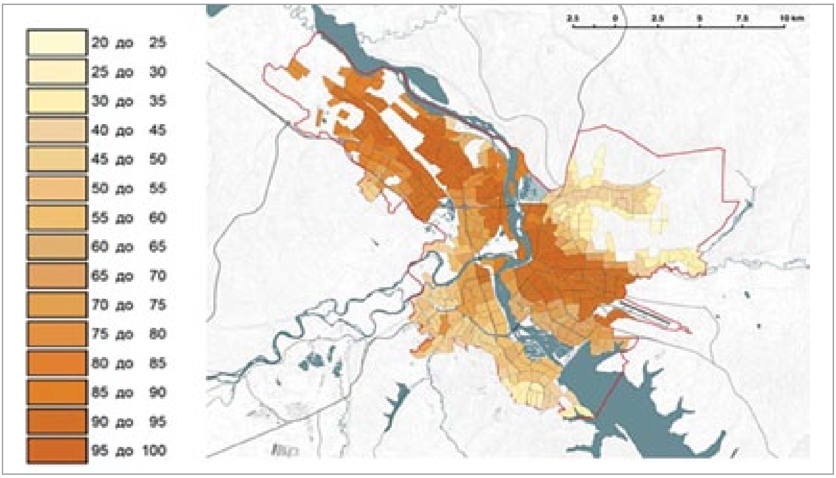

Fig. 4. Comprehensive environmental assessment based on the measurement units

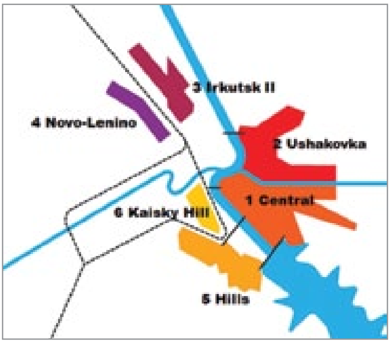

Fig. 5. Schematic view of 6 towns inside of Irkutsk city

Another tributary is the Ushakovka River. All these natural features as well as railway and highways cut the urban fabric. So Irkutsk city is divided into 6 different neighborhoods or local towns with specific life and environment (fig.5): Central, Ushakovka, Irkutsk II, Novo-Lenino, Hills, Kaisky Hill.

The results of the comprehensive ecological assessment are shown on the Fig. 4. Cartography methods are based on the territorial landscape conditions, results of environmental impact assessment (air pollution, soil contamination, noise and vibration, sanitary status) geochemical rates, atmosphere self-cleaning potential. Quality characteristics are determined by empirical studying, mathematical simulation and expert ranking of factors from minimal to maximal result. The dark color reflects the most serious environmental situation.

Our researches have revealed that these towns have the individual planning structure, environmental conditions, transport accessibility, social infrastructure and as a result different life quality. For example Central town is a historical and modern center of Irkutsk. Almost all administrative buildings, theaters, museums, libraries are located here. But the environmental situation is bad, the main negative factors are high level of transport pollution and the lack of recreation space. Town of Novo-Lenino is a modern Irkutsk, the problem of air pollution produced by the biggest Novo-Irkutskaya thermal power station is the important environmental issue for this neighborhood [4].

Researches of the city environment included also sociological poll of inhabitants in each neighborhood. Each neighborhood has characteristics that make it special, which helps form its unique identity and shapes each person's connection to the broader community. Sustaining character is vitally important to the residents as it defines their individual neighborhood and community and creates a quality of place like no other. In order to maintain character, important identifying features must be protected and integrated into urban-planning development for the period up to 2035 year (Table 1).

Table 1. Schematic view of 6 towns inside of Irkutsk city

#	Town	Main urban-planning issues	Directions for sustainable
1.	Central	Traffic jams and great number of cars, high level of transport pollution, noise of aviation, lack of green areas and uncomfortable public spaces	Forming the natural frame and ecological corridors, creation of public spaces, revitalization of river valleys and forming a new quay along the Angara river. Provide a continuum of land uses that allow a variety of uses and housing types to meet the needs of the community while ensuring the preservation of neighborhood character in an efficient manner. Equal distribution of park spaces, activities, and facilities to meet the diversity of local areas

2.	Ushakovka	The housing is moral and physically old, bad public transport. Sewage treatment plants require major repair or renovation.	Creation the connection with Central town on the base of ecological corridors of Angara and Ushakovka rivers, reorganization of transport system, revitalization of precious industrial build-up areas. Encourage a variety of housing types to meet the needs of residents of all ages and economic abilities. Provide for a safe and sustainable water supply that meets the current and future needs of the community.
3.	Irkutsk II	Environmental situation is critical. Law density of work places, bad transport accessibility, lack of the entertaining and recreational objects. The cultural life is absent.	Forming the new public center, improving the connections with Novo-Lenino neighborhood. Provide a mix of housing that meets the economic and life-style needs for the diverse population.
4.	Novo-Lenino	Poor social infrastructure, public transport is insufficient, traffic jams, law quality of green areas. Parks are absent. Environmentally poor quality of air.	Preserving of natural stream in individual sector. A comprehensive network of paths and linear parks connecting all parts of the town Enhance the integration of cyclists and community public transit services.
5.	Hills	The absence of parking areas, traffic jams, dirty streets. The neighborhood that need more playgrounds.	Protect existing neighborhood identity and character. Protection of specific hill relief as a comfortable family neighborhoods with good ecology and calm environment. Forming the pedestrian connections.

			Preserving of the attractive landscapes. Provide for the safe access and use of the pedestrian facilities for users of all ages and abilities. Conserve sensitive natural areas for aesthetic and ecological purposes.
6.	Kaisky Hill	Chaotic parking areas, uncomfortable park zones, traffic jam, the absence of places for kids	Forming of the linear public space, improving of the integration of rail way and terminal. Conserve sensitive natural areas for aesthetic and ecological purposes.

CONCLUSION

The spatial development strategy produced by Genplan Institute of Moscow outlines numerous initiatives that the city will undertake to make Irkutsk a more sustainable city. Our goal is to stop of urban sprawl and preserve the existing borders of city, to develop the built-up areas and brown-fields. The city we need is compact where accessibility is supported by a fine-grained block and street network lined with buildings and facilities providing amenities and services with a mix of uses and sizes. Schools are within walking distance from homes, offices are located no further than a few transit stops away from homes. Shopping for daily necessities is within walking distance of residential buildings and located near transit stops. The amount and quality of walkable areas is essential to promoting healthy behaviours and lifestyles, as well as reducing dependence on motorized transport and introducing more green space in Irkutsk.

The topic of a natural (blue-green) frame plays a key role in the concept of a spatial development of Irkutsk. This frame should serve binding elements in development of all 6 towns. It is very important to protect and conserve the natural resources of the area in a manner that balances their ecologic, economic, and aesthetic potentials to preserve natural features and ecosystems of Irkutsk city. The parks and gardens provide access to nature and recreation for city dwellers. They serve important ecological functions. They are accessible by all residents, including the elderly and persons with disabilities. 10 recreational areas are recommended for perspective use. These areas (parks, green corridors and water-based recreation zones) will increase access to open space and the water, help meet diverse recreational needs, and improve the quality of outdoor experiences.

The decision of transport problems is a key task for the majority of large cities in Russia. Irkutsk we need should have an efficient and affordable mobility systems that guarantee the right to mobility for all and an equitable access to workplaces, places of worship and recreation, culture and services. According to simulation of transportation flows up to 2035 year our proposals concern the eco-friendly rail transport development and construction of 5 new bridges that ensure the integration and coordination of the neighborhood transportation systems with the city's facilities and modes of transportation.

So well-planned city of Irkutsk will allow all residents the opportunity to have high quality of urban environment, safe, healthy, and productive lives.

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The role of ecosystem services in reduction of health risks in cities: cases from Germany

INTRODUCTION

Today, over half of humanity lives in towns and cities, and by 2030, this number will swell to 60–75% [6, 14]. The problems caused by rapid process of urbanization are enormous and varied: together with the increased concentrations of pollution and land transformation in the urban core and periphery, by intensification of climate change they threaten human health. However, consequences of these interrelated processes and the risks and hazards that they pose to both human well-being and ecosystems remain underexplored. The nexus between ecosystems and environmental health can be good explained through the concept of ecosystem services [11]. A term of ecosystem services refers to the conditions and processes through which ecosystems, and the species that make them up, sustain and fulfil human life [4, 10, 11]. Ecosystem services are based on ecological functions that incorporate fundamental ecosystem supporting services, but with benefits realized as regulating services, i.e. services which maintain environmental quality (e.g. waste assimilation), provisioning services (e.g. the supply of natural products such as food) and cultural services (e.g. settings for recreation and various non-use social or cultural values) [2, 17]. As the benefits that people get from nature, ecosystem services contribute to human health and well-being making human life possible and worth living [11]. In this regard, the fundamental importance of ecosystem services (ES) for human well-being and everyday life brings

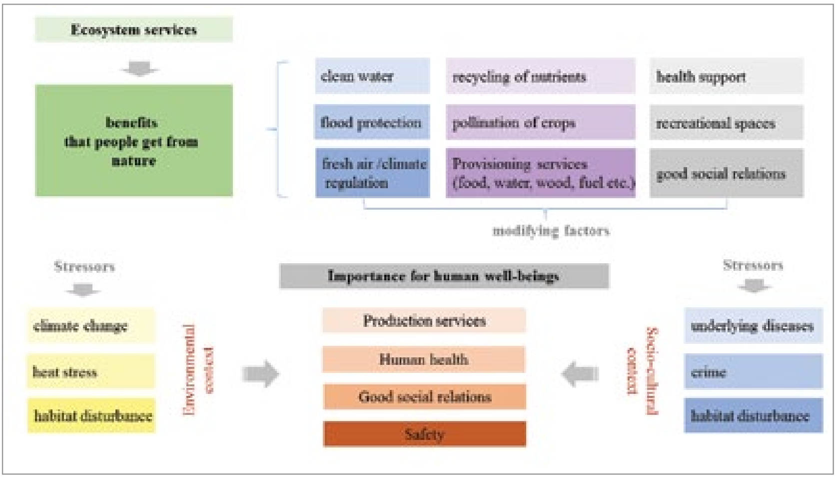

Fig. 1. Conceptual model of integrating ecosystem services with human health and well-being

together the environmental and socio-economic context of this relationship that occurs in production services, human health, good social relations, safety etc. (Fig. 1).

While some progress has been made in the research on ES [6, 7, 8, 11, 13, 14, 17], the links between ES and human wellbeing are still not well understood, and links to reduction of environmental and human health risks in cities even less so. Although ecosystem services are recognised as assessment endpoints for ecological risk assessment in the huge amount of research [14], still lots of countries did not incorporated them into ecological risk assessment practice in a general way. Although the importance of ecosystem services in human health and well-being is worldwide recognised [11, 17, 18, 22], the debate in which way and amount they comprises human well-being in Russia is still on-going in the literature. However, there has been a growth in interdisciplinary science and international joint projects on ES and their contribution in supporting human resilience [7, 15, 19]. The paper presents the results of one of such projects conducted by Department of Environmental Management of the Moscow State University and Department of Geography of the Humboldt University of Berlin in the framework of the research grant "Landscape and human-wellbeing: identification, assessment, and communication in the field of ecosystem services" (2014–2016) supported by the Parliament of Berlin. The paper aims to answer a question how the ecosystems and human health in the case study regions are interlinked. It illustrates how changes in land use and climate resulted in high level of environmental risks in cities can affect health directly, and which indirect impacts on human health can be observed there. The paper also try to explore more directly the ways in which the condition of ecosystems and the health of urban populations are linked, and what benefits could be obtain from the ecosystem services.

The paper uses the WHO's definition of human health as "a state of complete physical, mental and social well-being" [22]. The term of environmental risk was derived from [5, 21] and means both natural disasters (e.g. flooding, storms, fires etc.) and man-made risks (e.g. collapsing ecosystems, freshwater shortages, nuclear accidents etc.) that have potentially negative consequences for human beings. Primary (field research, semi-structured interviews with citizens and experts, and participative observation in case study regions) and secondary sources (literature review, regional statistics) were gathered. The information from secondary sources was verified during the field research in Leipzig and Berlin in 2013-2016.

STUDY DESIGN

STUDY AREA

Located in East Germany and being a capital of the country, Berlin (together with Hamburg, Munich, Cologne) refers to Germany's four major cities with more than a million inhabitants. The City of Leipzig is one of the Germany's 15 urban agglomerations with more than 500,000 inhabitants. The both cities underwent a severe shrinkage phase after reunification in 1990, and refer now to the fastest re-growing cities in Germany. As a consequence of the German renunciation in 1990, a structural change in urban land use and built-up structures occurred in the both cities. Additionally, a broad urban restructuring process has been underway since 2000, characterized by different processes of urbanization, transformation in land use, and new concepts (also environmental oriented) implemented in the programs of urban planning in Leipzig and Berlin [1, 16, 20].

Table 1. Socio-environmental indicators for Leipzig [1, 16]

Indicators	Leipzig	Berlin
Population in 2015	560,472 inh.	3,520,031 inh.
Area in 2014	297.38 km²	891,68 km²
Number of city districts	10	12
Population density	1,900 inh./km²	3,948 inh./km²
Unemployment rate in 2014	9.4%	9.2%
Geoposition / coordinates	51° 19’ N, 12° 23’ E	52° 31’ N, 13° 24’ E
Climate	a humid continental with warm summers and no dry season and with mild to cold winters	temperate continental with warm summers and cool winters
Altitude	113 m	36 m
Annual precipitation	595 mm/a	570 mm/a
Average temperature	18.1°C in July, -0.3°C in January	18°C in July, -1°C in January
Forest area in 2014	25.81 km² (7%)	163.64 km² (18.4%)
Area of public green spaces	93.65 m² per capita	37.84 m² per capita

The case study regions are situated in a lowland area and a rather small amount of forests and semi-natural area (7% in Leipzig and 18,4% in Berlin, see Table 1) around the two cities. In contrary to this indicator, Leipzig has a higher rate of public green space (93.65 m² per capita) in comparison to Berlin (37.84 m² per capita). The region has a temperate (Berlin) / humid (Leipzig) continental climate with an average annual precipitation ranging from 595 mm in Leipzig to 570 mm in Berlin. The average annual temperature is quiet similar in the both cities (near to 18 °C in July, -0...1-°C in January).

Contrary to the USA, the UK, the Netherlands, Germany still does not have generally applicable guidelines for the implementation of ecosystem services approaches for urban landscape planning [7]. However, the Saxonian city of Leipzig and the capital of Germany — city of Berlin are highly suited for this study because the governance structures of city development and nature protection often apply the principles of the urban ecosystems services concept as it will be shown in the paper.

MATERIAL AND METHODS

In general, the methodological approach considered here assumes recently developed conceptual frameworks in the literature on ecosystem services [11, 17, 18, 22]. In line with [14] this paper considers that adoption of ecosystem services as a type of assessment endpoint is intended to improve the value of risk assessment to environmental decision making, linking ecological risk to human well-being, and providing an improved means of communicating those risks. According to this approach [22], ecological risk assessment derived directly from the state of the ecosystem (e.g., biophysical structure and processes), and based on ecosystem services serve different purposes. The project includes the elaboration and testing of an interdisciplinary set of criteria and indicators, based on experiences from various European cities [8]. It comprises criteria to evaluate ecological and social issues regarding urban ecosystem services (and green spaces among them) and especially how they can contribute to mitigate environmental and health risks for urban population. The selection of indicators consists of those indicators for which data of the actual situation and potential of changes are available (e.g. secondary statistics data from regional Environmental and human health reports were verified during the field research and nature observation in the case study region). These indicators included: extensive and intensive land use and its change, use of urban green spaces; air, water and soil quality, measured by the possibility of contamination on the site; biodiversity characteristics (diversity of species, structural variety etc.); climate regulation services and cultural services (recreational potential, indicators of mental and physical health). Methodical approach used in this research were also adopted from [2] that established methods of environmental damage assessment for the purposes of human health analysis as the contamination of land presenting a significant risk to human health. Conceptual model of integrating ecosystem services with human health and well-being implemented in this research is based on research of [3, 7, 8, 9] and presented below (Fig. 1).

Methodically, both primary (field research, semi-structured interviews with citizens and experts, and participative observation in case study regions) and secondary (literature review, reports of City administrations, environmental and health statistics) sources were gathered. The information from secondary sources was verified during the field research in Leipzig and Berlin in 2013–2016 and supplemented by the semi-structured interviews with citizens and experts as well as questionnaire surveys on perception of public green spaces among urban population of Berlin and Leipzig.

RESULTS AND DISCUSSION

On-going transition in land use, air, water and soil pollution together with the global processes of climate change are resulting in more unpredictable weather patterns, sea-level rise and more frequent and extreme storms [5, 14]. In this context, the regulating services provided by ecosystems are critical for climate change adaptation and disaster risk reduction [2, 13]. Examples of these services include climate and water regulation, protection from natural hazards such as floods and avalanches, water and air purification, carbon sequestration, and disease and pest regulation [8, 11]. These services determine the central role of ecosystem management in climate change adaptation and disaster risk reduction as shown below. The results presented here are part of the research on the interaction between environmental hazards (e.g. heat waves — urban heat island, floods, and airborne pollutants) and urban population of Leipzig and Berlin. The major goal was to understand this relation by analysis of assessment of the impacts that these hazards have on citizens and urban landscapes areas.

URBAN HEAT EFFECT AND AIR POLLUTION

The phenomenon of urban heat island is characterised from [18] as a climatic feature for a city with 1 million people or more in that the annual (surface and air) temperature of the urban area can be 1-3°C warmer than the surrounding region. Some publications show the results of temperature difference up to 7°C [5, 6, 11, 21]. A great number of publications [9, 12, 15, 20, 22] illustrate that human health and well-being are negatively affected by rising outdoor temperatures describing direct effects such as heat cramps, heat edema (swelling), heat syncope (fainting) or heat exhaustion and heat stroke that can cause organ damage and death.

It is broadly recognized that the urban heat island has both a beneficial and a detrimental bioclimatic impact on human health [3, 9, 11, 22]. Thus, its positive side can be shown through a shortening of the winter frost season and a reduction of the number of heating days, in which air pollutant emissions decrease. In addition, the risk of cold-related illnesses and deaths through a shortening of cold winter period is reduced that we can observe in the last 10 years in both Leipzig and Berlin. However, such shortened frost seasons and milder winters have initiated an extension of the vegetation period and thus the pollen season, which have increased level of allergies and caused the changes in the allergen spectrum. Nevertheless, the urban overheating in the summer months has negative effects for the human organism when high air temperatures, low wind intensities and spatially diverse radiation conditions lead to heat stress also during daytime and nights in the summer. Heat waves are a special problem in cities of Berlin and Leipzig, as buildings and impervious areas heat up over days, store this heat and release it with a delay. Both cities distinguish themself with the outstanding mixture of developed and green areas through a mosaic of different micro-scale climates and thus large differences in the thermal conditions in a small space.

How can we effectively mitigate the urban heat island effect and air pollution in cities? Based on the concept of ecosystem services, green infrastructure in the form of shade trees can create a seasonal (up to three months in temperate zones) cooling effect and contribute to local climate regulation [20]. Green space (urban parks, squires etc.) can prevent the absorption of radiation by surfaces and the release of pollutants as well as cool the air through evapotranspiration. In the same time, the relative lack of green space (and water features) contributes to the urban heat island [3, 8]. Our results show the reduction of local temperature by urban green (especially in the form of trees) by 1.4-2.8°C in Leipzig and Berlin. It helps to minimize and prevent health issues associated with heat (e.g. blood pressure, cardio-vascular diseases, dehydration) but also other associated health problems such as skin cancer as tree shade directly protects individuals from UV radiation. Furthermore, the green spaces within the urban green infrastructure can reduce the transport of air pollutants to an urban centre worsened by urban heat island [20].

It is widely understood that urban green spaces have a natural ability not only to reduce local air and ground temperature but also to filter pollution from the air [3, 11, 18, 22].

The problem of ambient air pollution is of a great importance for both Berlin and Leipzig as tens of thousands of their citizens die prematurely each year due to acute air pollution and that high summer temperatures lead to increased illnesses, hospitalizations and deaths. Common air pollutants in Leipzig and Berlin include particulate matter (PM), sulphur dioxide (SO2), ground-level ozone (O3), nitrogen dioxide (NO2), and carbon monoxide (CO). There is correlation between high level of air pollution and reduced lung function that can worsen health problems such as asthma, chronic obstructive pulmonary disease and cardiovascular disease [1, 16, 20].

Urban vegetation in assemblages which fix filtered substances can improve the air quality by filtering particulate matter (PM10), nitrogen oxides (NO2) and sulphur dioxide (SO2). The study results show that green roofs in Berlin (together with brownfield reuse and villa densification) can reduce air pollution through PM10 up to 53% in compare to the city areas where roof greening not possible or not implemented. The finding of this research stated that on average the daytime air temperature of parks were an estimated 1–30C cooler than built-up (non-green) urban areas both of Leipzig and Berlin. The greening of streets in Berlin and Leipzig reduces the transport emissions up to 35%; green spaces (especially under trees) hold up to 60% of dust.

As the German population ages and extreme heat waves in both studied areas become more common across the country, urban green spaces can provide essential, natural protection. Thus, as a provider of livelihoods to healthy environments, urban green in Berlin and Leipzig contributes to reducing up to 25% of morbidity from respiratory diseases: citizens, especially children, from the districts with a higher

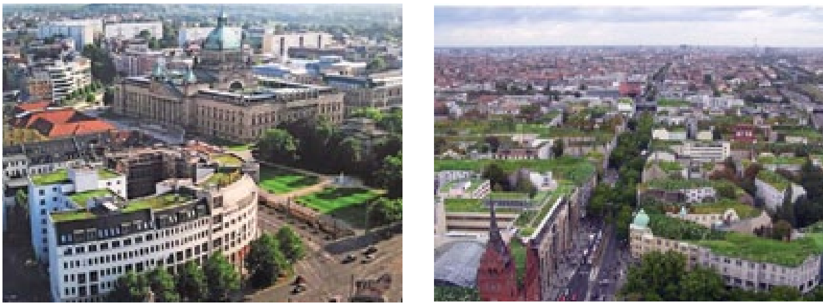

Fig. 2. Berlin: buildings with green roofs in Leizig (left) and Berlin (right)

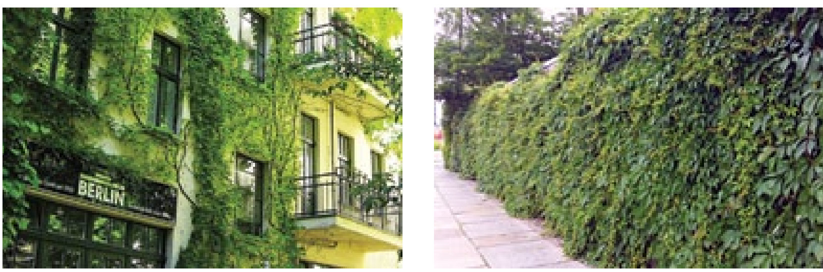

Fig. 3. Green walls in Berlin (left) and Leipzig (right)

rate of green area show a lower level of respiratory diseases — asthma, bronchitis — compared to their neighbours from green-poor districts. The results of our interviews with citizens of Berlin and Leipzig clearly show the therapeutic function of urban green for mental health (leading e.g. to stress reduction, operating as a source of inspiration) and its contribution to ecological education and sense of place among citizens.

The assessment of green infrastructure in Berlin and Leipzig has revealed that it was established not only as random mosaic of different green spaces but also as a whole complex of interconnected green infrastructure elements. Such elements include green corridors, roofs, ecological axes along city roads and river embankments and resource saving technologies. An increase in green areas in old city districts is surely restricted by the heritage status but cases from Leipzig and Berlin present it is also possible through the introduction of new technologies such as vertical and container gardening, greening roofs (Fig. 2) and walls (Fig. 3).

Green buildings (e.g. urban buildings with an exterior vegetated roof or wall) can greatly contribute to reduction of environmental and human health risks caused by heat stress and air pollution [3, 7]. While green roofs and walls may not be as effective as street trees in improving air quality, they are a useful alternative in areas where there is limited capacity for tree planting — especially in the city centers of the both case study areas.

Which effects it brings for the future city development, e.g. in the adaptation to the climate change? For example, the "living walls" (Fig. 3) provide local cooling and significantly reduce both wall surface and adjacent air temperatures. The results of this research being in line with [8, 20] show that during the warmest periods, air temperatures were 3°C cooler in the presence of the vegetated wall and surface temperatures behind the vegetation were as much as 9.9°C cooler than the brick wall in both Leipzig and Berlin, even though both walls were irrigated at the same rate. There is some evidence that green walls in street canyons are more effective than green roofs for mitigating in-canyon air pollution and may perform better than trees in areas where wind flow is reduced [3]. We have investigated the beneficial effects of plants of the green walls on the human well-being: 1) local cooling (air temperatures is 3°C cooler in the presence of the vegetated wall); 2) improved energy efficiency (up to 10-20%); 3) aesthetic improvements; 4) building structure protection (limit thermal fluctuations through additional level); 5) improved indoor air quality, reduced noise; 6) increased biodiversity; 7) marketing potential; 8) improved health (physiological and psychological benefits).

Solar panels on the city buildings (Fig. 4) can also reduce both global warming and urban heat island. The implementation of solar panels is good both for producing energy (and hence contributing to a decrease of greenhouse gas emissions) and for decreasing the urban heat island, especially in summer, when it can be a threat to health [7]. The studies of [3] have stated that in future climate conditions, solar panels would also help to decrease the demand of air-conditioning. Alongside with the other deployment of renewable energy systems, solar panels are one of the main adaptation strategies of living in city.

Fig. 4. Solar roofs in Berlin (left) and Leipzig (right)

FLOODING

Severe floods with devastating impacts on their citizens, economic activities and the environment affect Germany every year, and due to climate change are likely to become more frequent and devastating (Fig. 5). Major factors that increase flood damage refer to extreme weather events and changes in land use, especially increased concentration of assets in urbanized areas on floodplains or processes of deforestation. In addition, changes in the agricultural landscape, increased sealing of drainage basins through urbanization, and control work in river valleys (such as riverbed narrowing and straightening) have contributed to an increased threat of urban floods. Especially typical for urbanized areas are urban floods resulting from intensive rainfall that exceeds the capacity of urban sewage systems [1].

Situated at the intersection of three rivers (the Weisse Elster, Pleisse, Parte), Leipzig has always been vulnerable to danger of flooding. As consequences, 404 households were damaged by the flooding in 2002, more than 20.000 inhabitants were affected by flood in 2013, total economic damage costs were 11.6 (2002) and 15 billion Euro (2013) [1, 7].

To fight this danger, the river beds have been expanded and mechanical flood control and diversion systems have been installed. However, simply focusing on physical infrastructure was not enough to solve the problem of floods. A more efficient way of adapting can be developed through the ecosystem-based approach. Such approach was used in the framework of the above mentioned project conducted to-

Fig. 5. Flooding in Saxony in 2013: the railway line from Magdeburg to Leipzig was flooded (left), a resident stands at his property on a flooded street in Grimma by Leipzig (right)

gether with the department of landscape ecology of HU Berlin and the department of computational ecology of the Helmholtz center for environmental research. Flood risk assessment in the region of Leipzig was done, which focuses on conceptual and system dynamics modeling to mitigate urban flood issues (Flood Control Management in Leipzig). So, flood mitigation measures should be based on following pillars to keep damage levels as low as possible and to distribute the burden fairly: 1) integration of flood prevention into land use development; 2) green rivers — more space for rivers in their natural conditions; 3) "stretchable" flood plains; 4) connection of landscape protection and flood protection concepts; 5) no new buildings in flood prevention areas; 6) monitoring and modeling.

For purpose of technical flood protection, in Saxony over half a billion euro has been invested in technical flood protection since the catastrophic flooding of 2002. Approximately one billion euro is planned for concrete walls and dikes, etc., earmarked for investment by 2020. Throughout Germany, two thirds of the former floodplains have been lost to dikes and other flood protection measures. That is why natural flood protection by providing rivers with more space is of a great importance. First, it includes such measures as dike relocation that offers the opportunity of combining sustainable and modern flood protection with nature conservation objectives and hence of safeguarding resources for future generations [8]. Also the forest restoration and especially increase of diversity species can contribute to mitigate flood or consequences that will be caused by them: it was found that plants in communities with only one single plant species (monocultures) were less able to cope with flooding compared to plants grown in mixtures totalling 10–12 species.

Provision and control of the quantity and quality of water can be also fulfilled through urban green infrastructure [3]. Here, green infrastructure is important to water quantity for its ability to facilitate the recharge of groundwater stores and control surface runoff volumes. Green infrastructure supports water quality through its ability to filter pollutants that fall with the rain and also pollutants that are collected in surface runoff. Urban green infrastructure (especially forests) plays a major role in the hydrological cycle as it facilitates the infiltration and storage of water in soils and releases water back into the air through transpiration (e.g. the process by which water drawn out of the soil is released into the air through the process of plants "breathing") [7]. It is hoped that the Flood and Water Management Action Programs in Berlin and Leipzig will complement the management of flood risk with a mix of measures including increased implementation of the green infrastructure that supports the hydrological cycle and promote public health in the cities.

NOISE

In the European large towns and agglomerations such as Berlin and Leipzig the increasing during the last years, noise exposure together with poor air quality and intense traffic in urban areas contribute to low quality of life. To manage the situation, the Noise reduction plans (Action plan) were developed by Senate for urban development and the Environment in Berlin and the City Council of Leipzig that will be updated every 5 years [1, 16]. It based on European Environmental Noise Directive and reflects its implementation into German law. The goal of the noise action plans is to reduce environmental noise, i.e. the disturbances from noise outside buildings.

To the major health risks from exposure to noise in cities refer: 1) displeasure, discomfort; 2) lost of concentration or get tasks done; 3) sleep disturbance; 4) chronic stress; 5) cardiovascular diseases, including heart attack and stroke — extra 10 000 cases of prema-

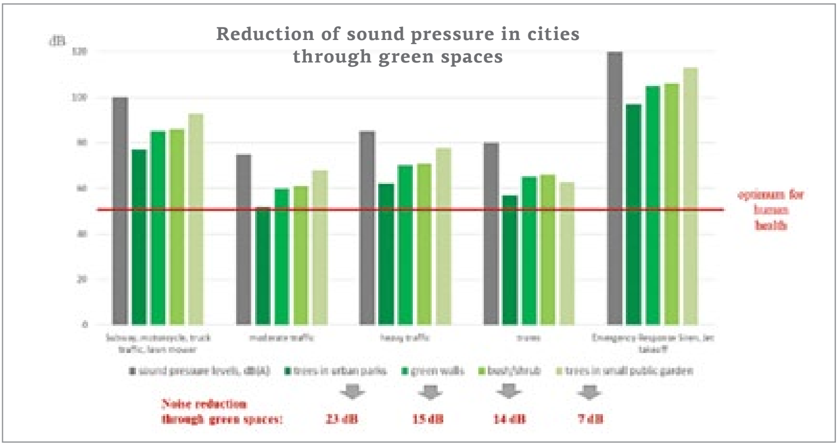

Fig. 6. Reduction of sound pressure in cities (cases from Leipzig and Berlin, average value) through green spaces

ture deaths each year [22]. Having in mind that noise reduction from planning to implementation is a long process taking years involving complex measures, the government of the both cities uses the scientific experiences from the different research projects. One of such projects was to analyse how the ecosystem services can contribute to solve a problem of urban noise. It was stated that vegetation can satisfactorily decrease a sound levels along highways. In forest site, a significant reduction was observed (of 15 dB) as opposed to grass-covered ground (fig. 6). It is important to underline that trees of urban parks have a maximum capacity to absorb acoustic pressure in the city up to 23 dB. It was stated, that the efficiency of tree barriers depends, not only on the expected acoustic results, but on other factors, such as safety, maintenance, aesthetics, cost and its acceptance by local communities. In addition, the combination of soil, plants and trapped layers of air within green wall systems can act as a sound insulation barrier. The research shows that green wall with a 10-12 cm substrate layer can reduce sound by 15 dB. This could be particularly important in areas of high noise pollution in Berlin and Leipzig such in the approaches to airports, as these levels are sufficient to provide noise insulation to buildings under aircraft flight paths.

OTHER THREATS TO HUMAN HEALTH AND WELL-BEING AND HOW URBAN GREEN CAN CONTRIBUTE

The previous paragraphs have shown how urban risks from land use change, air pollution, noise, heat stress, flood impact to human health of citizens in Berlin and Leipzig can be reduced through urban greenery. This study suggests that contact with the natural environment could protect people from becoming sensitised to allergens, by building up the human immune system. If contact with biodiversity-rich environments can help reduce sensitivity to allergens and boost immunological tolerance in general, this could have significant implications for urban planning, environmental protection and health policies. In addition, asthma reduction and immunity increase refer to the most important benefits from urban green [9, 10].

Thus, linear parks and open spaces make compact living attractive and viable. Trail networks link individual parks, making them easier to bike and walk. For instance, old rail lines in Berlin and Leipzig were transformed into greenways, and gardens planted on rooftops maximise limited space and contribute to recreational services. In last two decades, governments of Berlin and Leipzig began a program to convert vacant lots into publicly accessible green spaces. The study shows that greater access to green is associated by citizens of Leipzig and Berlin with less depression, provide mental restoration and some evidence of a positive benefit of a walk or run in a natural environment in comparison to a synthetic environment. The questionnaire surveys conducted in urban parks of Leipzig and Berlin has revealed that living closer to urban green spaces, such as parks, is associated with lower mental distress. The results of our interviews with citizens of both cities clearly show the therapeutic and recreational functions of urban green for other aspects of mental health such as a source of inspiration and its contribution to ecological education and sense of place among citizens.

CONCLUSIONS

The research has shown how ecosystem services can address many of the challenges that cities increasingly face, and what kind of environmental and human health risks and in which way can be manage through the concept of ecosystem services. Air pollution (especially from industry and transport), climate change effects (e.g. urban heat island) according with such natural hazards as flooding, forest fire are all highly relevant to human development in cities, and many indicators of human health and well-being are caused or exacerbated by a lack of access to the ecosystem services of a good quality. Illustrated on the cities of Berlin and Leipzig, it shows the negative externalities of urban growth resulted in large amounts of emissions and other negative consequences of pollution (such as noise) and different consequences for human health of urban population. In this research, the role of natural (green) areas in reducing of environmental and human health risks as well as supporting of healthy life is linked with such ecosystem services such as air purification, temperature regulation, groundwater recharge, and cultural services including health improvement, aesthetics and recreation, all leading to healthier lifestyles.

Three dimensions of integrating urban ES and quality of life were analysed: ecological — moderate the impact of human activities by absorbing pollutants and releasing oxygen, improve the urban climate and maintain the balance of the city's natural urban environment, emphasize the (bio)diversity of urban areas; economic — might deliver products and create an increase in the economic value of an area as well as in the value of real estate; social — contribute to physical and mental health, can embrace a wide range of human activities, help to foster active lifestyles, play an important role in the basic education of citizens with regard to the environment and nature. The study results present a high environmental activity of citizens in Berlin and Leipzig. These cities are known for pioneer uses on vacant lots, like the community gardens, and also for protests and resistance against development plans, with some non-governmental groups being active for decades. Organised protest groups have been successful in conserving vacant inner-city areas.

The cases from Leipzig and Berlin show that the implementation of low impact design principles in urban green management can be a good strategy since it takes into account the character of the local plant communities; it contributes to the creation of biologically sustainable and pollution resistant ecosystems [8]. There are good examples from study region such as the greening roofs and facades, implementation of resource saving technologies (solar roofs). Additionally, a direct involvement of local residents into the landscape design, creation and maintenance of green spaces can contribute to a sustainable co-development of the city and an increase in public responsibility, vandalism reduction and social interest in maintaining and improving the quality of the urban area and its citizens.

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SPECIAL SESSION II
"Attractions and risks at the Baikal region"

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The complex geographical expeditions in the Republic of Buryatia

INTRODUCTION

Complex geographical expeditions have been carried out in the Republic of Buryatia by the students and teachers of the Faculty of Geography of the Lomonosov Moscow State University since 2012. The following areas have been studied: Severobaikalsky, Barguzinsky, Tarbagataisky and Pribaikalsky districts of the Republic of Buryatia (Fig.1).

In the Baikal region there is difficult environmental, economic and social situation associated, on the one hand, with the protection of the Baikal natural territory, Lake Baikal as the World Natural Heritage, and, on the other hand, with the need to conduct economic activity in the region. Our researching was aimed at identifying ways to optimize nature management of the study areas through integrated approach.

METHODOLOGY

The integrated approach includes the research of different aspects of nature management. First, the study of nature, including topo-

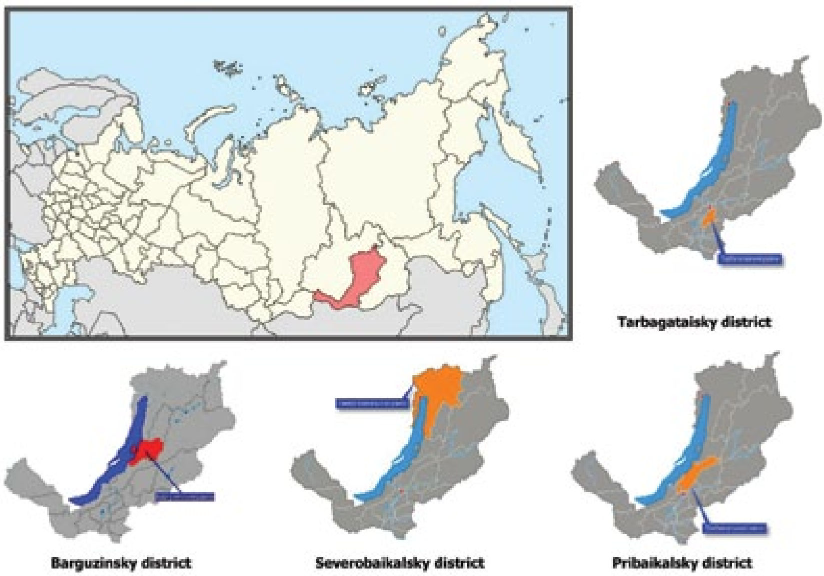

Fig. 1. Location of the research areas

nymic research in the context of a comprehensive study of nature management as a system (nature, culture, history, economic activity). Second, sociological studies on the socio-economic situation in the various administrative districts of the Republic of Buryatia. Thirdly, we conducted geoecological studies in some areas. And finally we studied the recreational potential of the territory.

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STUDIES OF NATURE MANAGEMENT AND TOPONYMICAL RESEARCH

To study the history of human activity and contemporary nature management the toponymic research was carried out. The analysis of the data obtained (about 1000 toponyms were analyzed and systemized) helped to create the toponymic dictionary. The analysis shows that the largest number of toponyms have Russian origins, much less the Buryat and Evenk toponyms, although the Evenki were the first habitants of these vast territories. But later they were driven away by people of other nationalities. This is especially true of the taiga (the Evenki were mostly hunters). The Buryats preferred to settle in steppe areas (they were nomadic, herders). Almost all the geographical names have been renamed when Russian people came, gradually displacing the Evenki from here.

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. The map reflects the natural features of the area, fishing grounds, fishing and hunting objects and crafts, objects of natural and cultural heritage, etc. The analysis of the map shows that primarily the resource-fishing and traditional types of nature management continues to grow in the area, 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) which is the second largest ethnic Russian group in Buryatia. The Semeiskiye belong to the unique Russian culture which developed under specific conditions that never repeated in other Russian ethnicities [1].

SOCIOLOGICAL STUDIES

Sociological studies serve as a link between theoretical research and reality. To conduct a poll, a questionnaire was developed for people of different target groups.

The aim of the survey was assessing the prospects for the development of the region and the development of the Republic of Burya-

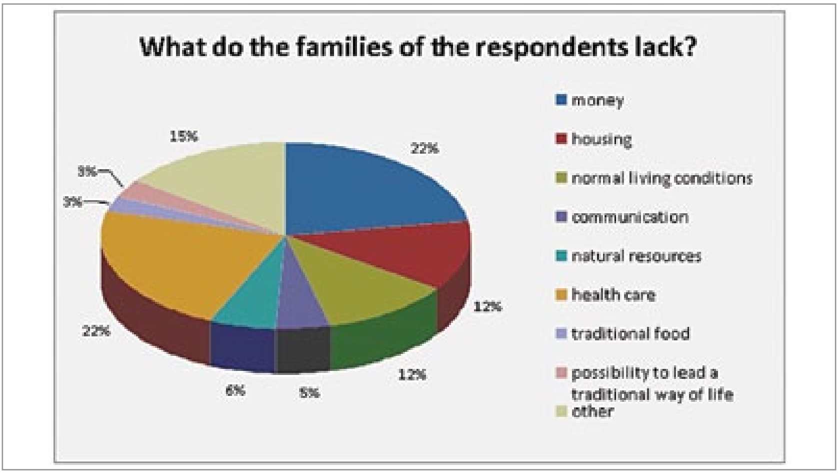

Fig. 2. Location of the research areas

tia in general from the point of view of the local population. We were interested in the following points: 1) how the locals assess the situation in Buryatia; 2) in what the locals see the development of their region; 3) if the locals are aware about the prospects of development of the area and whether they have a desire to participate in decisions about its future development; 4) whether local people want to preserve the natural environment, traditional industries; 5) what the local people think about the prospects of tourism development and whether they are ready to work in this field. The data was interpreted and displayed in the form of diagrams (Fig.2).

The majority of local people favors the possible development of traditional industries, tourism and recreational activities and are ready to contribute to it. The locals are not indifferent to their land, as well as to their future. They care about preserving the nature of their area. Most of them are going to continue staying on their native land, and for them it is essential that their opinions should be taken into account when making decisions about future development of the region.

On the other hand the limitation of predatory nature use, preservation of a large part of the territory for future generations controlled by its recreational use with all the natural resources, the adoption of "transparent" decisions on the development of natural resources from the part of managers, their willingness to establish contact and to listen to public opinion could become the basis for the beginning of the process of environmental planning and management in the region [2].

GEOECOLOGICAL STUDIES

One of the most important aspects of research in the study area was the study of contemporary environmental situation in order to assess the prospects for the development of recreational activities. Investigations were carried out on the example of a number of model sites, one of which was a recreational area of Lake Kotokel. The lake belongs to the basin of Lake Baikal, and is the third largest body of water in the basin of Lake Baikal and in the whole Zabaikalye. The lake and its surroundings can be used for public recreation and year-round health resort treatment (balneotherapy). However, after the 2008-2009 Lake Kotokel largely lost not only fishery, but also recreational value due to the sharp deterioration of the ecological state of the aquatic ecosystem of the lake. All recreational facilities on the lake were closed, fishing, swimming, water usage in household purposes was banned.

Fig. 3. Factual data map on Lake Kotokel

Hydrochemical research was carried out to estimate the current ecological status of Lake Kotokel and its suburbs (Fig. 3).

The contamination on some indicators was observed. Analysis of the quality of water in wells and boreholes of coastal settlements used for drinking and domestic purposes was

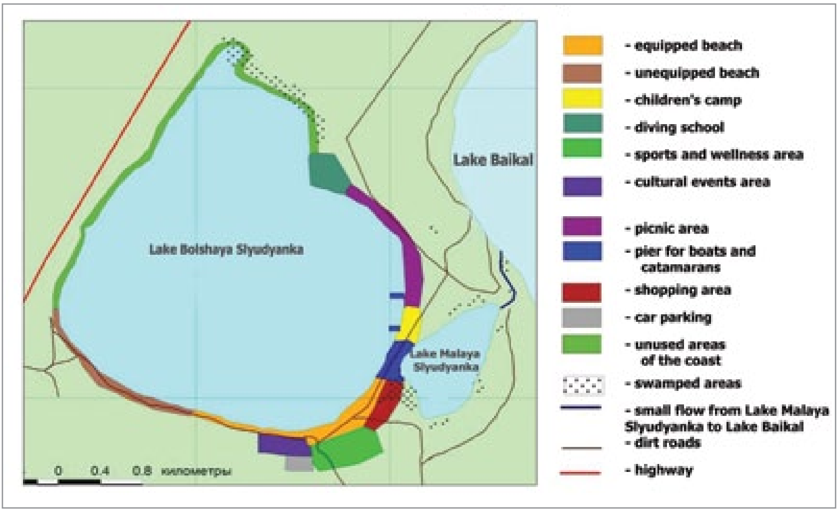

Fig. 4. Modern recreational use of Sludyanskiye Lakes

made. The sources of drinking water in coastal settlements are of serious concern, where the water quality does not meet sanitary standards. Thus, the current ecological status of the lake requires the adoption of measures for its further purification, artificial reproduction and the introduction of valuable fish species, rehabilitation of recreational infrastructure, and improvement of drinking water sources. Only comprehensive measures in conjunction with constant control of the environmental situation of the lake can help restore its recreational attractiveness in the whole Baikal region. The hydrochemical network was established to continue the geoecological monitoring at the locations of recreational facilities and prospective tourist routes [3].

STUDIES OF RECREATIONAL POTENTIAL

Within Baikal Natural Territory there are many other small lakes that attract attention of both local residents and international visitors. Currently, these small lakes are the objects of recreation, boating, recreational fishing and family rest with children. They attract the tourists' attention by warmer water, more convenient beaches and bays, equipped camps on their banks, and others.

However, active recreation on small lakes are often located too close to the shoreline of Lake Baikal and can become a source of negative effects on the ecosystem of Lake Baikal. Moreover, it causes environmental damage not only to terrestrial and aquatic complexes of recreational areas around the lakes, but also creates serious problems for the recreants themselves and even in some cases can lead to health problems [4].

During the expeditions two of these lakes situated neat Lake Baikal in the Severobaikalsky district have been studied: Bolshaya Slyudyanka and Malaya Slyudyanka. Landscape profiling has been carried out on Bolshaya Slyudyanka Lake, where several areas of the coastal zone have been distinguished (different in character of their use and accordingly in the degree of their recreational load): 1) zone of equipped beach with a maximum recreational load, 2) zone of "wild" unequipped beach, 3) background landscape with minimal disruption in the northern part of the lake (Fig.4).

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.

ACKNOWLEDGEMENTS

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Climatic changes and environmental risks of nature management at the Baikal region

INTRODUCTION

There are marked evident climatic changes in the Southern Siberia, including the Baikal region. Based on the analysis of climatic data obtained from meteorological stations of Republic Buryatia for 1970–2015 years period, temperature's trends and rainfall's changes have been detected in different regions of the Republic (Fig.1). The global warming trend, the amount of precipitation decreasing, the climatic parameters annual amplitude increase and the growth of climate continentality are stated.

Trend's analysis shows the growth of average annual temperatures during the period by 1–1.5° C for majority of the stations. And also there is a decrease in average annual rainfall from 30 to 100 mm, while maintaining or slightly increasing on the other stations. This causes the evaporation increase and a reduction of flow-surface, and with the increase of water intake for the Angara GES cascade it results in reducing of the lake Baikal level.

The increase of summer temperatures, accompanied by abnormally hot and dry summers, contributes to increasing fire risk in the region. The evident correlation between annual and summer temperatures trends and growth of fires' number, square and duration is stated for discussed period.

The dynamics of climatic indices affects on the productivity of agriculture also. Decreased crop productivity in some regions of the country is closely related on the one hand with general decline in the agrotechnical level and on the other hand with the growing climate aridization.

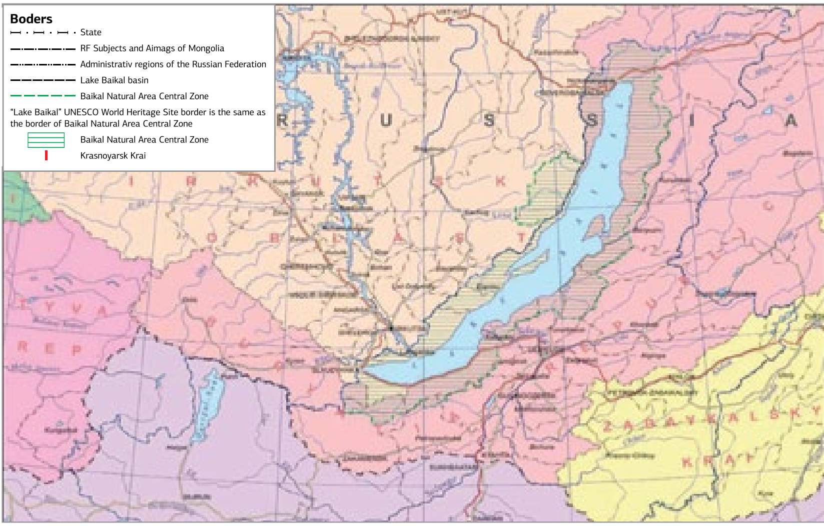

Fig. 2. Data of meteorological stations of the Republic of Buryatia

In general, climate change has an impact on the whole complex of natural resources management, and this factor should be considered for the development strategy of the Baikal region.

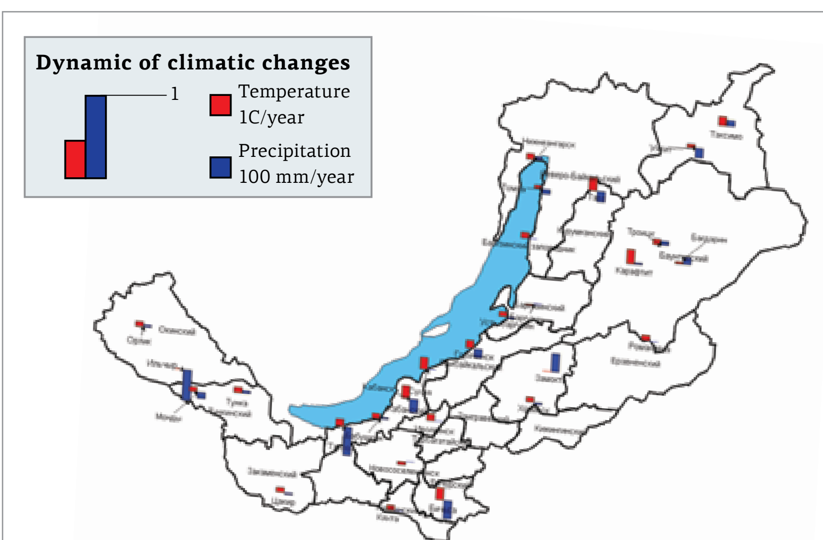

Fig. 2. Data of meteorological stations of the Republic of Buryatia

MATERIALS AND METHODS

Analysis of climate changes within the Republic of Buryatia area was fulfilled on the base of meteorological data obtained from 29 regional weather stations (Fig. 2). We have used the databases of the National Oceanic and Atmospheric Administration (*http://gis.ncdc.noaa.gov*), All-Russian Research Institute of Hydrometeorological Information FGBU "RIHMI-WDC" (*http://meteo.ru*).

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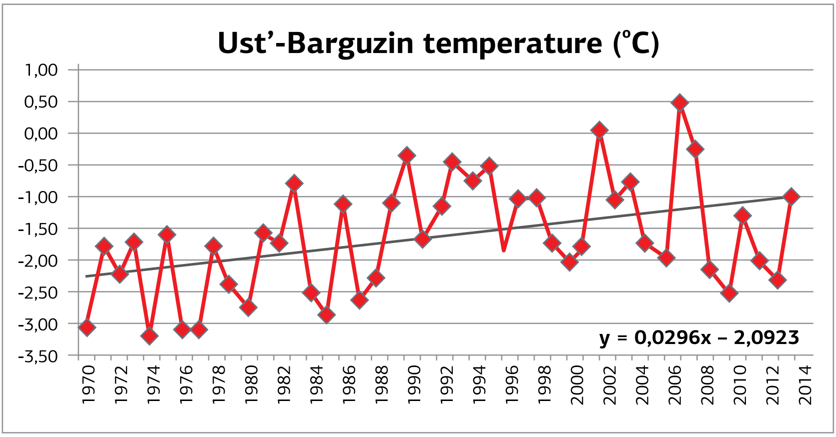
The values of annual, average summer and average winter temperatures as well as values of the annual, average summer and average winter precipitation for 1970–2015 years period were treated. Average monthly climatic parameters were estimated according to their daily values. Average annual values were calculated by the monthly average values for each station. At the base of average annual and seasonal temperature and precipitation values the linear trends graphs have been constructed for all weather stations, while each of them had corresponding trend lines' equations.

In order to analyze the fire risk due to climate changes, as well as the dynamics of the Lake Baikal level and the Selenga River runoff, the statistics and graph materials from the Baikal Institute of Nature Management, the data of the *http://fires.kosmosnimki.ru* site, the reports the RF Ministry of Natural Resources and Environment and reports of the Ministry of Natural Resources and Environment of the Republic of Buryatia were used [3,7]. Correlation analysis methods have been applied in order to reveal the degree of correlation between the climatic indicators dynamics, fire risks and runoff changes.



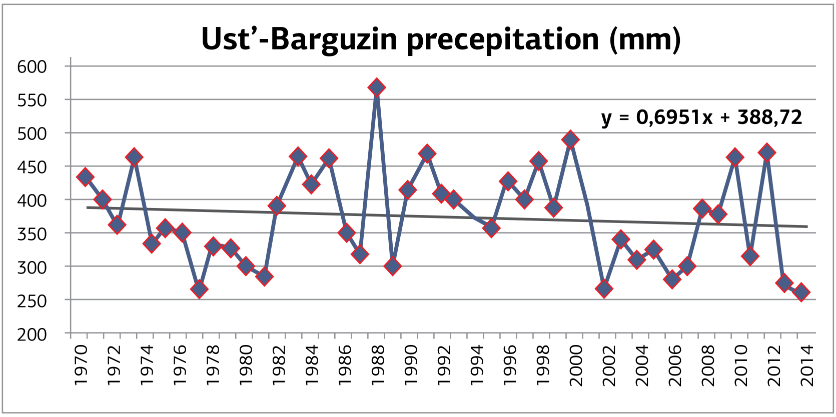


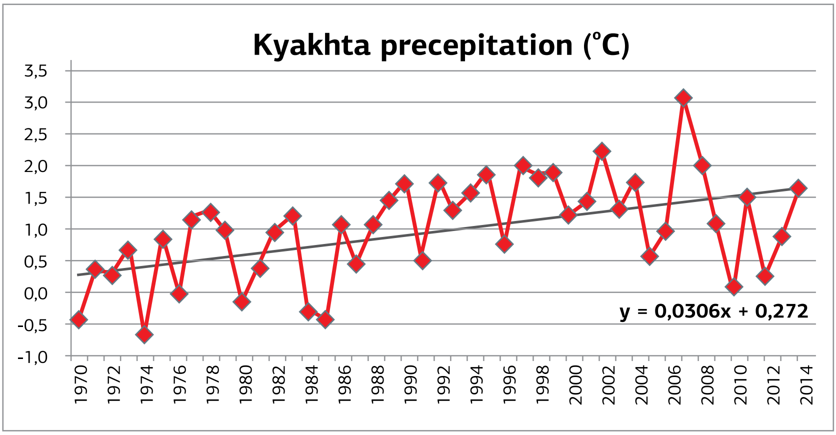
Fig. 3. Linear trends of meteorological data for the Ust'-Barguzin station for 1970-2014 years

RESULTS

The evaluation of climatic parameters dynamics have shown the growth of average annual temperatures by more than 1 degree for 45 years for the majority of the stations and more than 2 degrees increase for 6 stations (Kabansk, Goryachinsk, Suhaya, Taza, Khorinsk, Karaftit) during 45-years period.

The maximal linear increments of average annual temperature was observed in Kurumkansky (Taza station) and Khorinsky (Khorinsk station) districts, they are 3.0°C and 2.8°C respectively.

The precipitation values are slightly declined or constant for most part of stations. The maximal decrease of precipitation was observed



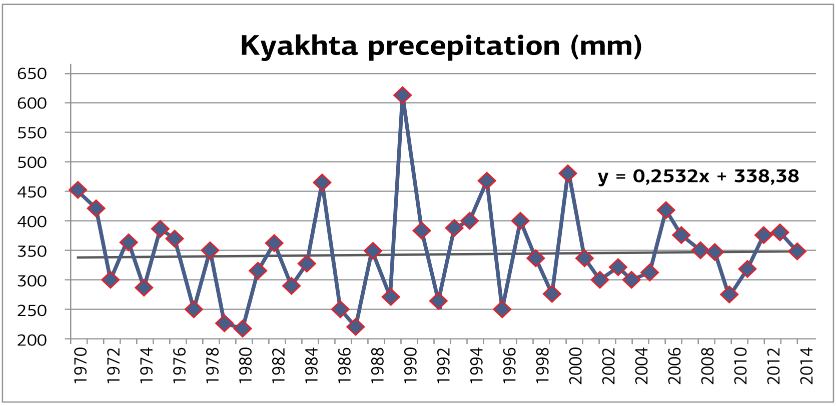


Fig. 4. Linear trends of meteorological data for the station Kyakhta for 1970-2014 years

in the southern regions, for example, 27.5 mm, or –0.8 mm / per year was observed in Bichursky district. By contrast in the northern taiga area (Nizhneangarsk) a slight increase in 36 mm or 0.01 mm per year was observed. Figures 3 and 4 show the temperature and precipitation linear trends for two typical stations (Ust-Barguzin station in Barguzin river valley, and Kyakhta station in the southern dry steppe dist rict).

It should be noted that in comparison with the European part of Russia, where the average annual temperature growth is due to winter temperatures growth mainly; there is observed the increase both winter and summer temperatures in the Baikal region[4,6]. The seasonal temperature trends at the station Khorinsk are presented in Figure 5.

Analysis of the seasonal temperature dynamics has detected the maximal increase of summer temperatures in the steppe and dry steppe areas, as well as in the northern taiga. The Baikal lake brings a softening, smoothing effect on the dynamics of seasonal temperatures. The Baikal districts are distinguished by relatively small increase of winter and summer temperatures, they consist 2,15° C or 0.05° C per year and 3.15°C or 0.07°C per year, respectively.

Other patterns are revealed in the precipitation distribution. There has been revealed a steady growth in the northern and mountainous areas (Muya, Severobaikalsk, Okinsky), while there is marked a significant decreasing in more cultivated steppe, dry steppe and suburban areas. For example Khorinsky area is characterized by reducing amount of summer precipitation by 33 mm

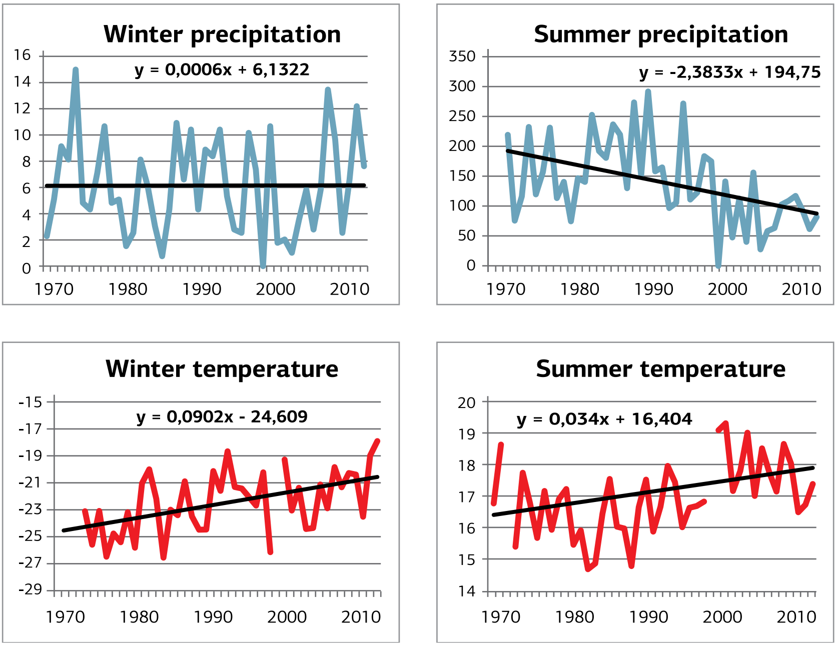


Fig. 5. Meteorological data for the station Khorinsk for 1970-2014 years

during the study period, while winter precipitation amount remains at the same level.

In general for the Republic of Buryatia, the zone with maximal and steady increasing surface air temperatures and decreasing precipitation was distinguished for the study period. This zone includes all steppe and dry steppe areas of the central and southern part of the country located in the Selenga River Basin.

Global warming in terms of increased summer temperatures and decreasing rainfall directly affects the growth of fire risk in the region. The cycle of these disasters has been revealed during the observed period. On the average, large fires appear across the whole region once per 12–13 years, but recently the cycles become more frequent. On the average, every year fires cover about 34 thousand ha but this value has increased twice for last 10 years. Observed steady increase both of fires' number and fires' area presents clear evidence of climate changes in the region. The most severe fires had appeared in 2014 and 2015, when higher summer temperatures and minimal summer precipitation had been fixed. The forest area burnt during these two years, is more than for 30 years before. While on one hand, the number of fires is largely connected with anthropogenic factor, but the fires' duration and area is closely correlated with summer temperatures and precipitation and their dynamics (Fig.6).

At present, the scientific and economic communities, the regional authorities and local people are concerned on fluctuation of the lake Baikal level and its critical values. The problem is associated mainly with the energy industry on the Angara river. This factor, however, is may be regulated by political and economic mechanisms. But the lake level dependence on natural and climatic factors presents more difficult and serious problem.

The level regime of the Lake Baikal has two periods - a natural mode (until 1958) and regulated — since 1958. The long-term lake level increased by 0.82 m under the HPP exploitation, with the highest level increasing by 0.33 m and the lowest — by 0.3m, while over-regulation have affected the oscillation amplitude which increased from 93 cm to 99 cm. Now the minimum acceptable level of water in the lake is 455.54 m.

SESSION 4
"Nature and environmental risks and policies"

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Environmental policy in Russia and education

INTRODUCTION

A holistic, systemic environmental policy has become a reality of the public administration in Russia (then the USSR) since 1972. In many respects it was a reaction to the results of the Stockholm UN Conference on the Environment (June 1972). Initially, the mission of environmental policy in the country was the protection of nature and the rational use of natural resources. After the United Nations World Conference on Environment and Development (Rio de Janeiro, Brazil, 1992), the mission of environmental policy was linked to the objectives of the concept of sustainable development, supported at the state level.

It is of fundamental importance that education has always been seen as a necessary condition for successful environmental policy. Thus, one of the provisions of the Stockholm Declaration clearly defines "Environmental education is necessary". It was this position that was actively perceived in the USSR as a guide to action. As a result, the world's first international conference on environmental education was held in the country.

In 1977, UNESCO and UNEP on behalf of the United Nations held the First World Intergovernmental Conference on Environmental

Education in Tbilisi. This conference was the most important event, symbolizing the fifth anniversary of the Stockholm Declaration, a historical document that laid the foundation for the reorientation of the world community from spontaneous uncoordinated development to planning for the optimal future of mankind. The Tbilisi Declaration laid the foundation for the development of environmental education, which, to a large extent, facilitated the timely preparation of the population in our country for the implementation in everyday life of new principles consistent with the modern concept of sustainable human development

Progress towards sustainable development helps to objectively identify existing environmental constraints on economic development and to make society adapt to such constraints. Implementation of sustainable development principles, supported by government, can enable a new stage of the 'greening' of education — a radical modernization of the education system by linking environmental issues to all of the subjects taught in secondary schools and universities. The development of environmental culture among the general public is to be achieved using the potential offered by both formal and non-formal education.

EDUCATION AND EDUCATION FOR SUSTAINABLE DEVELOPMENT

The idea that education is a driver of change for the better future is not a new one. In one form or another it has been recognized by different countries and cultural communities. In European culture values of education entered the number of the spiritual priorities in antiquity. According to contemporaries, Socrates believed that knowledge is virtue. Whereas, Decartes, the greatest philosopher of the middle ages, declared that knowledge is power. This idea was vividly reflected in the 20-th century, including in our country.

Successful cultural revolutions of the 20-th century have shown that development of education is a sine qua non for progress almost everywhere in the world — both in the West and in the East. Education has become a universal and virtually irreplaceable tool for social progress. It is natural, that by adopting in 1992 the Concept of Sustainable Development as a global paradigm, humanity defined education as a prerequisite for its achievement.

Later it became clear that only political declaration was not enough. And if the role of education is really so significant, it should have much bigger political support. It is not surprising, that the proposal of extending such support and enhancing the status of education in a global context was made by Japan — the country that fully enjoyed the beneficial effects of the educational revolution in the Meiji period, which literally means "enlightened rule". It was in this period, as we know, that emerged the logo — "study and work day and night." This national idea for state development allowed to overcome its feudal backwardness and to become one of the world leading countries.

It is symptomatic that after the passing away of Emperor Meiji, the significance of this principle, emerged during his reign, was not weakened, but also significantly increased. In modern language, this principle and the policies which are based on it, effectively contributed to sustainable development of the country, fully confirming the universal nature of education as a factor of progress. We can assume that, in 2002, this has prompted the Japanese government to address the United Nations, launching a long-term global initiative in support of education for sustainable development (ESD). This initiative was enthusiastically backed by UNESCO and the international community at large. The period from 2005 to 2014 was declared the UN Decade of Education for Sustainable Development (DESD), Japan becoming its main sponsor, and UNESCO was designated as its executive agency (5).

Japan was real leader in DESD whose authority as the world humanitarian leader has increased significantly. It is therefore quite natural, that the final conference of the DESD was scheduled in this country. It was held on 10 to 12 November 2015 in Nagoya, one of Japan's largest cities, the provincial capital of Aichi, pronounced features of the national model of sustainable development.

The conference was the highlight of educational policy at the international level. It may have great impact on educational policies at the national level. Participation of the world leading experts in education, just as thorough preparation by Japan and international structures have been major factors in the success of the conference. Despite certain difficulties, the conference was able to meet the challenges, the most important of which was the assessment of the current state of education in the world and its mobilization to address the problems of transition to sustainable development.

The conference adopted the Nagoya Declaration, aimed at strengthening of the role of ESD, as a major universal tool for sustainable development in the world, and endorsed the UNESCO Roadmap of the Global Action Programme for ESD. The mainstreaming of ESD in the international agenda, as one of the most important areas of global policy for sustainable development as put forth by the World Summit Rio + 20 is the main informal result of the meeting in Nagoya. Further integration of the global educational community based on the understanding of its responsibility in the face of global challenges of our time and the perception of growing support from political stakeholders and the world community is the other outcome of the forum.

The final document of Nagoya conference was unanimously supported which means that the international community sees no obvious alternatives of ESD, just as the Rio + 20 saw no alternatives of sustainable development. Integration of the DESD into national development strategies will open up new opportunities to make the future we want possible (2, 6).

SUSTAINABILITY: RUSSIAN POTENTIAL

In recent years, the Russian political leadership has cited the principles of sustainable development with increasing frequency. As Vladimir Putin said in a speech on August 1, 2009: '…nearly all developed countries now live by the logic of sustainable development.' The speech, effectively called for greater inclusion of this logic in Russian political, economic and social practice. But the decisions, which are taken using this logic, must take account of Russia's specifics and exploit the achievements of Russian science, which are still far from being used to the full.

The concept of sustainable development, as it exists today, is justifiably viewed worldwide as an interdisciplinary approach for addressing the most complex challenges, which society faces. As well as its large economic content, sustainable development also concerns geography and social ecology (which is closely related to geography). The development in Russia of an original concept of rational environmental management was a major and datable step forward in Russian science, signaling the appearance of a new scientific field — the geography of development, — which objectively supplements development economics (or the economics of sustainable development, as it is otherwise known).

The outstanding Soviet scientist, David L. Armand (geographer, landscape scientist and conservationist) can be considered to be an originator of the concept of rational environmental management thanks to his book, published in 1964 by Mysl publishing house under the highly significant title For Us and Our Grandchildren. The book was to be for Soviet readers what the book by the Swiss author, Jean Dorst, Before Nature Dies would be for western readers. For Us and Our Grandchildren gave the first detailed exposition in Russian of the modern scientific approach to the use of natural resources, which treats them as crucial and eternal sources of value for human society. In effect, it was a manifesto for rational management of natural resources, offered to society as an alternative to the wastage and neglect of the treasures of nature, which had become widespread at the time.

The affinity between the ideas and content of the Western concept of sustainable development and the Russian concept of rational environmental management is unsurprising, since both concepts reflect the movement of civilization towards greater equity and responsibility for the future. So the ideology of sustainable development has continuity with approaches that are already well-known in Russia, although not fully implemented, and the ideology is not alien to the traditions of domestic environmental management and to the Russian national mentality. It is also important to note that the concept of rational environmental management was not a completely new invention of its main ideologues, but expressed continuity with the classical ideas of the 'socialization of nature', which are themselves consonant with the environmental traditions of the peoples of Russia as a kind of our common national intangible heritage. This point offers a strong basis for the ideology of sustainable development in Russia (1, 3).

NEW CHALLENGES AND GLOBAL DEVELOPMENT

The world is finding a new way of living with technology, where qualitative characteristics will depend largely on new approaches to natural resource use. The world is entering into a new technological order, where qualitative characteristics will be largely determined by the technology of the "new environmental management". These are more needed now than ever before as the inevitability of 'greening' of the economy (a move away from the moribund 'grey' economy) becomes increasingly apparent. Humanity seems to have no other option but to make the economy and ways of life conform to environmental criteria. There is no alternative to the green economy.

The new global development paradigm requires observance of natural 'limits to growth', adapting our social and economic parameters to the conditions of the environment. Finding a solution to this unprecedentedly complex problem is only possible by making science serve the goals of sustainable development. Academic and applied science in Russia is aware of its responsibility to ensure technological breakthrough to a sustainable future. But that will require dozens and possibly hundreds of Russian research centers and much greater state support for science and education than is now available.

Genuine changeover to a 'green' economy in Russia requires real adoption of environmental criteria in industry, for which Russia is essentially ready, having a system for the training of specialists in this field already in place. But more is needed to make the transition to sustainable development not only in word but indeed. Experience of recent decades shows that Russia's attempts to travel the path of sustainable development have been unsuccessful and the country has actually been wasting time. The main reason for this must be the inability of the crucial part of the country's leaders to understand it and make such a transition.

Until now, leaders in many spheres of Russian life have had a fairly abstract or even a distorted picture of what 'sustainable development' means, including its environmental component. In a country where, as ever, formal leaders decide everything, they are continuing to do so without taking into account of the urgent need for transition to sustainable development. The requirements of social justice, social responsibility and environmental culture are viewed as pleasantries, and not priorities that need to become a part of our living arrangements.

In this situation the only way to achieve radical change for the better is to appoint people with adequate knowledge, skills and competence in the field of sustainable development to positions of responsibility at all levels and in all spheres of life, and this is only possible by means of appropriate modern educational technologies However, the extent of the new educational paradigm in Russia can and should be much greater, reflecting the processes and phenomena that can be observed in other parts of the world.

CONCLUSION

The historic summit in Rio de Janeiro in 1992 set out an Agenda for the 21st Century, which identified a wide range of strategies to achieve sustainability, including a key role for education. It was hoped that national governments would review the state of environmental education situation in their respective countries and strengthen their support for it at all levels. Work is indeed underway around the world to put ESD systems in place. In developed countries, it has led to impressive development of the institutional framework and the provision of government support. This experience is of interest to Russia. But while creative borrowing of foreign experience can prove valuable, it is also necessary to fully utilize domestic potential in the respective fields.

A global project for ESD represents a unique opportunity to raise the status of education as a civilizing institution. It also offers a real chance to demonstrate the potential of science to modern society, and to introduce environmental culture as a vital element in the system of knowledge and skills that can ensure the genuine stability and well-being of society.

The ongoing discussion of how to establish ESD in Russia is occurring in a post-crisis context, and it creates many new challenges for our society. But that in no way detracts from the urgency of such improvements to education. The words of the famous Russian scientist and humanist, Academician Vladimir Vernadsky, are more relevant now than ever: ‘Russia’s salvation depends on the expansion of education and knowledge.’ (4). We, his descendants, can see ever more clearly that the same precept is the road to salvation, not only for Russia but for the whole world. There is nothing available to us in today’s society, which is better suited for addressing crises and achieving sustainability, than ‘the expansion of education and knowledge.’ And this is true not only with respect to economic crises, but also to environmental and social crises, which represent even greater challenges for humanity.

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Land-lake-atmosphere interaction under global climate change and regional landuse change over a large tropical lake and its vicinities: case study in Cambodia

I would like to introduce my research work at the environs of the Tonle Sap Lake in Cambodia and its implication to a potential research activity on the Lake Baikal area in Russia.

TONLE SAP LAKE IN CAMBODIA

The target area of this study is the Tonle Sap Lake. This lake is located in Cambodia, in the lower Mekong River Basin in the Indochina Peninsula. Due to the existence of distinct rainy and dry seasons under the tropical monsoon climate, the water level of the Mekong River experiences a large seasonal change and the reverse flow at the Tonle Sap River occurs during the high-water season of the Mekong River. The Tonle Sap Lake usually drains its water to the lower Mekong River through the Tonle Sap River, but during the reverse flow season of the Tonle Sap River (i.e. the rainy season), the river water of the Mekong flows into the lake and it makes the lake expanded with inundation water. As a result, the lake area changes from approximately 2,500km2 at the end of the dry season to 15,000 km2 at the end of the rainy season. The maximum lake size is about half of the Lake Baikal in Russia, and it is more than 20 times as large as the Lake Biwa, the largest lake of Japan.

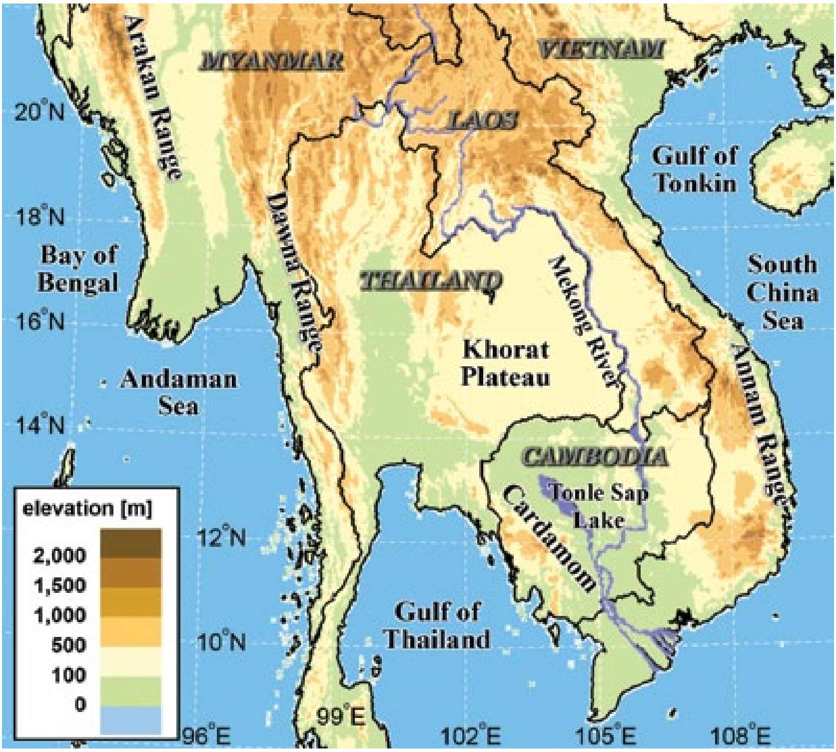

Fig. 1. Map of the study area

RESEARCH MOTIVATION

The inundation area of the lake is mainly used as paddy fields. Among surrounding areas of the lake, the western plain is the most agriculturally productive area in Cambodia and known as "Cambodian rice bowl". In the western area, characteristic local rainfalls have been recognized by the author's study [Tsujimoto and Koike, 2012]. Although this area is under tropical monsoon climate with distinct rainy and dry seasons, at western Cambodia, rainfall continues at the post-monsoon season (i.e., the beginning of the dry season) at nighttime and early morning.

I have been investigating the characteristics and the mechanisms of this local rainfall in order to contribute to consider a productive, sustainable, and holistic agricultural land management under changing environment and growing economy with globalization. In addition to the cli-

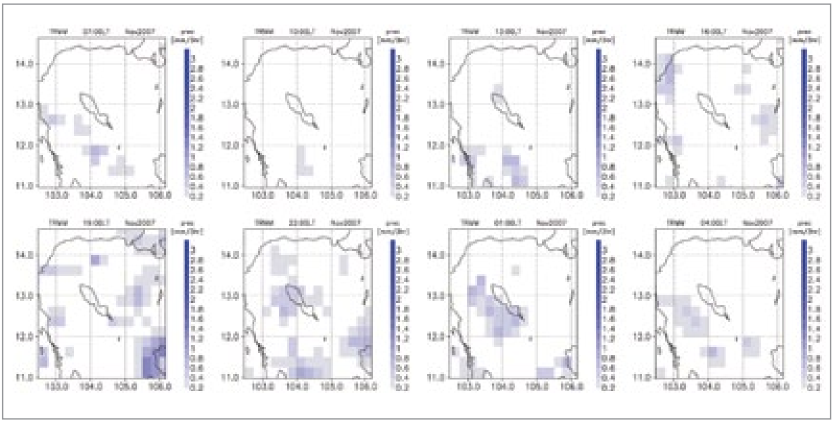

Fig. 2. Three hourly rainfall observed by satellite averaged for November 2007

mate change, this area is under a significant land surface change by both large-scale deforestation and basin development with dam construction. Since large-scale land surface change may affect the atmospheric circulation by changes of land surface fluxes, the characteristic local rainfalls in this area may change by these land surface changes, and then may affect the local agricultural water resources. The objectives of this study is to examine the possibility of the rainfall change by land surface changes through understanding of local rainfall mechanisms in this area.

CHARACTERISTICS AND MECHANISMS OF THE LOCAL RAINFALLS IN THIS AREA

Fig. 2 shows the monthly averaged 3-hourly rainfall observed by satellite in November 2007. As shown, rainfall events mostly occur at nighttime and it is dominant at the western side of the lake.

The mechanisms of this rainfall and its affecting factors have been investigated using a regional atmospheric model, the Advanced Regional Prediction System (ARPS) [Xue et al., 2000; Xue et al., 2001]. By the analysis, the land breeze at night from southwestern mountain to the lake was found to be playing a key role to bring this rainfall [Tsujimoto and Koike, 2013].

The land-breeze circulation is basically driven by the thermal contrast over the land and water, as it is well known. However,

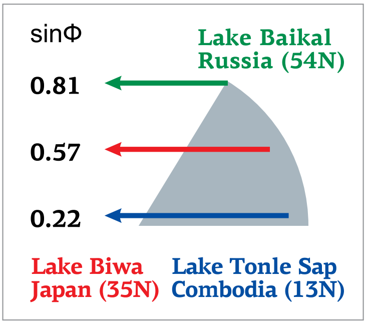

Fig. 3. Difference of latitudes for the three lakes, the Lake Baikal, the Lake Biwa, and the Lake Tonle Sap.

the night-time thermal contrast is smaller than that of day time and night-time circulation tends to be weaker than that during day-time.

At middle latitude in the northern hemisphere, the day-time circulation, lake-breeze, rotates clockwise during day time due to the Coriolis force and breezes from the opposite side after a half day, at night time. Since this lake-breeze-oriented wind breezes together with the thermally-driven land breeze, the "apparent" land breeze at night also develops. At low latitude with smaller Coriolis force, however, the rotation is weaker so that the nocturnal land breeze must be smaller than the mid-latitude one, if other conditions are the same.

Considering this theoretical estimation, the land-breeze in the Tonle Sap Lake in Cambodia had been thought to be weak. However, by the ground observation and numerical simulations, the land-breeze at night in this area was strong enough to bring even rainfalls. Through the analysis, it was revealed that the lake surface area is very high at this lake, more than 30 degrees, and the high water temperature of the lake keeps nighttime thermal contrast strong even during nighttime and make the development of strong land breeze possible.

The Coriolis parameter, f, is described with f =2ωsinφ, where ω indicates the angular velocity of the earth and φ indicates latitude. The parameter f is then calculated to be 3.0 x 10–5 /s for Cambodia (Tonle Sap Lake), 9.0 x 10–5 /s for Japan (Lake Biwa), and 12.0 x 10–5 /s for Russia (the Baikal Lake), reflecting the difference of the latitude, as shown in Fig. 3.

A study on the land-lake breeze circulation in Russia would be very interesting from the view point toward the systematic understanding of the relationship of the land-lake breeze circulation, latitude, and surrounding land condition (geology, vegetation, etc.). Therefore, it would be a great pleasure for me if I could launch a collaborative study for the lake Baikal.

METHODOLOGY

In order to improve the numerical simulation of this local rainfall, an effective use of ground observation, satellite observation, and numerical modelling in a combined way would be very useful. In Cambodia, there exists no operational radiosonde observation for upper atmosphere. We did an on-the-job training of the radiosonde observation with Ministry of Water Resources and Meteorology, Cambodia, in February 2008 and carried out collaborative intensive observation in May 2008 and November 2013 with them. Using the observed data for upper atmosphere together with the data assimilation technique for a regional atmospheric model, WRFDA [Barker et al., 2012], we could improve the rainfall simulation accuracy over Cambodia, as shown in Fig. 4.

SUMMARY

In the vicinities of the Lake Tonle Sap in Cambodia, with limited irrigation facilities, farmers are depending mainly on rainfall for agriculture. Some rainfalls are brought not only by the seasonal monsoon but also by the local lake-land-atmosphere interaction.

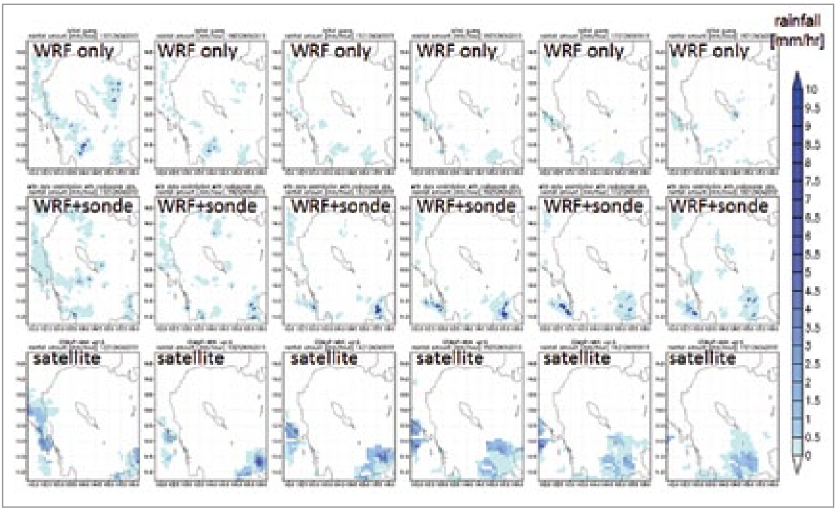

Fig. 4. Simulated and observed hourly rainfall over Cambodia. (Upper) by atmospheric model (WRF) only. (Middle) by WRFDA with a model and radiosonde data. (Bottom) by satellite observation.

For that local atmospheric circulation, land-breeze at nighttime is the key, but theoretically, it should be weak under the low latitude. Exceptionally high lake water temperature makes nighttime land-breeze very strong and contributes to the local rainfall (and agricultural water resources) in dry season. Such a mechanism and its evidence have been clarified by an integrated approach through lots of ground observations and field surveys, satellite information, numerical modelling, and theoretical analysis.

I am very much interested in the study of the Lake Baikal as a comparative study with the Lake Tonle Sap and other lakes in the world under different conditions, especially regarding the land-lake-atmosphere interaction and its effects on meso-scale meteorology, precipitation, water resources management, and food security under global climate change and socio-economic change. I really wish to visit the Lake Baikal!

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Potential of renewable energy in development of green economy in the Baikal region

United Nations Conference on Sustainable Development ("Rio + 20"), held in June 2012 in Rio de Janeiro, in fact summed up twenty years of attempts to change the traditional type of human development on a sustainable development model, which is based on the formation of a "green" economy. An important feature of this economy is the efficient use of natural resources, preservation and increase of natural capital, reduction of environmental pollution, low carbon emissions, prevention of loss of biodiversity and ecosystem services, the growth of income and employment. The transition from the traditional model of economic growth to the "green" economy can be considered as the global trend, which determines the stability of not only the individual national economies, but also of the entire planet [5].

For our country's special role in the implementation of the concept of transition to "green" economy plays the energy sector, which is a significant consumer of hydrocarbons and the polluter [6]. These issues can be largely resolved by the wider use of renewable energy (RE), which due to the natural and socio-economic characteristics, can become the most popular in the regions of Siberia and the Far East. One of the competitive advantages for the development of Energy of the Republic of Buryatia and the Irkutsk region are — among other factors — the presence of a significant amount of energy for the development of renewable energy.

OBJECTS AND METHODS OF RESEARCH

In the present work, a comparative study of natural capital and socio-economic factors that lead to the possibility and relevance of renewable energy development in the Irkutsk region and the Republic of Buryatia. The main attention is paid to the analysis of the potential of solar and wind energy, but no less important is the potential of small hydro and bioenergy through the use of waste timber and woodworking industry. Areas considered subjects of the Federation are characterized by varying degrees of availability of traditional energy resources, as well as the level of their production and use.

In the Irkutsk region there are significant reserves of coal and lignite, oil, gas and hydropower. In the area of being a large-scale coal mining, gas and gas condensate, however, until now it has one of the lowest areas of gasification performance, resulting in gas supply to consumers is provided mostly dry and liquefied petroleum gas refineries and from external sources.

Republic of Buryatia, has large reserves of brown coal, which is the basis of the thermal power generation and exports; gas supply to the consumers of the republic is carried out on the basis of liquefied natural gas from external sources. As a result, from the point of view of energy balance Irkustk area it is energy, and the Republic of Buryatia — area with insufficient energy of the Russian Federation. However, in the territory of both regions is a range of energy-deficient areas with an autonomous power supply due to the significant removal of them from the centralized power of highways, lack of gas transport infrastructure, energy networks depreciation of fixed assets (depreciation reaches 60%). As a result, the share of the population receiving electricity in a limited mode of autonomous diesel plants is high (up to 39 times — up to 100%), even in some areas of the energy surplus of the Irkutsk region.

RESULTS

The results of the analysis of the renewable energy of natural capital, which implies the supply of natural energy resources of the territory, the use of which for production purposes is currently possible. The above definition merges with the concept of the technical potential of renewable energy resources, which, according to [1], is defined as a part of the gross (theoretical) potential, which is the conversion into useful energy is possible with the current level of development of technical means and in compliance with the requirements for environment protection. For its part, referred to as gross potential annual energy contained in this form of renewable energy source (RES) at a given point or in the territory in full its transformation into useful energy used.

The focus of this work is given the resources of solar and wind energy of the Republic of Buryatia and Irkutsk region.

Geographical features of the Irkutsk region and the Republic of Buryatia define high potential of solar and wind energy. At the same time due to weather conditions and latitudinal location of specific energy characteristics of the incident solar radiation at any orientation of the receiving surface is slightly higher in Buryatia (the average value of the daily amount of total solar radiation coming onto the horizontal surface are 3.0–4.0 kWh/m^2/day) than in the Irkutsk region (2.5–3.5 kWh/m^2/day). The amount of wind resources in the Irkutsk region and the Republic of Buryatia is not so great and changeable. It is defined as a macro-circulation processes and orographic structure of the terrain. Considerably weakened by air transport in the mountain valleys, where his speed in most cases does not exceed 1 m/s at a height measuring vane. The maximum wind energy performance is characterized by the west coast of Lake Baikal (the average annual wind speed of 5–8 m/s). The increase in wind intensity activity characteristic of the ridge and watershed areas of the highlands, but its precise quantitative assessment is difficult due to lack of routine observations [2].

Technical resources for heat production are determined as the basis of specific annual heat output of typical solar water heating systems (estimates 1996). It was assumed that the SWH can take no more than 0.8% of the area in each subject of the Russian Federation.

Technical resource for electricity production is estimated based on the fact that the area occupied by the solar installation occupies

0.1% of the territory of the RF subject, efficiency solar converters was assumed to be 15%.

Economic resources for heat production are calculated based on the following assumptions:

1. Installation of hot water are effective only in those territories where their specific annual capacity is more than half of 0.52 GCal/m^2 (typical value for the climatic and economic conditions of the North Caucasus).
2. Plants solar hot water can potentially be provided by 50% of the population in rural areas and 10% of the urban population.
3. One person, provided with hot water from a solar installation, we have 1 m^2 solar collector.

However, these estimates do not allow an analysis of the spatial distribution of resources, and obtain — for the resources of wind and solar energy — solely on the basis of meteorological observations. At the same time, weather stations on the territory of Buryatia are few, and only two stations — and Bagdarin, Ivolginsk — spend actinometrical measurement. In this regard, we have to prepare data sets for solar energy resource data NASA SSE climate database were used [4], thematically focused on renewable energy needs and contains an array of data with high spatial resolution (1x1 degree of geographical coordinates) [3]. To justify the use of this data set, we have carried out a comparison of the incident solar radiation values obtained by ground-based measurements (weather station data) and mathematical modeling in conjunction with the satellite monitoring (NASA SSE data).

Seasonal Distribution of monthly average daily amounts of total solar radiation incident on a horizontal surface, and direct solar radiation incident on a surface normal to the line for two of the analyzed solar radiation stations shown in Fig. 1. From the analysis of the graphs it can be seen that the use of the database NASASSE for solar energy resource assessment in the territory of Buryatia and the Irkutsk region is justified. During the comparison, it was found that the relative error of NASA δ data are as follows: for the total solar radiation falling on a horizontal surface under Bagdarin, δ = 0,10%, according to the article. Ivolginsk δ = 0,17%. For direct solar radia-

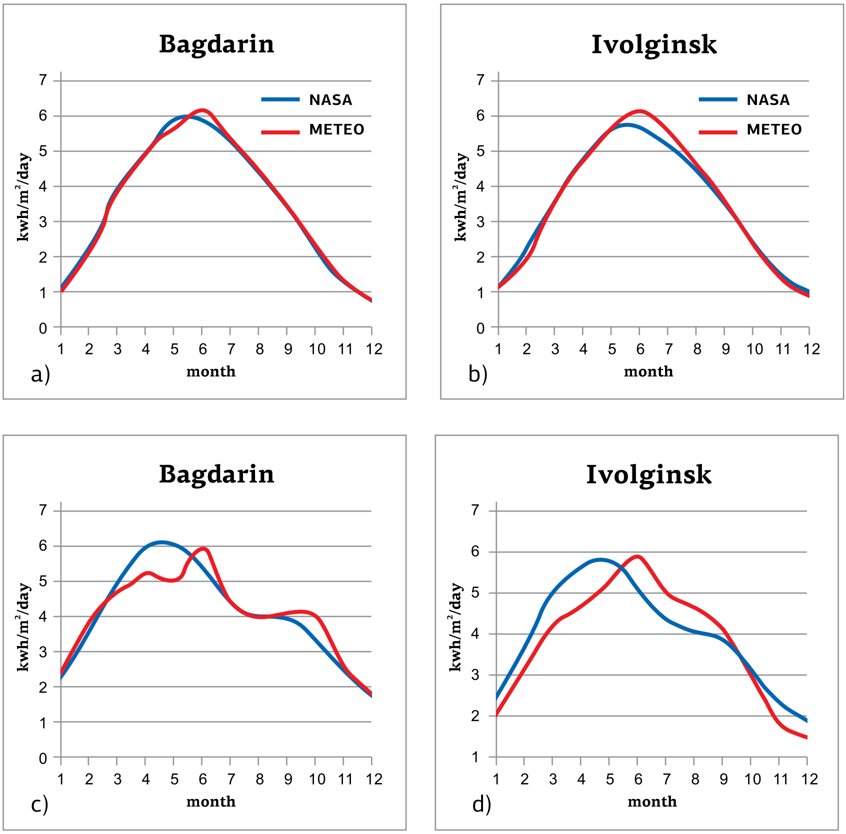

Fig. 1. Comparison of the distribution of monthly per diem amounts of total solar radiation incident on a horizontal surface (a, b), and direct solar radiation incident on a surface normal to the line (c, d) according to the weather stations and data NASASSE.

tion incident on a surface normal to the line of art. Bagdarin deviation δ = 0,33%, according to the article. Ivolginsk δ = 0,42%. Using DB NASASSE arrays of incident solar radiation data were prepared and mapped, which can then be used for the assessment and zoning for solar energy resources.

Above, we have already been given data on the average wind speeds in the territory of the Republic of Buryatia and Irkutsk region. Average annual wind speed at the meteorological stations of the territory in question are low: 4.8 to 1,3 m/s. To assess the possibility of using wind as an energy source is necessary to define and analyze the repeatability of energy active winds and the power of the wind flow. At most stations with an average annual wind speed of about 2 m/s wind energy active repeatability (speed of 5 m/s) is not more than 10-20%. Only on the coast of Lake Baikal, it reaches 50% in December, but varies greatly throughout the year. Specific power of the wind flow N (W/m^2, the sweeping wind wheel) for most of the territory does not exceed 25 W/m^2 at an altitude measuring vane. On the shores of Lake Baikal specific power of the wind flow can exceed 500 W/m^2, but varies greatly by season. Sufficiently high level of wind energy potential is celebrated in winter in mountainous regions — 90-160 W/m^2 at its extremely low values in summer — less than 1 W/m^2.

In the Republic of Buryatia, the greatest number of days with strong winds (15 m/s and more) are usually in areas where the average speed of its enhanced. For example, in Barguzin number of days per year with high wind speeds (15 m/s and above) is 70, Ulan-Ude -31 Novoselenginsk –24, –25 Kyakhta. The amplification of wind speed occurs in spring (March, April, May) and during this period there is more than 60% of days with strong winds from the total number of average cases. In November and December it is dominated by the winds of the northern areas at a rate of 2 to 5–6 m/s, and in winter in the same direction, wind speed decreases to 1–2 m/s. Calm Winter weather causes significant cooling air sedentary, and large industrial sites (Ulan-Ude, Gusinoozerskaya) lead to a sharp increase in pollution of the atmosphere with the formation of frosty mist. In the summer, the prevailing westerly winds, increasing the number of eastern and southern winds, the rate of which varies from 3–6 m/c on the coast of Lake Baikal 1–2 m/c in the rest of the country.

With the winds of the western points of the compass are always connected abundant precipitation. Thus, due to the low background wind speeds in most areas of the Irkutsk region and the Republic of Buryatia the use of wind as an energy source may be a promising only on the coast of Lake Baikal and in the mountainous areas.

Fig. 2. Photocells and solar panels on private house (Ulan-Ude) — A. Sun collectors on the roof of the hotel "Baikal Plaza" area of 150 m2 (Ulan-Ude) - B.

EXPERIENCE IN THE USE OF RENEWABLE ENERGY IN THESE REGIONS

Currently, in the Republic of Buryatia are practically no energy generating wind power facilities, however, achieved significant-given the overall low level of development of renewable energy in Russia-progress on the use of solar energy for heating and hot water (Fig. 2). Thus, according to the Center for Energy Efficient Technologies (LLC "CFEET" Buryatia), in the country in 2000–2008 was built 75 solar water heating installations with total area of 3190 m^2. These plants generate about 2.5 thousand KWh of thermal energy per year and prevent 1,200 tons of harmful emissions into the atmosphere.

The specific natural and economic conditions are difficult and isolated from the power consumers of the Irkutsk region, taking into account resource availability creates the preconditions for the use of different types of renewable energy that can be a complement to the existing sources of energy (diesel power), thereby reducing the amounts of increasingly expensive fuel oil.

CONCLUSION

Renewable energy sources are used in the territory of the Baikal region in an amount not corresponding to the real needs and potential. In the Irkutsk region there are only a few objects and projects in this field; priority for the conditions of the Irkutsk region are considered small and mini hydro power plants of various types, depending on the terrain and slope riverbeds. In the Republic of Buryatia are practically no energy generating wind power facilities, however, achieved significant — given the very weak development of renewable energy in Russia as a whole — success on the use of solar energy for heating and hot water via solar collectors.

In some cases, for power autonomous consumers a combination of expensive generation based on renewable energy sources with low-cost (to the capital cost point of view) — it is necessary on the basis of the diesel engine; while achieving a reduction in the total cost of installation, provided the stability of energy supply and saving expensive diesel fuel. Prospects for optimizing the energy balance in the region through the use of solar and wind energy.

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Meeting abstract of the presentation in the 3rd Russian-Japanese Collaboration Seminar for Sustainable Environment entitled:

Experimental study on gentle slope failure by the Kumamoto earthquake in 2016

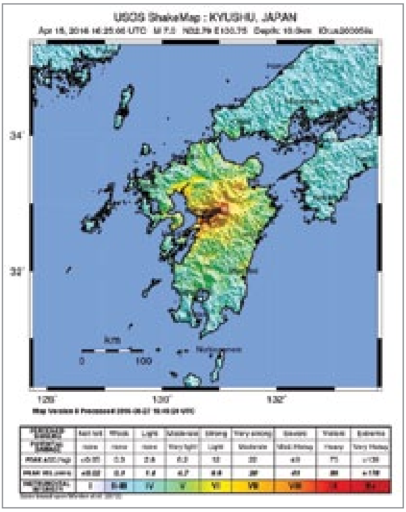

Fig. 1. The seismic intensity map by USGS (http://earthquake.usgs.gov/earthquakes/eventpage/us20005iis#shakemap)

INTRODUCTION

On April 14, 2016, a Mw= 6.2 earthquake struck at the Kumamoto City of Kumamoto Prefecture in Kyusyu Region, Japan, followed by Mw= 7.0 main-shock on April 16. The area between Kumamoto City and Mount Aso was most badly affected (Fig. 1). The two earthquakes killed at least 49 people, about 3000 injured and displacing more than 44,000 residents. Thousands of buildings and many roads were damaged, and landslides occurred.

The survey was conducted by New Zealand Society for Earthquake Engineering / Geotechnical Engineering Laboratory, the University of Tokyo joint investigation team for the 2016 Kumamoto Earthquake.

Photo1. Large landslide flows on the gentle slopes

LANDSLIDE FLOWS ON GENTLE SLOPE

Near the Kyoto University research facilities, large landslide on the gentle slopes of about 10 degree tilt occurred (Photo 1). This is believed to be due to pumice layer containing water being subjected to ground motion, inducing "liquefaction" phenomenon.

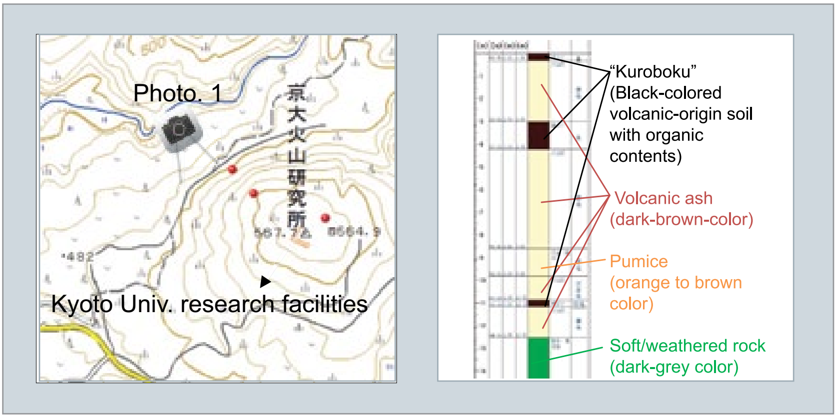

Fig. 2. Borehole data around Kyoto Univ. research facilities (http://geonews.zenchiren.or.jp/2016KumamotoEQ/index.html)

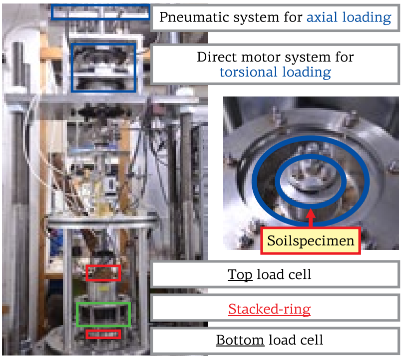

Photo2. Stacked-ring shear apparatus

EXPERIMENTAL TEST

To investigate mechanism of landslide flows on gentle slope, we are planning to conduct the cyclic and monotonic loading test on pumice using newly developed apparatus so-called "Stacked-ring shear apparatus" (Photo 2).

The stacked-ring is composed by 5 pieces of vertically arranged donut shape metal rings. Prior to the application of monotonic loading up to more than 1,000% shear strain, cyclic shear loading is applied (Fig. 3).

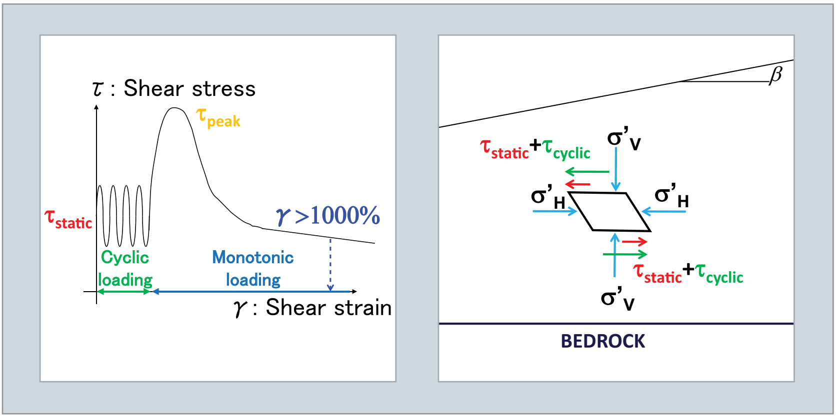

Fig. 3. Stress conditions during loading

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All figures are clippings from the poster we used in the presentation at the 3rd Russian–Japanese Collaboration Seminar for Sustainable Environment.

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Meeting abstract of the presentation in the 3rd Russian-Japanese Collaboration Seminar for Sustainable Environment entitled:

Experimental study on gentle slope failure by the Kumamoto earthquake in 2016

INTRODUCTION

Mega-delta regions in Southeast Asia are vulnerable to multiple flood disasters such as fluvial floods and coastal storm surges [Wong et al. 2014]. Simultaneous occurrence of these two phenomena may cause more severe inundation in low-lying coastal regions than in isolation [Kew et al. 2013], [Klerk et al. 2015]. In addition, future climate change driven by global warming would exacerbate fluvial flood risk [Hirabayashi et al. 2013]. However, studies dealing with both river and coastal floods have been limited within relatively small scale applications that are not sufficient for large-scale analysis including mega-delta regions, and global- or large-scale studies have not handled both of them. Hence, the present study addresses this research gap: quantification of compound risk of fluvial floods and storm surges in the Ganges Delta, which is one of the largest deltaic regions in the world.

METHODS

A global river routing model, CaMa-Flood [Yamazaki et al. 2011], was utilised in this study. Explicitly representing flood inundation dynamics, the model has been proved to have a good skill in reproducing flood inundation extent.

One previous study demonstrated for the first time the potential impact of future sea level rise on fluvial flooding by using CaMa-Flood [Ikeuchi et al. 2015], owing to the incorporation of the backwater effect in river discharge calculation. However, they neglected spatiotemporal variation of coastal water levels caused by ocean tides and surges. In this study, we advance this approach to achieve modelling fluvial flooding and coastal storm surges in the Ganges Delta.

Global Tide and Surge Reanalysis (GTSR) dataset has recently been released, which is the world's first reanalysis of global coastal water levels [Muis et al. 2016], and was coupled with CaMa-Flood in this study to simulate tide and surge impacts on fluvial flood inundation.

The storm surge event caused by Cyclone Sidr in 2007, Bay of Bengal, was taken in this study, which caused severe damage in the GBM Delta. The simulation domain was the whole Ganges River basins as shown in Figure 1.

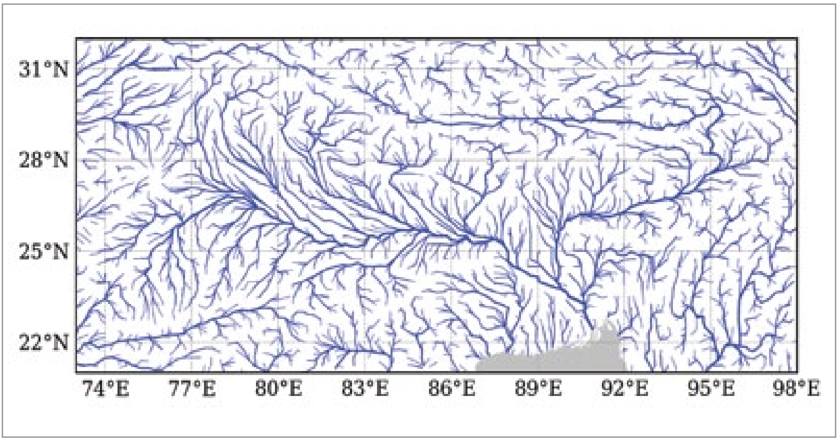

Fig. 1. The calculation domain and the river network map in CaMa-Flood.

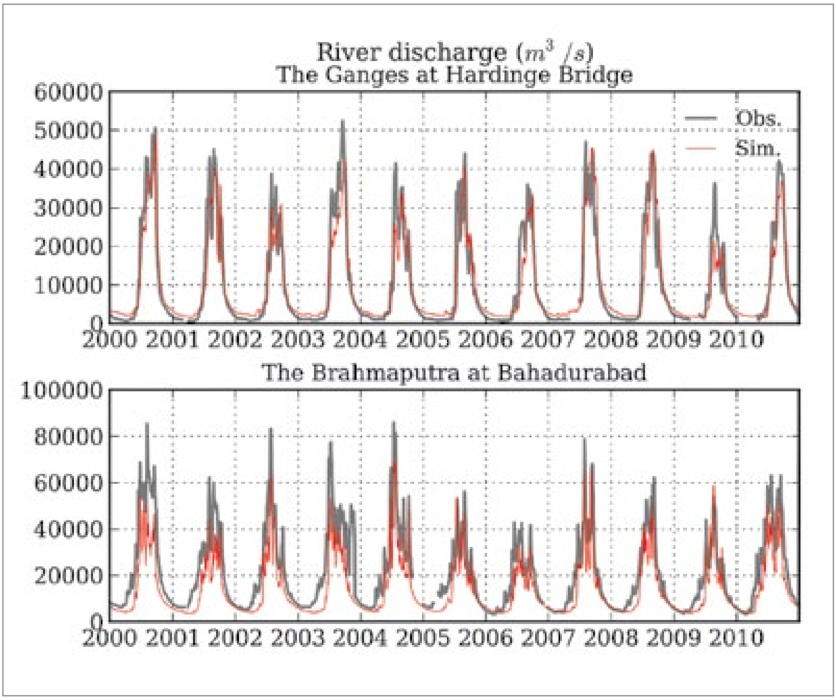

Fig. 2. Validation of river discharge of the Ganges and Brahmaputra rivers modelled by CaMa-Flood against observation. The grey and red lines are observation and simulation, respectively.

RESULTS AND DISCUSSION

First the river and coastal models were separately validated against observation. For validation of CaMa-Flood, modelled river discharges were compared with observed data of Institute of Water Modelling as shown in Figure 2. Correlation coefficients in the Ganges and the Brahmaputra rivers were 0.82 and 0.92 in the Brahmaputra respectively, indicating that the model can reasonably capture seasonal variability of river discharge.

Figure 3 shows the coastal model's performance to reproduce storm surge height caused by the cyclone. Observed data were derived from previous literature [JSCE 2008]. The model was found to simulate the reported extreme water levels.

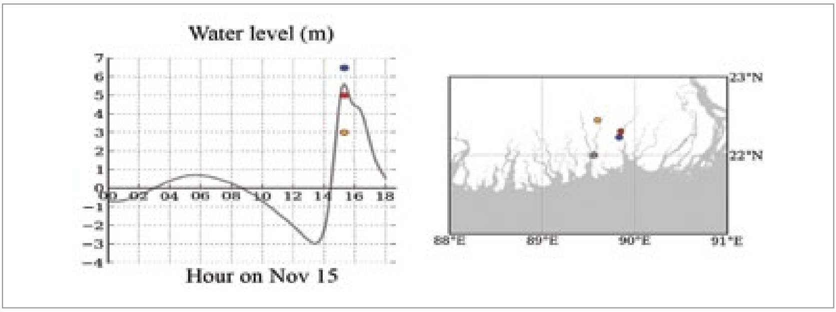

Fig. 3. *Left:* validation of the storm surge model. The coloured dots are observations, and the grey line is the simulation results. *Right:* geographical locations of points in observations and simulation

Finally we conducted a compound simulation of fluvial floods and storm surges in the case of Cyclone Sidr in the Ganges Delta. Figure 4 shows the flood inundated area after Cyclone Sidr's landfall there. It shows that inclusion of the coastal model into the river model exhibited better reproducibility of flood inundation extent.

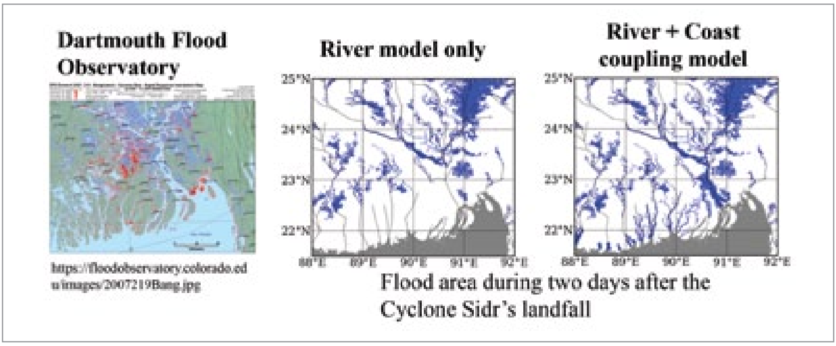

Fig. 4. *Left:* Flood inundation extent (the red colour means inundated areas) derived from Dartmouth Flood Observatory. *Centre and right:* flood inundated areas within two days after the cyclone landfall with and without coastal model's outputs

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Meeting abstract of the presentation in the 3rd Russian-Japanese Collaboration Seminar for Sustainable Environment entitled:

Geographical characteristics of flood and poverty — the case study in Myanmar

INTRODUCTION

In 2015, UN States Members adopted Sustainable Development Goals (SDGs), whose priority is to eliminate poverty by 2030. Poverty has been an important problem since the past and it's getting more attention recently. Poverty is a complex phenomenon because countless factors may cause poor condition. Recently, disasters are focused as it can affect a bad influence on poverty.

On the other hand, flood frequency is estimated to increase around South East Asian countries, including Myanmar (Hirabayashi et al. 2013). Thus it is important to know the situation and characteristics of people who are living in flooded areas.

In such a situation, it is well documented that the poor live in the riskiest environments like on floodplains or other areas at high risk of flood in urban area (Satterthwaite et al. 2007) and there are many studies which focused on the relationship between poverty and disasters (Olsson et al. 2014). Some of them analyzed how climate change would affect poverty in country-scale (Wisner et al. 1994; Stephane Hallegatte et al. 2015; Winsemius et al. 2015). One of them says that across countries, poor people are over-exposed to droughts and urban floods (Winsemius et al. 2015). Another study suggests that poor people are seen as the most vulnerable to flood effects of natural hazards and disasters can have long-term economic consequences for those in poorest conditions (Dercon 2004). But it is also indicated that the situations strongly differ across countries and regions (Winsemius et al. 2015). Though there are many studies about the topic, studies which focused on the relationship between flood and poverty can't be said to be enough so far.

TARGET AREA

Bago city, Myanmar, is the target area of the research (Figure 1). Bago city is the fourth biggest city in Myanmar whose population is around 400 thousand in urban area and there was a dynasty in the past.

Myanmar is developing rapidly after the democratization in 2011. Bago city is located at the cross point of the two big roads; Yangon-Mandalay rail road which connects two biggest cities in Myanmar and ADB East-West Economic Corridor which is under construction. Moreover, a new airport is going to be constructed at the outskirts

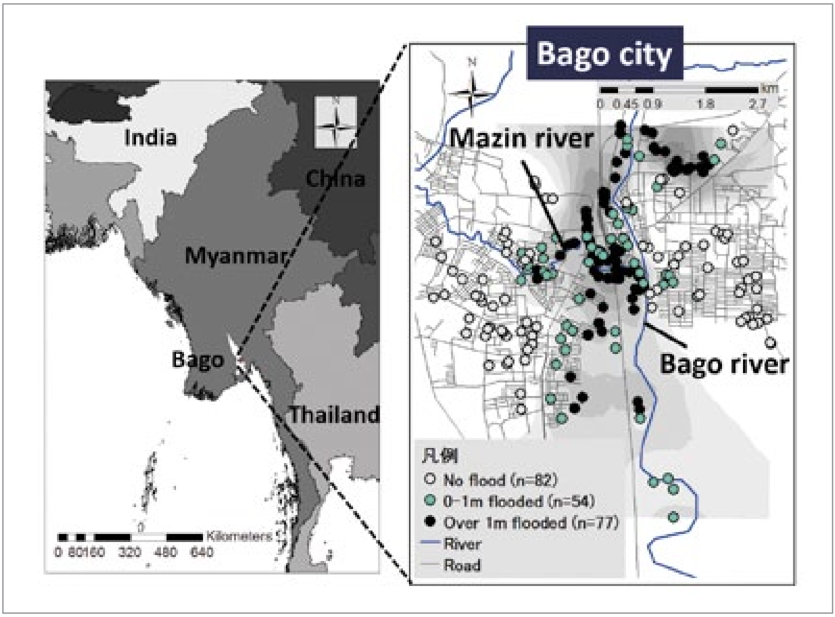
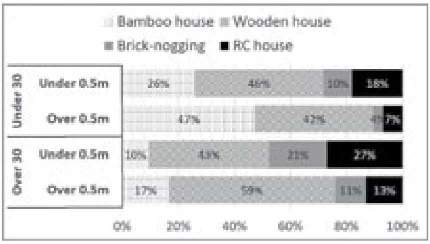
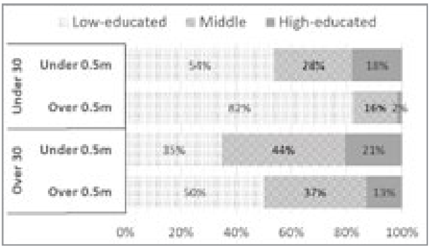


Fig. 1. The location of Bago city and the location of households





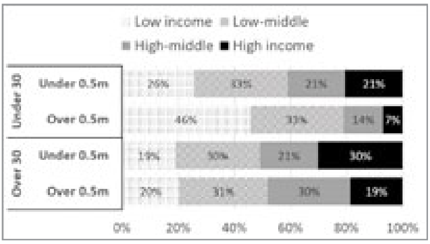


Fig. 2, 3, 4. Relationship between the income level and flood depth categorized by the average age of a household

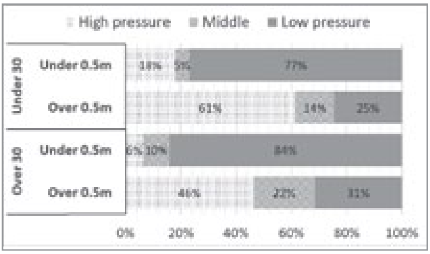


Fig. 5. Relationship between the financial pressure after the flood in 2011 and flood depth categorized by the average age of a household

of Bago city. Considering the situations above, Bago city is estimated to develop rapidly as well. However, Bago city is annually flooded and poverty is becoming a problem. Urgent countermeasures are required due to the rapid progress which may increase the gap of the rich and the poor in the future while there are almost no studies about this topic in this area. Therefore some information for the decision making is needed for the area.

SURVEY RESULTS

Figures 2, 3, 4 and 5 show the relationship of household factors with flood depth categorized by the average age of a household. It is shown that households whose age is high are living in better conditions than the ones of low age as for house type, education level and income level. It is also confirmed that households which experienced higher level of flood tend to be in worse conditions. Moreover, lower aged households also tend to have experienced more financial pressure than the ones of higher age. The map is shown in Figure 6 as for the income

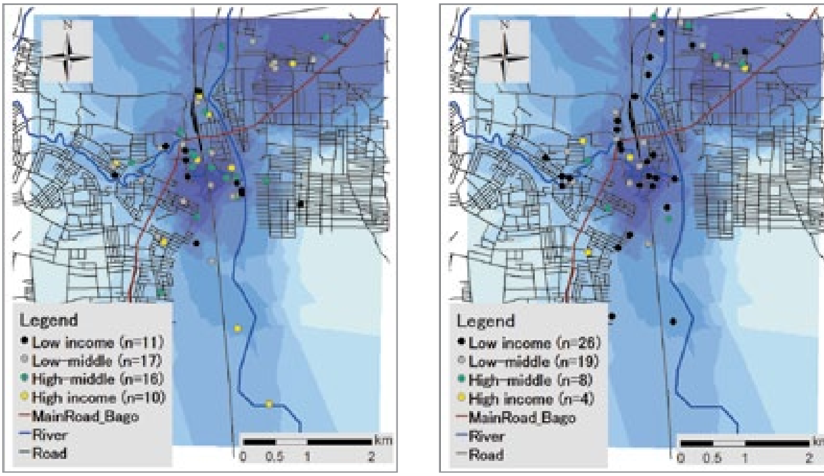


Fig. 6. Relationship between the financial pressure after the flood in 2011 and flood depth categorized by the average age of a household

level and it can be seen that there are more low-income households on the right figure which shows the households whose average age is under 30 years old.

As a consequence, it is said that households which experienced higher floods and whose average age is lower tend to live in worse conditions as for the house type, education level and income level. They also suffered more

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Meeting abstract of the presentation in the 3rd Russian-Japanese Collaboration Seminar for Sustainable Environment entitled:

An event attribution of the 2012 Amazon flood

INTRODUCTION

It is predicted that global warming increase the flood occurrence [Hirabayashi et al. 2013]. Additionally, the latest IPCC report indicates that it is possible global warming increases the probability of extreme event, for example heavy rainfall, river flood and so on. [IPCC 5th report 2014]. Be based on this background, Event Attribution technique, which quantifies contribution of human-induced global warming on recent extreme event using a number of ensemble of past climate by Atmospheric General Circulation Model(AGCM), is invented [Pall et al 2011]. Due to the limitation of river models implemented in AGCMs, however, an application of EA is limited for climate variables such as heat wave and precipitation. Hence, We therefore conducted a number of ensemble simulation of river discharge using a river and inundation model forced by runoff obtained from EA experiments and applied to the data to quantify how global warming increases on 2012 Amazon flood.

2012 AMAZON FLOOD

During 2011/2012, intense rainfall was reported in a large part of northern Amazonas basin, which led to anomalously discharge since

January 2012. On 19 April, The discharge at Tamshiyacu station (Fig. 1) attained 55400m3/s, which is the highest value recorded in the Peruvian Amazonas River. This situation caused inundations in the main cities in Peruvian Amazon basin and affected about 140000 people [Espinoza et al 2012].

Fig. 1. Relationship between the financial pressure after the flood in 2011 and flood depth categorized by the average age of a household

DATASET

EA experiment datasets are made by using MIROC5 AGCM forced by surface sea temperature (SST), sea ice distribution (SID) and external forcing. In EA experiment datasets, there are three kinds of data. First one is ALL scenario, which is 100 ensemble historical simulation between 2010 and 2014. Second one is NAT scenario, which is 100 ensemble non global simulation between 2010 and 2014. Final one is ALL-LNG scenario, which is 10 ensemble long historical scenario between 1949 and 2013. Boundary conditions of ALL scenario are all external forcing (greenhouse gas, change of solar radiation, volcanic activity and so on), observed SST and SID. On the other hand, Boundary conditions of NAT scenario are external forcing except induced by human, SST and SID without global warming influence. However, to consider uncertainty of remove global warming influence, we use 2 NAT scenario. One is NAT_CMIP5, the other is NAT_dtr.

METHODS

We employed CaMa-Flood [Yamazaki et al. 2011], global hydrodynamic model. EA experiment river discharge dataset is made by conducting CaMa-Flood simulation forced by runoff obtained from EA experiments.

We use FAR method to quantify how global warming influence on 2012 Amazon flood, which is defined as follows [Hamaguchi et al 2014].

$$FAR = (P_A - P_N) / P_A \tag{1}$$

Where PA is the probability of flood occurrence in ALL, PN in NAT. Then, Threshold of flood is defined as return period 10 years in ALL-LNG (82,429m3/s). When FAR value is positive (negative), global warming increases (decreases) the possibility of flood occurrence.

Because we can't gain Tamshiyacu station data, We chose one observed station, Sao Pauko De Olivenca (SPO) station (Figure1), and drew cumulative distribution function based on 100 ensemble river discharge at SPO station. Then, we quantify how global warming influence on 2012 Amazon Flood.

RESULTS AND DISCUSSION

Fig. 2 shows cumulative distribution function based on 100 ensemble river discharge at SPO station in each scenario. Blue line is bigger than green line, so Natural variability in 2012 made flood easier to occur even without global warming. Additionally, red line is bigger than blue line, global warming increases probability of 2012 Amazon flood. The probability of flood occurrence in ALL scenario is 17.7%, in NAT-

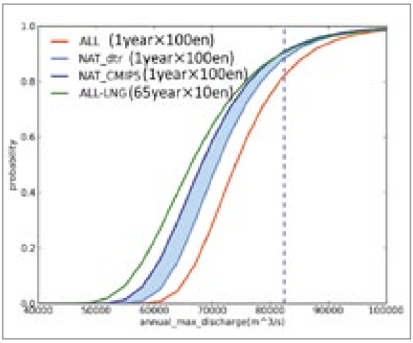

Fig. 2. Cumulative distribution function based on annual max discharge based on EA river discharge experiment. In case of ALL, NAT_CMIP5 and NAT_dtr, 100 ensemble annual max river discharge in 2012. In case of ALL-LNG, CDF is drawn based on 10 ensemble annual max discharge between 1949 and 2013 (10×65 years). Blue dot line shows threshold of flood (82,429m^3/s).

CMIP5 scenario 9.1%, in NAT-dtr scenario 11.5%. FAR is calculated based on formula (1). FAR value is 0.48 in case of NAT-CMIP5 scenario, 0.35 in NAT-dtr scenario. These result indicated that human influence increased probabilities of the 2012 flood in Amazon to 35-48%.

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All figures are clippings from the poster we used in the presentation at the 3rd Russian–Japanese Collaboration Seminar for Sustainable Environment.

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Meeting abstract of the presentation in the 3rd Russian-Japanese Collaboration Seminar for Sustainable Environment entitled:

An event attribution of the 2012 Amazon flood

INTRODUCTION

Much of the infrastructure in Japan was developed during a period of high economic growth. Because more than 50 years have elapsed since this infrastructure's construction, it is assumed that aging will progress rapidly in the future. In fact, because of a lack of financial and professional resources, some local governments in Japan are unable to carry out adequate inspections.

In the context of this difficult situation surrounding maintenance of such infrastructure, in recent years advanced municipalities around the world have taken full advantage of information and communication technology (ICT) for improving public service delivery [1]. Most local governments now operate websites to exchange and share information with citizens about local problems such as potholes on the road [3].

This paper studies a citizen-driven system for local public service improvement in Chiba City (Chiba Report: http://chibarepo.force.com/). This system is called 'Chibarepo'. It enables citizens in Chiba City to report and share information about local problems such as potholes, graffiti, broken paving slabs, or street lighting using images and location information. Hence, there is large amount of accumulated information about damaged infrastructures submitted as reports from citizens. However, citizen-submitted data from Chibarepo is spatially and qualitatively biased. Therefore, it is insufficient for conducting infrastructure maintenance.

In this study, in order to compensate for the lack of reporting on roadways (highways), we took videos of road surfaces using an on-board smartphone and created a model that determines the presence or absence of damage to the road surface based on the videos taken. And we also indicate the possibility of automatic classification of images submitted by citizens through Chibarepo.

OUR APPROACH

Fig. 1 shows the distribution of locations for reports received from citizens through Chibarepo during the period of September 2014 to August 2015. As can be seen Fig. 1, information gathered by citizens has spatial deviation. There are some routes with no reports and some with many reports. Therefore, we complement this deviating but voluminous infor-

Fig. 1. The distribution of reported locations. Data were spatially concentrated around populated areas and well-known hotspots (e.g., Chiba Station)

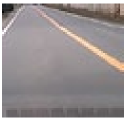
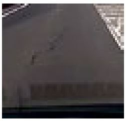
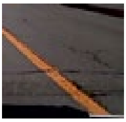
Smooth	Damaged	
	No Need for Repair	Needs Repair
500 images	396 images	107 images
		

Table 1. Training data set

mation by combining videos of roads taken by smartphones in a way that can be carried out easily by anyone.

For simplicity and ease, we chose an approach focused around using transfer learning to quickly create and train neural networks. AlexNet [2] and GoogLeNet [4] were used and compared as models in this research. AlexNet was the first work that popularized CNNs in computer vision, and contains 5 convolutional and 3 fully connected layers. GoogLeNet was designed to be a direct improvement over AlexNet for the task of classifying ImageNet.

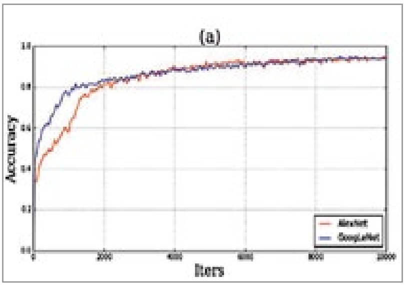
In this study, we traveled 500 km in Chiba City and captured video of the road surface. First, we trimmed the 256×256 region reflected from the road surface in video obtained during the road suface measurement experiment. Second, we cut out images from the 256×256 video at the rate of 1 to 0.5 seconds.

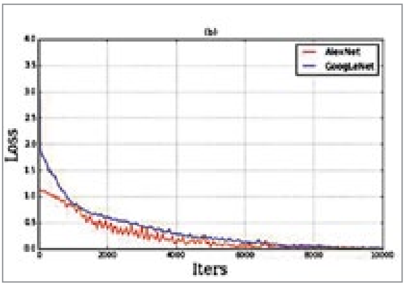
Finally, we asked local government officials to determine visually whether there was damage or not in the images. At that time, 3 categories were determined: "there is no damage (0)," "there is damage, but no need for repair (1)," and "there is damage, in need of repair (2)." Those 3 categories are used ordinarily in municipality infrastructure inspections. As a result, we obtained 1,003 images in total constituting the training data set (Table 2).

RESULTS AND DISCUSSION

RESULTS

We performed a single experiment that applied each model to raw pixel data for 10,000 iterations with a learning rate of 0.001 and a decay rate of 0.9. Each of the three classes of images were divided into 5 groups of images, and we performed 5-fold cross validation. As the structure of the neural network, we adopted AlexNet and GoogLeNet. The results are shown in Fig. 4 and Table 2. The accuracy at 10,000 iterations was 90% for AlexNet and 93% for GoogLeNet (Table 2).





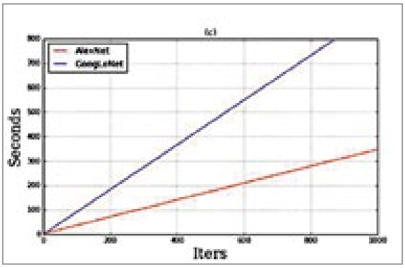


Fig. 2. Test accuracy, training loss, processing speed
(a) represents test accuracy, (b) represents training loss, (c) represents learning time

		True			Class Precision
		(0)	(1)	(2)	
Prediction	(0)	480	1	3	99%
	(1)	37	425	22	88%
	(2)	7	63	475	87%
Class Recall		91%	85%	95%	ACCURACY=90%

Table 2. Confusion matrix AlexNet

		True			Class Precision
		(0)	(1)	(2)	
Prediction	(0)	480	11	1	99%
	(1)	15	441	25	88%
	(2)	5	48	474	87%
Class Recall		96%	88%	95%	ACCURACY=93%

Table 3. Confusion matrix GoogLeNet

Image		
True	Damaged, No Need Repair (1)	Damaged, Need Repair (2)
Predic-tation	Damaged, Need Repair (2)	Damaged, No Need Repair (1)

Table 4. Example of an erroneous determination

DISCUSSION

Examining Table 2 and table 3, it can be seen that erroneous determination with respect to "Damaged. No Need for Repair (1)" and "Damaged, in Need of Repair (2)" stand out. This study was commissioned to create training data set for each civil engineering office jurisdiction, and determination criteria between the different offices are slightly different (Table 4). These differences are considered to have been a major factor in erroneous determinations. It is expected that, by clarifying the criteria for training data classification, determination accuracy will be improved. However, in this study, the models were trained by the training data created by a civil engineering officer. This is very meaningful.

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Meeting abstract of the presentation in the 3rd Russian-Japanese Collaboration Seminar for Sustainable Environment entitled:

Evaluation of secondary consolidation in peats based on Isotache model

INTRODUCTION

Peat is piled up the remain of plant residue which the resolution is inadequate for in cold and humid conditions.

Peat is distributed in Russia and Hokkaido in Japan. Peat has many characteristics. Those are high water content, high compressibility (large secondary consolidation) and small unit weight. Because of these characteristics, peat is classified "Special soil". These characteristics make some problems at Hokkaido. For example, uneven subsidence occurred at Hokkaido highway road. Compared to other soil or clay's subsidence, peat's subsidence is large.

Fig. 1. Uneven subsidence of highway

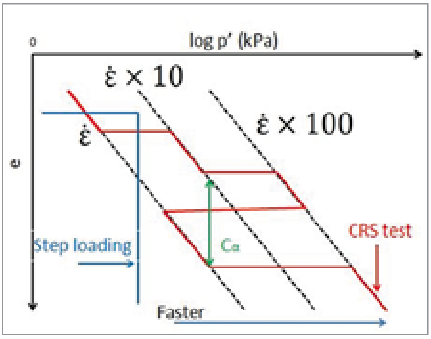

Fig. 2. Conceptual diagram of Isotache model

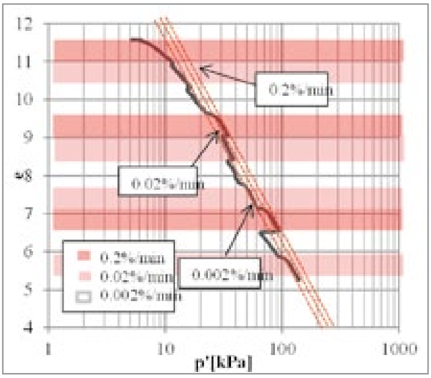

Fig. 3. e-log p' of CRS test

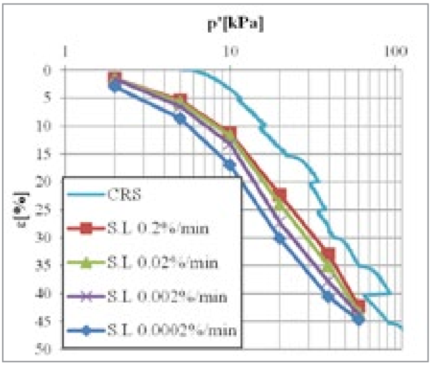

Fig. 3. ε-log p' of CRS test and S.L test

METHODS

Isot ache model is consolidate model with due regard to viscosity. The e-log p' relation is determined by the strain rate. The lines which are different strain rate are parallel and the lines are unambiguously determined by strain rate. This indicates that secondary consolidation is not depended on pressure. It is depend on secondary consolidation coefficient (Cα). If different strain rate is 10 times, Cα can be calculated.

There are many researches about Isotache model. But, researches of peat's secondary consolidation based on Isotache model are not so many. Therefore, applicability of peat's secondary consolidation based on Isotache model was evaluated by constant strain rate consolidation test (CRS test) and step loading consolidation test (S.L test).

RESULTS AND DISCUSSION

Fig. 3 is void ratio-effective stress curve (e-log p') of CRS test result of peat. This experiment's strain rate was 0.2, 0.02 and 0.002(%/min). The lines which were different strain rate were parallel and as strain rate was speeded, the line moved right side. These behaviors indicated that peat followed Isotache model. Moreover Cc and Cα were got from this result. Cc=4.98 and Cα=0.35. These values were large, compared to typical clay. It indicated that peat has high compressibility.

Fig. 4 is strain-effective stress curve (ε-log p') of CRS test result and S.L test result. S.L test's result was plotted at the points that strain rate was 0.2, 0.02, 0.002 and 0.0002(%/min). This indicated that peat didn't follow Isotache model, because the lines were not unambiguously determined by strain rate. But, Cc and Cα of both tests were almost same.

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All figures are clippings from the poster we used in the presentation at the 3rd Russian–Japanese Collaboration Seminar for Sustainable Environment.

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Meeting abstract of the presentation in the 3rd Russian-Japanese Collaboration Seminar for Sustainable Environment entitled:

Nearshore topography estimation by image analysis

INTRODUCTION

Peat is piled up the remain of plant residue which the resolution is inadequate for in cold and humid conditions.

Peat is distributed in Russia and Hokkaido in Japan. Peat has many characteristics. Those are high water content, high compressibility (large secondary consolidation) and small unit weight. Because of these characteristics, peat is classified “Special soil”. These characteristics make some problems at Hokkaido. For example, uneven subsidence occurred at Hokkaido highway road. Compared to other soil or clay’s subsidence, peat’s subsidence is large.

METHODS

1. UAV BASED MONITORING SYSTEM

The UAV-based monitoring system is composed of two sub-systems; the estimation of submarine bathymetry by using extraction of wave crest-lines and the estimation of subaerial topography by using SfM (Structure from Motion) technique.

In order to estimate water depth based on wave celerity, long wave has advantage in accuracy. Therefore, by using 2-dimensional wavelet transform, only wave crest lines of long waves are extracted from pictures taken by UAV at a height of 150 m as shown in Figure 1. Then, by tracking the lines, wave celerity, C, are calculated and bathymetry can be estimated by dispersion relation, Eq.1.

$$h = \frac{CT}{2\pi} \tanh^{-1} \frac{2\pi C}{gT} \tag{1}$$

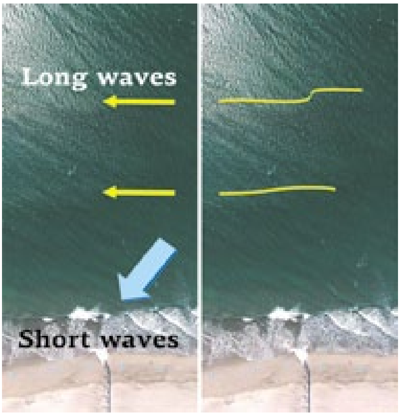

Fig. 1. Wave crest-lines extracted by using 2-dimensional wavelet transform

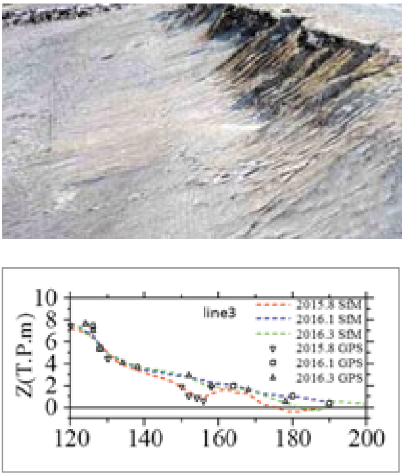

Fig. 2. Example of 3D model made from pictures taken by UAV using SfM and comparison of the result with GPS data

Subaerial topography can be estimated by using SfM technique [Mancini et al., 2013]. SfM is the process estimating 3-dimensional structures from 2-dimensional image sequences which may be coupled with local motion signals. By using this technique, 3D model of coastal area can be generated from pictures taken by UAV and it shows high accuracy as shown in Fig. 2.

2. MONITORING CAMERA BASED SYSTEM

Even though monitoring cameras lack mobility compared to UAV, they can be used as interpolation of UAV. By making time-averaged pictures, movement of sand bars can be tracked based on wave breaking which occurs at shallow area as shown in Figure 3 [Lippmann and Holman, 1989].

Time-averaged pictures also useful to follow shoreline changes as shown in Fig. 4.

APPLY THE NEW METHOD

The techniques discussed before are applied in several field

Fig. 3. Estimation of sand bars by using time-averaged pictures

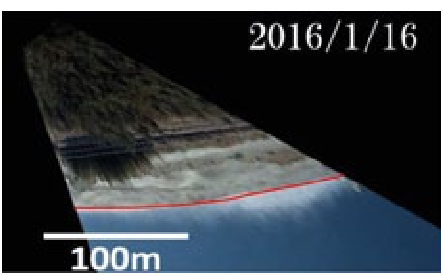

Fig. 4. Extracted shoreline monitored by the surveillance camera

Fig. 5. Introduced sand-bypassing system

surveys at Asaba Coast in Shizuoka prefecture where an outlet of automated sand-bypassing system (Fig. 5) were introduced in October 2015.

Fig. 6 shows one of the results of topography estimation using UAV techniques. By combining the results of UAV based monitoring and bathymetry data measured by using sonar, short-term topography changes in front of the outlet can be estimated as shown in Fig. 7.

UAV-based monitoring captured rapid depositional

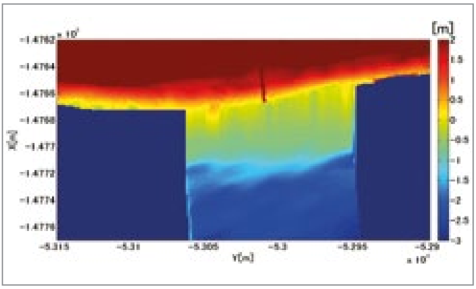

Fig. 6. Extracted shoreline monitored by the surveillance camera

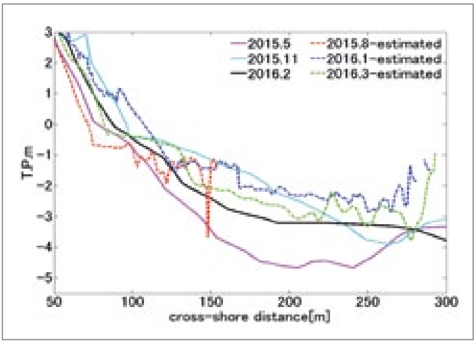

Fig. 7. Cross-shore profiles near the outlet (solid lines indicate measurements by sonar and dashed lines by UAV)

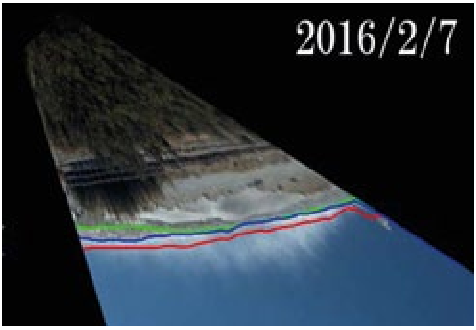

Fig. 8. Erosional trend caused by winter storm, captured by a monitoring camera. Red indicates shoreline of Jan 16th, green Jan 22nd, blue Feb 7th

trend after the install of the sand-bypassing system to the winter. Moreover, erosional trend in the winter caused by storm was also captured and which was also confirmed by monitoring cameras as shown in Fig. 8.

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Meeting abstract of the presentation in the 3rd Russian-Japanese Collaboration Seminar for Sustainable Environment entitled:

Wildfire detection around Lake Baikal by Himawari-8

INTRODUCTION

In recent years, forest fire has become a global social issue. Originally, forest fills the role of preventing the global warming by photosynthesis. Once it is burned, however, it merely becomes the emission source of carbon dioxide. Besides this one, forest plays a multifunctional role. so wildfire destroying forest has serious effect on global environment and society. For this reason, we must minimize the damage caused by forest fire, and it is necessary to predict forest fire spreading accurately the spreading of fire. In this study, we focus on two sensors on satellite. One is AHI-8 on Himawari-8, the other is MODIS on Terra/Aqua. Each spatial resolution and temporal resolution is different. We focus on this difference, and verify the fire detection performance. As the research target, we employ the forest fire that occurred around Lake Baikal in Russia August, 2015. Russian forest accounts for 20 percent of the forest in the world so it has a great influence on global situation rather than Russian situation. From the viewpoint of global environmental protection the importance of the Russian forest is also high, so in this study it is proper as a study site.

METHODS

In this study, we focus on three earth observation sensors, MODIS, Landsat-8, and Himawari-8. Every sensor has thermal infrared bands, so they can capture thermal radiation. Table 1 shows Himawari-8 and Landsat-8 sensor specifications and Table 2 shows the difference of each sensor resolution.

Himawari-8		Landsat-8	
Bands	**Wavelength (μm)**	**Bands**	**Wavelength (μm)**
Band5 (SWIR)	1.61	Band4 (Red)	0.655
Band6 (SWIR)	2.25	Band5 (NIR)	0.865
Band7 (IMIR)	3.88	Band6 (SWIR)	1.61
Band13 (TIR)	10.4	Band10 (TIR)	10.8

Table 1. Sensor band and wavelength

Satellite	Sensor	Spatial resolution	Temporal resolution
Himawari-8	AHI	2000[m]	10 min.
Terra/Aqua	MODIS	1000[m]	0.5 day
Landsat-8	OLI	30[m]	16 days

Table 1. Sensor band and wavelength

RESULTS AND DISCUSSION

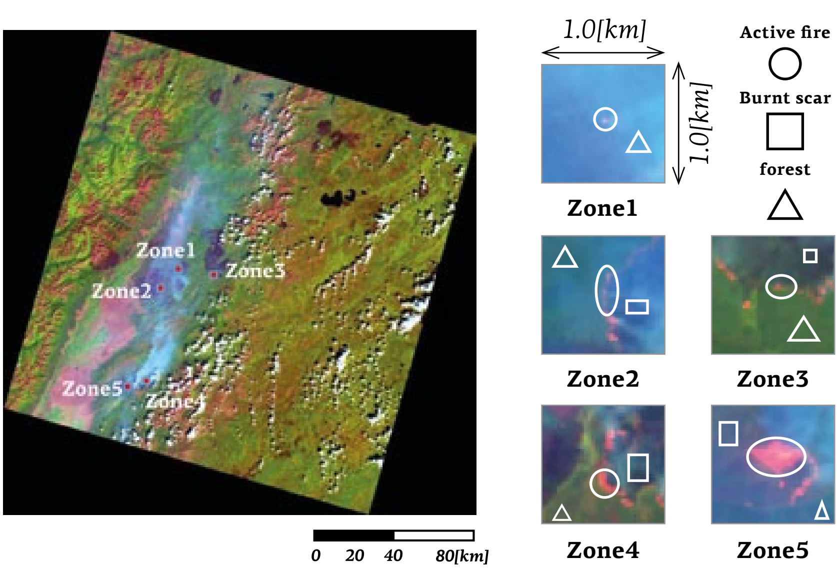

Fig. 1. 7th August, 2015 around Lake Baikal by Landsat-8

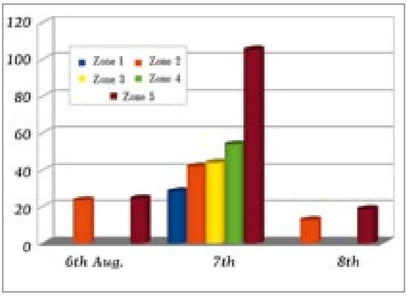

Fig. 2. Fire Radiative Power by MODIS8

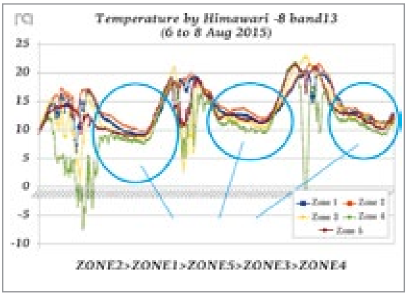

Fig. 3. Temperature by Himawari-8 band13

Fig. 1 shows the satellite image around Lake Baikal derived Landsat-8. Five active fire areas were set as fire target. It is the information on 7th August, 2015. The spatial resolution is 30 [m], but temporal resolution is 16 [days]. So daily fire detection cannot be carried out.

Fig. 2 shows the result of daily fire detection by MODIS. About Zone2 and Zone5, wildfire was detected even except 7th. About the other fire (Zone 1, 3, 4) was detected only the day (7th August).

Fig. 3 shows the result of fire detection by Himawari-8. Every ten minutes detection was successful among 6th to 8th, August. Although the temperature was influenced by daily variation or cloud, Zone 2 was highest, and Zone 4 was lowest a late night slot.

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All figures are clippings from the poster we used in the presentation at the 3rd Russian–Japanese Collaboration Seminar for Sustainable Environment.

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Meeting abstract of the presentation in the 3rd Russian-Japanese Collaboration Seminar for Sustainable Environment entitled:

A CGE analysis of economic costs of flood considering indirect loss: a case study of 2011Thailand flooding disaster

INTRODUCTION

Globally, economic losses from flooding exceeded $ 19 billion in 2012 (Munic Re, 2013). If global warming proceeds, flood risk will increase globally in particular Asia and Africa (Hirabayashi et al., 2013). Previous studies have been focused mainly on direct tangible losses, however, indirect loss could cause considerable effects on local economy as well. Hence, the objective of this research is estimating comprehensive flood risk including indirect loss and economical spreading effect of flood loss.

METHODS

We first developed a method to estimate comprehensive flood loss from numerically simulated variables from river and inundation model. We then conducted CGE analysis of 2011 Thailand flood to show economic costs of flood.

FLOOD SIMULATION

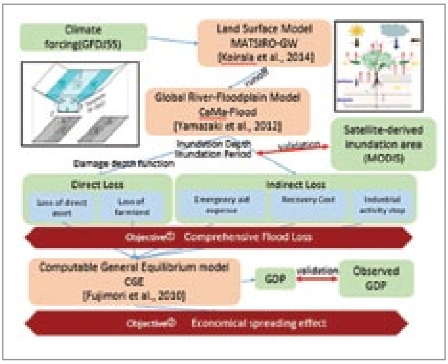

Fig. 1. Flow of this research

A retrospective river and inundation simulation was conducted by CaMa-Flood (Yamazaki et al., 2011). The CaMa-Flood was obtained from a land surface model, MATSIRO-GW (Koirala et al., 2014), forced with a corrected reanalysis data (Iizumi et al., in prep.). Satellite-derived river width (Yamazaki et al., 2015) was used for the simulation, while a parameter of river depth was calibrated to obtain best-fit of observed flood peak for the period between 1990 and 2000. Calculated daily inundation depth from CaMa-Flood at a 0.1-deg horizontal resolution was diagnostically downscaled onto DEM at 18 arc-second (about 500m).

DIRECT LOSS

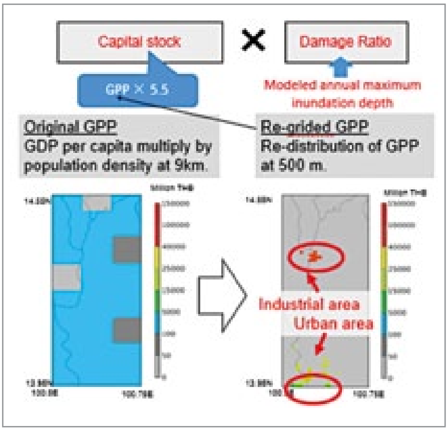

Fig. 2. Method of estimating flood direct loss

Direct loss was estimated from modeled flood exposure (potentially affected capital stock) and damage ratio defined from damage-depth functions for 3 land use types (urban, forest and cropland). Capital stock was obtained from re-gridded GPP (Gross Provincial Product) multiplied by a coefficient, 5.5, obtained from reported GPP in 2010 and estimated capital stock in 2010 by World Bank. Re-gridded GPP was obtained from a correlation of percentage of urban grid and GPP for 77 province, as capital stock of urban grid was 2482 times of other grid.

INDIRECT LOSS

Industrial activity stop and emergency expense was estimated as indirect loss. Loss of industrial activity stop, ILi, was estimated as a number of days of activity stop multiplied by total value-added amount as ILi = p x d, where p is value-added amount per day and d is the number of activity stop (1.75 x days of inundation depth > 1m). This ratio was decided from reported inundation period and stoppage of operation at 7 industrial estates. Emergency expense was calculated for households and business.

The former includes working cost of cleaning and additional family expense of fallback activities. Daily cleaning cost per household (1935 THB, on 2010 PPP), total cleaning day at inundation level, additional family expense and emergency expense per company were obtained from Japanese flood report (MLIT, 2005). Number of household and company of each province was obtained from Alpha Research Company Ltd. (2008) and uniformly distributed.

CGE ANALYSIS

A Computable General Equilibrium Model, AIM/CGE (Fujimori et al., 2014) calculates economic equilibrium. Model input was obtained from damage estimation by World Bank.

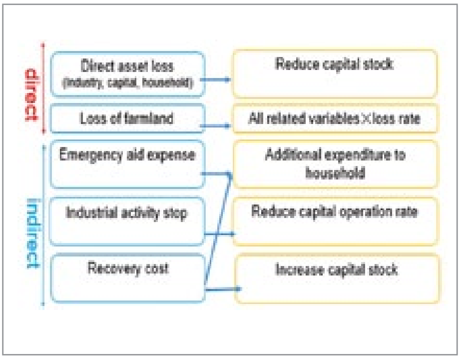

Fig. 3. Settings of flood loss in CGE model

Direct asset loss excep. farmland	Capital Stock (bil. THB)	Damage (bil. THB)	Percentage (%)
Agriculture, Forestry and Fisheries	1,676	5.67	0.34
Industry	211,770	513	2.36
Service	19,185	633	0.13
Transportation	6,224	248	1.02

Industrial activity stop	Production (mil. THB)	Damage (bil. THB)	Percentage (%)
Agriculture, Forestry and Fisheries	1,327,575	34,715	2.61
Industry	13,275,427	493,258	3.72
Service	5,566,942	244,822	4.4
Transportation	1,468,494	9,496	0.65

Table 1. Upper: Asset loss ratio of each industry.
Lower: Capital outage ratio of each industry

MODELED FLOOD LOSS

Modeled flood loss showed similar in magnitude comparing to independent estimation by the World Bank.Direct asset loss 845 bil.THB (The world Bank : 630 bil. THB). Industrial activity stop 223 bil.THB (The World Bank : 528 bil. THB (industry + agriculture)). Emergency expense 58 bil.THB (The World Bank : 38 bil. THB (household sector)).

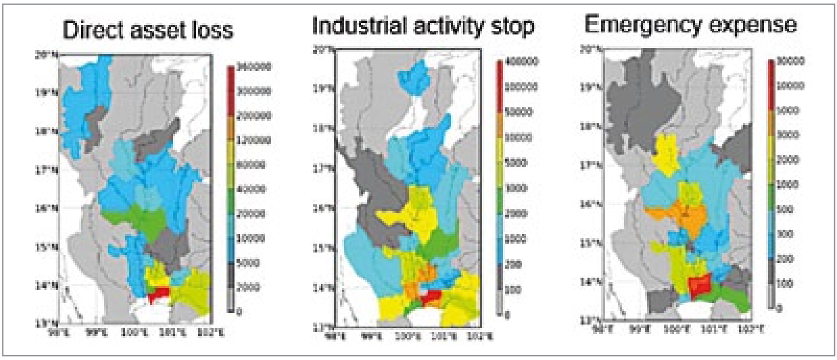

Fig. 4. Each flood loss per province

CGE ANALYSIS OF FLOOD LOSS

Calculated GDP loss by CGE model (GDP of 2011 Thailand flood minus GDP without flood) was -1.75%. This value is similar to the estimation of the World Bank (-1.1%). Although loss of asset is the largest, effect of GDP loss from Industry activity stop is the largest. The negative effect of flood loss lasts longer than 20-years after the event.

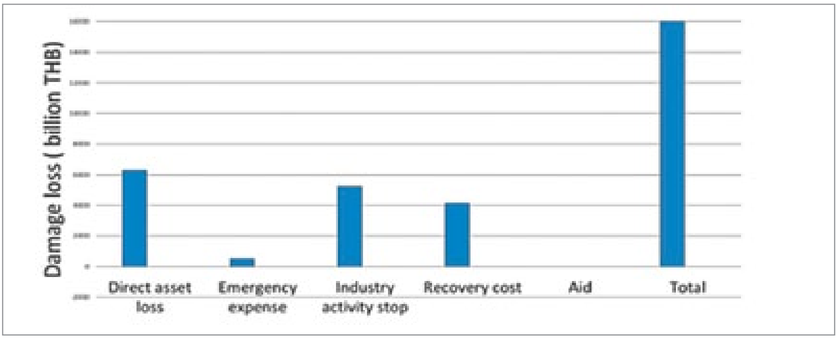

Fig. 5. Damage amount of each item

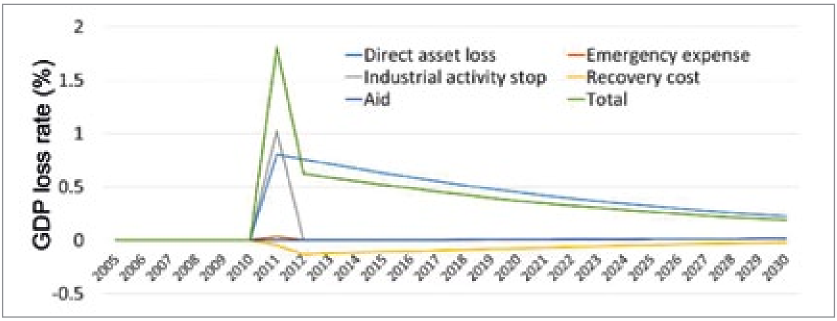

Fig. 5. Damage amount of each item

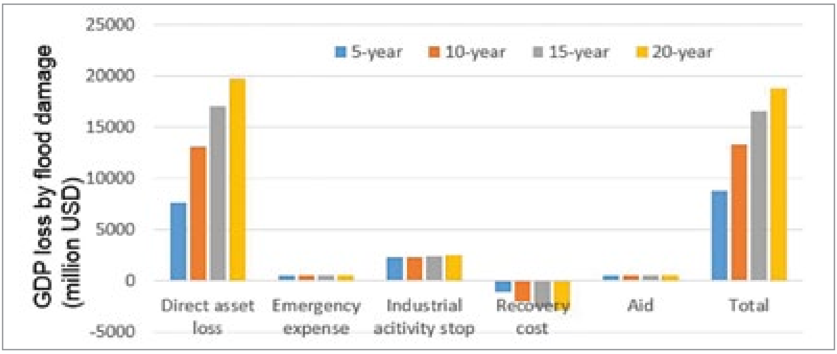

Fig. 5. Damage amount of each item

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All figures are clippings from the poster we used in the presentation at the 3rd Russian–Japanese Collaboration Seminar for Sustainable Environment.

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Meeting abstract of the presentation in the 3rd Russian-Japanese Collaboration Seminar for Sustainable Environment entitled:

Effect of water flow in internal erosion of sandy soils

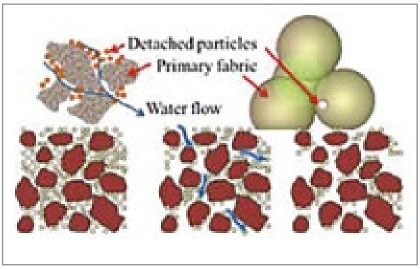


Fig. 1. Internal erosion process

INTRODUCTION

The phenomenon of internal erosion refers to the detachment of soil particles from the main structure due to the action of a fluid flow; both suffusion and piping are result of internal erosion in the ground, and can cause disasters in hydraulic structures due to heavy rainfalls. In order to know the influence of water penetration into the ground, a series of permeability tests had been performed in a highly erodible soil, applying water with various hydraulic gradients from the top part of specimens with different densities, and letting fine particles drain out, leaving the coarse skeleton behind.

TEST MATERIAL

In this study, colored red silica sand number 5 was used; this variety of sand is produced from the degradations of quartz, and has a mean diameter D50 of 0.5 mm. Also, non-plastic silt called DL-Clay was used; it is a fine material without plasticity that looks yellowish brown and has a mean diameter D50 of 23μm.

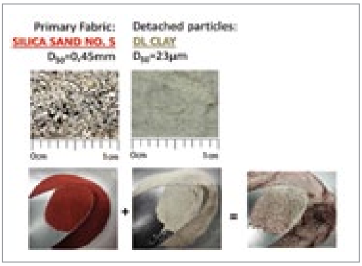


Fig. 2. Test soil

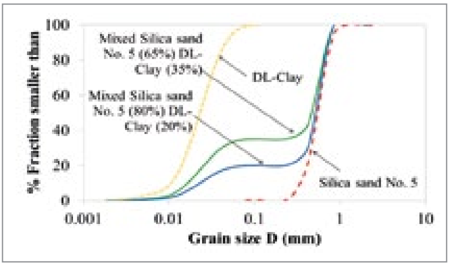


Fig. 3. Grading curves of the soils studied

Both soils (Silica sand and DL-clay) were mixed using various percentages combinations based on the study made by Kenney (1985), in which, the author suggested the maximum content of detached particles a granular soil can contain, and therefore the maximum loss possible. According to this, the percentages of Silica sand (primary fabric) and DL-clay (detached particles) were estimated taking into consideration the void ratio and average porosity.

Three soil conditions were studied: (1) loose soil (Dr= 4~10%) with 65% of primary fabric (silica sand) and 35% of detached particles (DL-clay); (2) loose soil (Dr= 4~10%) with 80% of primary fabric and 20% of detached particles; and (3) dense soil (Dr= 88~90%) with 80% of primary fabric and 20% of detached particles (Fig. 3).

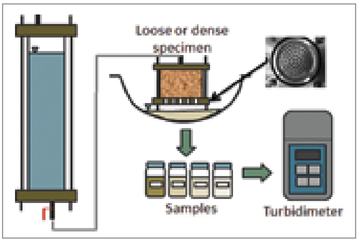


Fig. 4. Apparatus

APPARATUS

Pressurized water flowed from top to bottom in a chamber containing the soil in study, in order to investigate the effect of water and how it can drain out detached particles from a main structure. The acrylic chamber has an internal diameter of 81mm and height of 67mm; it has a bottom part with 88 holes of 5mm diameter, covered by gauze with opening of 1mm (Fig. 4).

TEST PROCEDURE

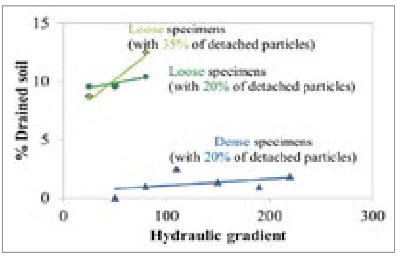
The water pressure is applied to the top part of the specimen and the water with detached particles is recollected from the bottom. The pressure applied was varied in every test. The water with fines was weighted, then, the weight of particles drained out was measured by drying the water in the oven. Additionally, the turbidity of the water expelled was measured during the experiments.

RESULTS AND DISCUSSION

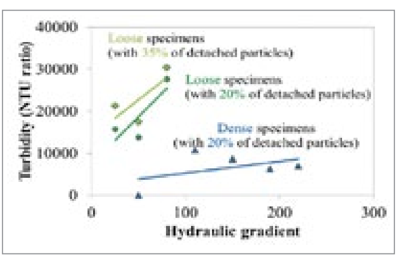
A highly erodible soil was used in loose and dense state; moreover, different percentage combinations of primary fabric and detached particles were used, examining the effect of the hydraulic gradient in the movement of detached particles. The percentage of soil expelled varies significantly between the loose and dense state. In the loose specimens the percentage drained out was around 10 to 13% of the initial mass, while the dense specimen reached around 3% in the more eroded case (Fig. 5 (a)). A similar trend is shown in the turbidity (Fig. 5 (b)).

A comparison between the grading curves of the soil before and after the test is shown in fig. 6, just the cases with extreme results are in the figure. For the soil with initially 20% of detached particles, the loss of grains is about 3% in the dense state and 17%. For the specimen with initially 35% of detached particles, the loss is around 13%.

Additionally, microscopic images were taken in order to estimate qualitatively the amount of detached particles in the struc-



a) *Amount of drained soil*



b) *Turbidity*

Fig. 5. Influence of the hydraulic gradient and density on the amount of drained soil and turbidity

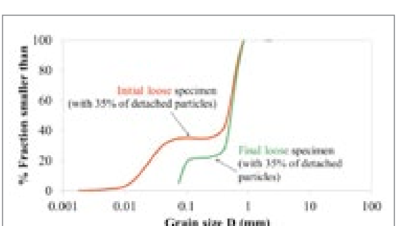


Fig. 6. Grain size distributions of initial and final specimens

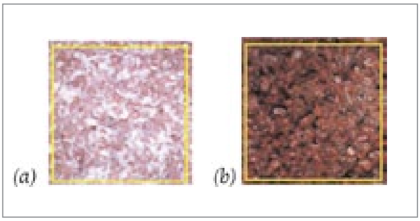


Fig. 7. Microscopic images of the specimens after the test (a) Dense specimen, (b) Loose specimen

ture of the soil. The images show that in the dense specimen after the test, still a large amount of detached particles (whitish particles) remain in the soil (Fig. 7 (a)), and that the amount of detached particles is considerably smaller for the loose specimen (Fig. 7 (b)).

CONCLUSIONS

Effects of a water flow in the internal erosion were studied in this research, by applying water pressure to soil considered as highly erodible. It was found that specimens with relative density around 4 to 10% exhibited a large amount of particles displaced (around 13% of the total), and for the specimens with relative density around 90% the particles drained out represented 3% of the total. The turbidity of the water that passed through the soil and carried out the detached particles was also measured, it was found that the turbidity value can be related to the amount of particles removed, and therefore the measuring of the turbidity can be used in field in order to estimate the grade of internal erosion.

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All figures are clippings from the poster we used in the presentation at the 3rd Russian–Japanese Collaboration Seminar for Sustainable Environment.

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Meeting abstract of the presentation in the 3rd Russian-Japanese Collaboration Seminar for Sustainable Environment entitled:

Housing recovery projects accompanying relocation in the affected coastal areas after disaster — 1993 Southwest-off Hokkaido earthquake and 2011 Great East Japan earthquake

INTRODUCTION

The Great East Japan Earthquake occurred on 11th March in 2011 and tsunamis followed by the earthquake brought severe damage mainly along the coast of east Japan. 5 years have passed since then but recovery activities still continue in the affected areas. Especially in the coastal severely affected areas, the residents have to relocate their homes to other places. Group relocation project has been currently planned in totally 135 districts. However, such project is quite costly and not easy to develop consensus and the situations in the affected area are complicated. So I would like to focus on a previous case where relocation project was performed successfully in the similar situations as in Great East Japan Earthquake. I chose two study sites; one is Aonae district in Okushiri town in Hokkaido as a previous case and the second one is Ogatsu district in Ishinomaki city in Miyagi. I aim to consider what we can learn from the previous recovery project by comparing these two cases.

Fig. 1. Locations of study sites

STUDY SITES

Two districts are taken up in this study;

A) Aonae district in Okushiri town in Hokkaido prefecture. Damaged by Southwest-off Hokkaido Earthquake.

B) Ogatsu district in Ishinomaki city in Miyagi prefecture.

Damaged by Great East Japan Earthquake.

Their locations are shown in Fig. 1. Two districts have following points in common:

- Both villages were devastated and residents need to relocat
- Both are fishing villages.

SITUATIONS OF DAMAGE

Both districts were severely damaged by earthquakes and tsunamis. The whole situations of damage in the two disasters are shown in Table 1.

	Southwest-off Hokkaido Earthquake	Great East Japan Earthquake
Magnitude	7.8	9.0
Max. Height of Tsunami	21m	9.3m
Casualty & the Missing	226	28230
Completely Destroyed House	577	121803
Damage cost	66 billion yen	17 billion yen

Table 1. Situations of damage

RECOVERY PLANS

A) Aonae district Okushiri town (Fig. 3)

To avoid residents relocating to outside of the town, special support projects for affected residents and industry were performed, fi-

[1] System of group relocation project is depicted in Fig. 2.

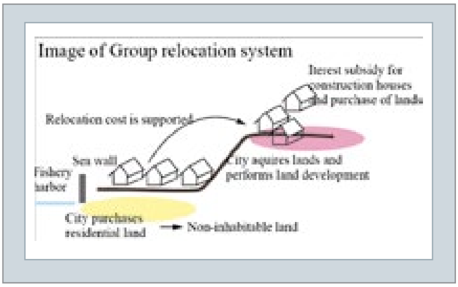

Fig. 2. System of group relocation project

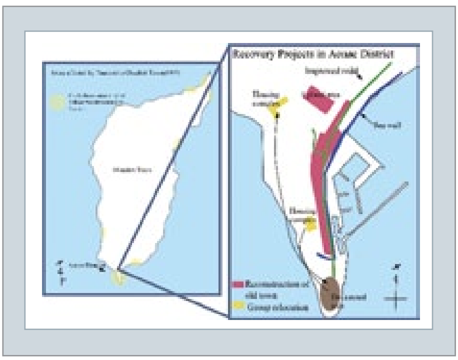

Fig. 3. Recovery plan in Aonae

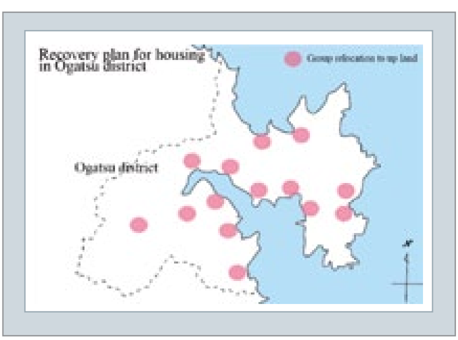

Fig. 4. Recovery plan in Ogatsu

nanced by national government and donation.

To implement relocation project, three systems were applied:

(1) Group relocation[1] for disaster mitigation

(2) Environment of fishing village improvement project; Reconstruction of old town

(3) Construction of disaster public housing

B) Ogatsu district in Ishinomaki city (Fig. 4)

To ensure the safety in terms of disaster mitigation, mainly two kinds of projects have been addressed;

(1) Group relocation to upland

(2) Construction sea wall.

As a result, residential places and working places for fishery will be separated.

PROCESS OF POLICY DEVELOPMENT

A) Aonae district Okushiri town

Three rough drafts of recovery project were presented to residents about two months after the disaster. Then it was shifted from restriction phase to recovery phase. Through briefing sessions between residents and government staff, residents showed their intensions for recovery plans. As a result, their intensions were completely split in three patterns. However, a compromise plan was made. Finally, consensus between town and residents was obtained four months after the occurrence of the earthquake.

B) Ogatsu district in Ishinomaki city

Basic policy for recovery was published by city one month after but concrete plans which includes group relocation plan were presented to residents about four months after the disaster. City held sessions for 12 days where residents exchanged their opinions for recovery plans. Recovery plan was formulated nine months later since the disaster. Still now intensions among residents are split.

CONCLUSION

To learn appropriate solutions after disaster is sought in this paper, comparing two similar disaster cases.

In Aonae case, various residents' intensions are reflected in the projects and its recovery plan seems to be flexible. On the other hand, in Ogatsu case, from the beginning up to now, one policy, or group relocation to upland has not been changed, though details were modified at many times.

These different points are found in process for recovery in these two cases. However, one common thing exists; government (town, city, prefecture) is forced to promote recovery projects as quickly as possible. Various residents' intensions were accepted in Aonae to avoid delaying recovery. On the other hand, in Ogatsu case to use group relocation to upland was decided before how the district recover is considered, in order to perform quick recovery. It takes time for residents to understand plans under complicated circumstances and to obtain consensus. Therefore, it is a good way to show detailed rough drafts at the beginning like Aonae district because it is shorter way for recovery, which Aonae case represented.

All figures are clippings from the poster we used in the presentation at the 3rd Russian–Japanese Collaboration Seminar for Sustainable Environment

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The lichen indication value in the evaluation of environmental risks

INTRODUCTION

Biological indication representing an estimate of the condition and quality of the environment became the most widely used in the 20th century. Already from the 30-ies of the 20th century began to develop, and then applied the various directions of indication. Bioindication objects — there are environmental conditions, the various components of ecosystems and their properties, etc. As biological indicators different visible organisms may be used for monitoring, because of sensitive to environmental conditions changes that can be easily studied. One of the aspects of bioindication, where the indicators are the lichens, is called the lichen-indication. A detailed overview of the standard methods of lichen-indication was carried out in the book "Lichens in ecological monitoring" [2].

PURPOSE

The main goal is to identify the contemporary state of the environment in Moscow Region on the basis of distribution within it rare and protected species of Usnea lichens included in the Red Data Book of Moscow Region (RDBMR) (2008).

Lichens are relatively widely represented in the nature. The number of species ranges, according to various estimates, between 13 500 and 26 000. Lichens of the genus Usnea — a special group of symbiotic organisms that live in conditions of relatively high humidity and minimal air pollution and is quite clearly react to environmental conditions changing [3].

There are 8 species of Usnea genus in the Moscow Region. One of these species in the mid-twentieth century completely disappeared in the region, 2 species can be detected extremely rare (1–2 finds). Species of the Usnea genus, which were found in the Moscow region in 2011–2014 are:

1. Usnea hirta (L.) Weber ex F.H. Wigg.;
2. U. dasypoga (Ach.) Shirley;
3. U. subfloridana Stirt.;
4. U. glabrescens (Nyl. Ex Vain.) Vain.;
5. U. lapponica Vain.

All these species are listed in the Red Data Book of Moscow Region (2008), their category of rarity were — 2, 1, 2, 1, 1 — respectively [8].

TASKS:

- Data processing of the monitoring undertaken on the territory of Moscow Region, during last few years;
- To create maps that highlight the differences in spreading of 5 rare protected species of Usnea genus in Moscow Region of in the past and at present;
- Assessment of the distribution of species depending on various factors: the climatic conditions [5], the position in the landscape [1], the specifics of the vegetation [4], the environmental situation, namely — the level of anthropogenic air pollution in the surface layer;
- Assessment of the current status of each of the Usnea sp. on the basis of new finds and identification of the most rare types, i.e. sensitive to pollution, which can be used as an accurate bio-indicators of the environmental state within the territory of the Moscow Region.

MATERIALS AND METHODS

Sources of information — the numerous monitoring reports and data of natural and technical surveys conducted in the Moscow Region (with the participation of the Nature Protection Fund “Verhovye” [7]), including those within the various nature protection areas (NPA). It should be noted that the study is based on the most important document — the Red Data Book of Moscow Region (2008), which listed all species of the Usnea genus, given their general characteristics and distribution in the Moscow Region on materials of lichenologists. Data on the finds in the last few years (2011–2014) are listed in the electronic database on rare species (the Data Bank "Verhovye"). For each found instance of lichen in the database there is a specific point with the serial number, geolocation coordinates for GPS-navigator, the table indicates the type of habitat in which is found the lichen, the substrate (branches, trunk, tree species, etc.), abundance and date of collection.

To create maps that should show the distribution of Usnea species in the Moscow Region, was taken the Map of administrative divisions of the Moscow Region (rural settlements). With the help of a GIS-package "MapInfo" on the maps were indicated the points at which we have found various species of Usnea in past decades since 1950, as well as all points of new finds 2011–2014. Author of essays about Usnea sp. in the Red Data Book of Moscow Region (2008) — is Tatiana Tolpysheva (Dr Sci Botany), and she identified all new finds of lichens.

To analyze habitats for the Usnea sp. in the Moscow Region has been analyzed thematic maps, some of which are listed below: vegetation cover maps [4], climate map and environmental map of the Moscow region (Fig. 1, 2).

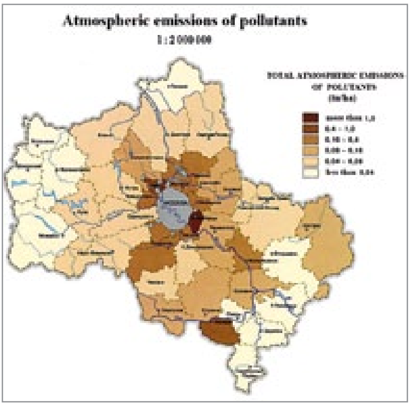

Fig. 1, 2. Climatic map of the Moscow Region (2005) and emissions of harmful substances into the atmosphere map of the Moscow region (1995) [5, 6]

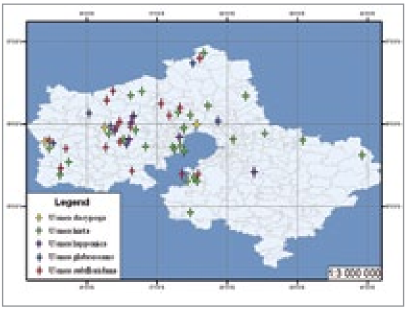

Fig. 3. The specificity of Usnea species distribution in Moscow Region (1950–1995) (compiled by E. Aristarkhova)

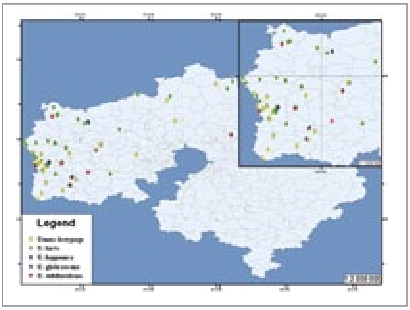

Fig. 4. The specificity of Usnea species present distribution in Moscow Region (1912–1914) (compiled by E. Aristarkhova)

Thus, in the Moscow Region was taken into account about 150 points, where found Usnea sp.: previous finds (1950–1995) — 59 points (Fig. 3), new finds (2012–2014) — 87 points (Fig. 4).

RESULTS AND DISCUSSION

The map showed Usnea sp. distribution in past decades almost on all territory of the Moscow Region with the exception of areas with the lowest humidity in the South and South-East of the territory (Zaokskaya and Central-Russian physico-geographical province), dominated by broad-leaved forests (Kashirsko-Zaraisky geobotanical district) and forest steppe begins (Serebryano-Prudsky geobotanical district).

Distribution of Usnea sp. is not evenly, it appears, in the Moscow Region highlighted areas where there is the largest number of finds and the largest number of different Usnea sp. This is the so-called zone of optimum hydroclimatic and geomorphological conditions, here is probably formed the most favorable environmental conditions for the emergence of those plant communities which have all the conditions for the emergence and further development of lichens.

It was along this border (can be traced to climate map) passes Zone Drop greatest amount of precipitation within the Moscow Region, which is an essential condition for the resettlement of lichens, given the suitability of these organisms to absorb necessary substances directly from the air, including by assimilation of drop-liquid moisture. Therefore, it is no coincidence various types of Usnea sp. concentrated around some rather large water reservoirs along the tributaries of the river Moscow, which are situated mainly in the north-east of Moscow Region. In areas where the air is most polluted with harmful emissions and dust particles, there was not Usnea's.

Obviously, the environmental conditions in the region for half a century have changed significantly, which affected both the microclimate and the composition of the air in the surface layer of the atmosphere, as well as on the nature of the flora and vegetation, including epiphytic lichen biota. Below you can see the map of the Usnea modern distribution in the Moscow Region (fig. 4) and the main results of the study, based primarily on cartographic analysis, literature sources and field materials (Table 1).

Biological species of lichens	Finds of lichens (early finds)	Physico-geographical province	Landscape typ [1]	Geobotanical district (new finds)	Formations and subformations of vegation [3]
Usnea hirta	51(27)	Verkhne-Volzhskaya	45(8)	Loto-shinsko-Taldomsky (6), Mozhaisko-Zagorsky (7)	Spruce soreel-wide-grass forest
		Verkhne-Volzhskaya	34(1.7)		Pine-spruce with oak and linden green wide-grass forest
		Verkhne-Volzhskaya	48(10)		Pine-spruce green moss forest
		Smolenskaya	40(24)		Spruce with linden and oak soreel-fern-wide-grass forest
		Smolenskaya	9(23)		Pine-spruce soreel forest

Table 1. Sensor band and wavelength

MAIN CONCLUSIONS

1. Species of the Usnea were found mostly in the north-western and extreme western parts of the Moscow Region, namely, in subnemoral and boreal coniferous forests, swamp forests and wooded swamps.
2. The maximum number of Usnea species are located in the western part of the Moscow Region in the Smolenskaya physico-geographical province, Mozhaisko-Zagorsky geobotanical district.
3. The most commonly encountered are Usnea hirta and Usnea dasypoga. They live in taiga-type (usually pine-spruce) forests and transitional bogs with young trees of downy birch and spruce. pine forests and on the outskirts of transitional bogs. These two species are probably the most resistant to air pollution and live on different species of trees, even in suburban areas (Shchelkovo, Odintsovo districts). The rarest and more sensitive to humidity and clean air are Usnea lapponica, U. glabrescens, U. subfloridana encountered only in the less built-up western and north-western districts of the Moscow region on the pine or birch trees. The most suitable conditions for lichens are formed on the outskirts of the transitional swamps and bogs of Lotoshinsky, Shakhovskoy and Mozhaisky districts, where for several decades no happened any fires.
4. Most of Usnea species are located in old and mature forests.
5. The development of rare epiphytic lichens in the southern and eastern districts of the Moscow Region is hampered by the presence of harmful emissions from factories, the lower troposphere dustiness, increased dryness of the air in the summer and frequent fires in pine forests and peat bogs bog massifs, including the reclaimed territories.
6. It is recommended to conduct more surveys in Solnechnogorsky and Istra districts, in the vicinity of the Istra reservoir, in Taldomsky district and swamp forests and swamps of the eastern margin of the Mescherskaya province.
7. Based on the current state of rare Usnea sp. advisable to consider changing the status of these species in the Red Data Book of Moscow Region. Usnea glabrescens has never been found in

the field from 1995 to 2014 years. It is necessary to continue searches of these species in the region, especially in the northern and eastern areas.

Thus, we were able to make a number of important conclusions, which may allow further developing of Usnea sp. protection in the Moscow Region, as well as serve as a basis for further monitoring, ecology and distribution of research as the species of this genus, as other epiphytic lichens with similar habitat requirements, and contribute to the development of studies of human impact on ecosystems — lichen-indication.

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Air pollution risk potential as index of sustainability to industrial impact (case study of the Hokkaido Island)

Hokkaido Island is considered as a reserve of native nature and environmental “donor” in Japan. Landscapes of Hokkaido are presented by coniferous, deciduous and mixed forests mostly grown on cambisols and andosols. 70% of these forests are estimated as modal or secondary derivative (probably transformed in past, but currently not under the human control and with a natural type of ecological succession) [1]. These landscapes have a very high value due to supported ecosystem functions and services. Because of it, we consider that assessment of Hokkaido landscapes vulnerability and sensitiveness/resistance to industrial pressure is very important.

In this research, we investigate the aspect of air pollution and calculate the index of air pollution risk potential, Kp [2]. This index reflects climatic conditions, which are typical for a given area and determine both accumulation and dispersion of pollution in the atmosphere.

The index was calculated according to the methodology of Y. Pykh, I. Malkina-Pykh, who tested their methodology with the object of Tohoku district. The equation for calculation of the Kp is looking as follows:

$$Kp = \frac{(P(V \leqslant 1) + P\ (\Delta T min,max \geqslant 9) + P\ (Q \leqslant 1))}{(P\ (V \geqslant 3) + P\ (\Delta T min,max \leqslant 5) + P\ (Q \geqslant 3.0)}$$

P (V≤1) — number of days with calm wind (wind speed ≤ 1 m/s);

P (V≥3) — number of days with wind speed ≥ 3 m/s;

P (Δ*Tmin,max*≥9) — *number of days with daily temperature gradient* ≥ *9oC;*
P (Δ*Tmin,max*≤5) — *number of days with daily temperature gradient* ≤ *5oC;*
P (*Q*≤1) — *number of days with precipitation* ≤ *1 mm;*
P (*Q*≥3.0) — *number of days with precipitation* ≥*3 mm.*

The number of days with the mentioned values of variables reflects the probabilities of these variables. If the value of $K_p < 1$ then the self-purification process exceeds the accumulation of pollutants in the atmosphere.

The methodology [2] is appropriate in the case of using Japan Meteorological Agency data. Meteorological data of 134 meteorological stations in Hokkaido were taken under the account for the 30-years period (1986–2015): daily mean data of maximum and minimum temperatures, precipitations and wind speed [3]. The index was calculated for January and July, also for annual average.

The results of research shows that in winter the Japan Sea side of the Hokkaido is characterized with low K_p values and south-eastern part of the island — with high K_p values (Fig. 1).

Mostly this can be explained due to features in precipitation course. A cold, dry, continental polar air from Siberia is much modified over the Japan Sea, and becomes warm, moist and unstable after passing the Japan Sea. As a result it brings frequent snow and cloudy conditions to the windward Hokkaido Japan Sea side. On the other hand sunny, dry weather prevails on the Pacific side. It is known that a lot of precipitation provides good self-purification abilities of atmosphere.

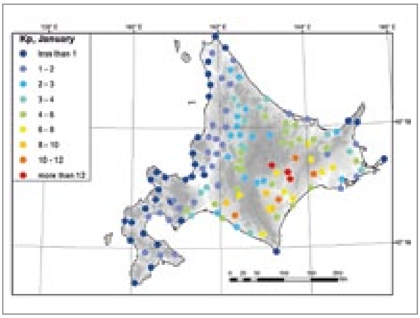

Fig. 1. The index of air pollution risk potential, Kp, January.

The minimum of K_p values are found in Oshima peninsula (station Matsumae, K_p=0,29): there are a lot of precipitations and strong winds. The maximum of Kp values have territories in the north-eastern part of Tokachi valley (station Hombetsu, K_p>12): there are landscapes between Hidaka Mountains and Shiranuko highlands,

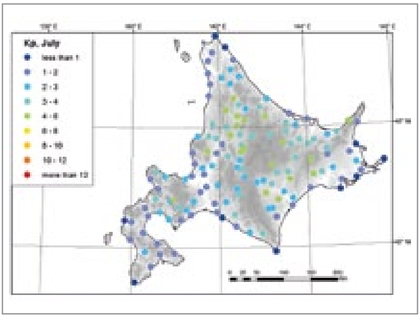

Fig. 2. The index of air pollution risk potential, K_p, July

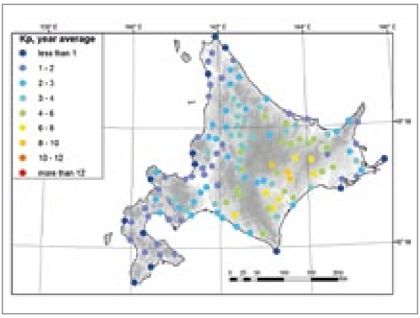

Fig. 3. The index of air pollution risk potential, K_p

which are sheltered by the relief of mountains, and the wind velocity precipitation amount are not high.

Therefore in winter, the assimilative capacity of the atmosphere and self-purification abilities from the pollutants in western part of the island is higher. Also low K_p values have Erimo cape, Nemuro peninsula, Shiretoko peninsula.

In summer season, the difference between meteorological stations is not so big (Fig. 2). The low values of Kp (K_p= less than 2) are shown for the coastal ecosystems among all island (Oshima, Hidaka, Nemuro, Soya) and higher values of K_p (K_p=3–6) are found in the inner parts of the island (Tesio valley, headwaters of Tokachi river, Abashiri plain).

Speaking about the annual average data, basically, the situation reflects the spatial features of the index Kp in winter season (Fig. 3). Thus, the highest index (K_p= more than 3) is typical for Tokachi plain, Abashiri plain, Kamikawa basin, Furano basin. The worse self-purification meteorological characteristics have landscapes in headwaters of Toshibetsu and Abashiri rivers — due to the very high the index of air pollution risk potential in winter. The best situation is observed in landscapes of Japan Sea side and coastal areas.

For the air pollution analysis it is important to know the balance between the volume of pollutant emissions from the sources (thermal power plants, industry, automobiles) and self-purification ability of the atmosphere (the index of air pollution risk potential, K_p). For instance, Sunagawa power station produces around 15 000 tons SO2 per year [4], but due to the good meteorological assimilation features of this territory, pollutants mostly are taken out from the landscapes and ecosystems can be considered as sustainable (resistant) to the emissions. On the other hand, the emissions of Asahikawa town industry (around 450 tons SO2 per year) could make strong negative damage to the landscapes because of the low self-purification abilities of the atmosphere here.

The regional differences of index of air pollution risk potential may be helpful in regional policy, environmental impact assessment, industrial development of the region in relation to air quality management and environmental management on the whole. Ecological technologies and monitoring may be recommended especially for the regions with the high index of air pollution risk ptential.

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Geoecological research at the Central zone of Baikal: environmental and tekhnogenic risks

INTRODUCTION

Geoecological research was carried out from 2012 to 2016 by students and teachers of the Faculty of Geography, Moscow State University in several summer and winter expeditions by Department of Nature Management. That research includes two main parts: hydrochemical research and landscape research. The first part connects with analysis of anthropogenic and nature influence on water ecosystems of the lake Baikal and some smaller lakes and rivers in Severo-Baykalskiy, Barguzin and Pribaykalskiy districts of the Republic of Buryatia and on the Olkhon Island. The second part is the assessment of recreational potential of landscapes in Spatial Economic Zone tourist-recreation-type "Baikal Harbour" in Pribaykalskiy District.

HYDROCHEMICAL RESEARCH

To choose the sites for water sampling the cartographic method was used. The choice was determined by the location of villages, tourist campuses and highways near the shores and flowing streams to recognizing the anthropogenic influence on water ecosystems. The water samples has the primary hydrochemical analysis includes temperature, pH, mineralization parameters and then were processed in the laboratory of the Department of Nature Management.

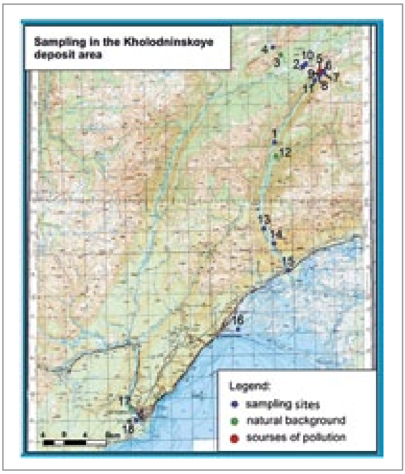

Fig. 1. Water sampling sites in Severo-Baykalskiy District

Fig. 2. Water sampling sites in Barguzin District

Sites of water sampling are shown in fig. 1–4. There were own unique aspects and reasons to make researches in each region.

In Severo-Baykalskiy Disrtict (Fig. 1) environmental impact of the Kholodninskoye lead-zinc pyrite deposit on the Kholodnaya River and Lake Baikal were assessed. “Kholodninskoe” located in the catchment basin of Lake Baikal, it’s ore body has not been developed, but the streams from mines continue to pollute rivers with heavy metals. The researches took place from 2013 to 2015 and inconsiderable influence on the Kholodnaya River was detected.

In Barguzin District (Fig. 2) the research was carried out in Zabaykalsky National Park located in the middle section of the eastern shore of Lake Baikal and on the Svyatoy Nos peninsula. There are a big number of tourists with their personal transport on the shores, so the anthropogenic impact in recreation sites in National Park is the main environmental problem. Water sampling was carried out in Chivyrkur Bay and some others small water reservoirs of the territory of National Park in summer and winter field from 2015 to 2016. As a result the excess of concentrations near tourist camps in Chivirkuiskiy Bay and Barguzin Bay, natural excess of concentrations in Barmashovoe Lake was recognized.

The main object of study in Pribaykalskiy District (Fig. 3) was the water quality of Lake Kotokel after the ecological disaster in 1990-s which stopped recreational development of tourists infrastructure near the lake. For estimating the current ecological status of Lake Kotokel and its suburbs the hydrochemical network was established to continue the geoecological monitoring at the locations of recreational facilities and prospective tourist routes.

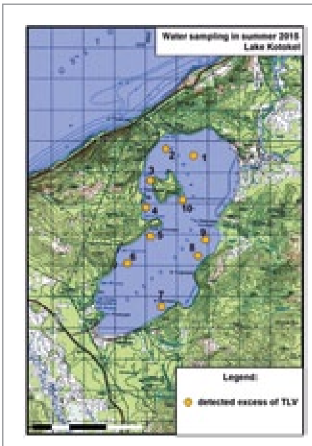

Fig. 3. Water sampling sites in Pribaykalskiy District

The research on the Olkhon Island (Fig. 4) was connected with problems with drinking water and touristic load. The water sampling was carried out in the Lake Baikal near the settlement Khuzhir and in some drinking water sources. That study took place in summer field season in 2014–2015 years.

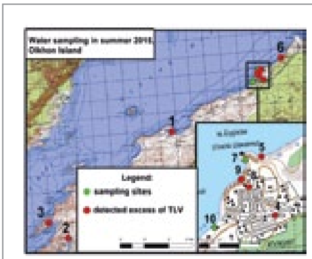

Fig. 4. Water sampling sites on the Olkhon Island

LANDSCAPE RESEARCH

The landscape research took place in Pribaykalskiy District in the most popular tourists site of coast from Gremyachinsk to Turka, which belong to Spatial Economic Zone tourist-recreation-type "Baikal Harbour" from 2013 to 2015 (Fig. 5). The Assessment of recreational potential of landscapes was included: study of the landscape structure and ecological capacity study of hazardous exogenous natural process, assessment of recreational attraction of landscapes. The comparison was made

Fig. 5. Region of landscape research

between key areas and background areas situated in the territory of Pribaykalskiy natural reserve. As the result the large amount of data was collected for thematic mapping and making distinguishing areas for different using.

CONCLUSION

In the course of the study the huge mass of data characterizing water quality in several areas of Baikal region was gathered. The lead-zinc deposit "Kholodninskoe" has insignificant impact on the River Kholodnaya. In the Barguzin and Pribaykalskiy districts and on the Olkhon Island the anthropogenic environmental impact on the water quality (the excess of background concentrations) caused by high recreation load was detected. The situation with Lake Kotokel has a positive trend: the water quality is improved naturally. By the results of landscape research thematic maps and recommendations for future improvement of beaches of Baikal Harbour" were developed.

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Dimensions of "Clean Ugra" brand formation

International community adopted several important documents promoting transit to "green economy". Among them: European program "20:20:20" directed at industry and power production "greening", UNEP "Green Course", "Rio+20" Declaration, OECD resolutions etc. [Green…2008]. According to these documents "green economy" main target is stabilization of economy development based on harmonization of "nature-population-economy" interrelations. UN experts mark 5 vital for "green economy" sectors: energy supply, transit to renewable energy sources, wastes processing, organic agriculture, ecological transport, rational water resources use. Green economy concept for Russia is relatively new and this term is not used in official documents. Nevertheless Russian future development programs for the next 10-20 year period correspond to "green economy" goals. It is obvious that mechanisms of transit to "green economy" will differ from state to state and even at a regional level in connection with environmental and socio-economic situation. Movement to economy 'greening' is demonstrated in Khanty-Mansy Autonomous Okrug-Ugra which has launched this process by elaboration of a special program. Ambitious plans for future development announced by the local administration are connected with transit to "green" economy model and "Clean Ugra" brand formation.

STUDY AREA

Hanty-Mansi Autonomous Okrug (region) - Ugra is the leading Siberian region of Russia (Fig.1). Its territory is occupied mainly by taiga ecosys-

Fig. 1. Khanty-Mansi Autonomous Okrug — Ugra

tems. The Ob River flat valley is bogged to a great extent. Western part is presented by spurs ridges of the Ural Mountains. Ugra economic development is based mainly on hydrocarbons extraction (57% from the country total priorities given to industrial land management model since 1964 caused negative environmental changes promoted by present-day climatic changes. They are connected with air and water pollution, mechanical disruptions, growth of lands occupied by landfills etc.

The following ecological problems are typical: environment pollution including solid wastes uncontrolled accumulation as the most urgent environmental problem; ecosystem mechanical disturbances connected with hydrocarbon extraction and transportation; degradation of reindeer pastures leading to indigenous population survival problems.

Several ecological risks belonging to specific "northern" are connected with environmental factors. These risks include cryological, exogenic geological and hydro meteorological. Among them: thermokarst effects, solifluction, landslides and avalanches in mountains (Berezovsky district) and from steep river banks, mudflows, erosion, floods etc. [Atlas..., 2004].

MATERIALS AND METHODS

Regional statistics, economic and environment reports, field data received during earlier studies, published data etc. were used in our studies. The principle method was system analysis.

RESULTS AND DISCUSSION

BACKGROUND FOR "GEAN UGRA" BRAND FORMATION

Possibility of economy "greening" for the sake of sustainable development of any territory is provided by combination of different factors including both natural and social-economic. Practical experiences demonstrate that territories independent of them fairly exist. For example climatic changes influence the global ecosystem processes thus involving social-economic changes. Globalization processes promote replacement of "dirty" industry to developing countries etc. Transit to "green economy" in Ugra meets various obstacles and options both limiting and promoting this process.

Main limiting factors are connected with Ugra geographical situation: long cold winters demanding additional energy supply, producing unfavorable weather conditions etc., slow biogeochemical turn-over (plant debris decomposition takes up to 20 years) and thus limited ecosystems self-purification capacity, promoting environmental pollutants accumulation in ecosystems, high percentage of bogged territories, relatively low biological productivity; long-range air pollutants transport from the Southern Ural and other neighbor industrial regions, water pollutants transported by transit river flow etc. (Fig. 2). The list of environmental hot-spots compiled recently in the Ural Federative Okrug, comprising Ugra, includes about 50 sources of air-born and water pollutants (Report..., 2008). Natural risks mentioned above also hamper the movement to "Clean Ugra" brand formation. Among them the most unpredictable is the climate change impact. Permafrost melting processes, solifluction may be accelerated. Outburst of plant diseases, worsening of sanitary-hygienic conditions due to permafrost melting, increase of areas of transmissible diseases such as malaria will accompany climatic warming. But opposite scenario exist as well.

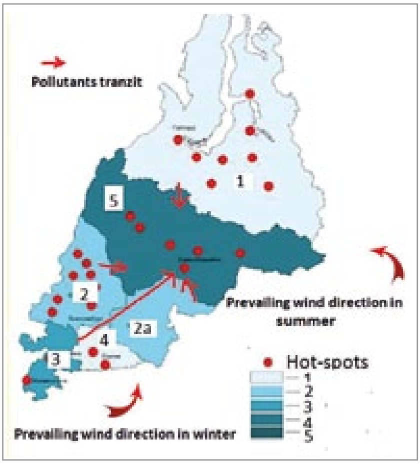

Fig. 2. Prevailing winds direction, pollutants transit routes and environmental hot-spots development.
1 — Yamalo-Nenets Okrug, 2 — Sverdlovskaya Oblast', 2a — Tyumenskaya Oblast', 3 — Chelyabinskaya Oblast', 4 — Kurganskaya Oblast', 5 — Ugra.

Social-economic limiting factors are connected with more than 50-year practice of hydrocarbons extraction, i.e. long before elaboration of important environmental protection standards. The present-day role of Ugra as one of the state's leaders in economic development promotes further industrial nature management development though

Fig. 3. Gross regional product per capita (2014) — Ugra position [based on: Platon Pskov, 2014]

ecosystem losses reduce the regional GDP to a high extent. But at the same time this fact promotes turn to elaboration of new methods of natural capital exploitation corresponding to “green” economy goals.

Promoting factors are connected with still large territories with minor technogenic impact, high percent of forested (taiga) territories, very high values of regional GDP compared to other regions of Russia (Fig.3), more than 90% of economically active population, higher expenditures for technological innovations than in Russia in general, etc.

OPTIONS FOR “CLEAN UGRA” BRAND DEVELOPMENT

Nowadays Ugra economic development is based on limited variants of natural capital exploitation. Renewable energy sources, biological resources (timber, hunting and fishing etc.), recreational resources are used inadequately but give a chance for economy diversification and transit to “green” economy. Combination of the already existing natural, economic institutional and social factors favor “Clean Ugra” brand formation. Natural factors include the following:

- More than 50% of the territory is characterized by: “low” and “very low” state of ecosystems anthropogenic disturbances;
- Richness in biological resources (timber, berries, mushrooms, hunting and fishing resources, medical plants);

- Renewable energy sources availability, including solar, wind, hydro energy sources, timber cutting by-products suitable for biogas production;
- High potential for ecological buffer territories development including indigenous population traditional nature management territories.

Leading positions in Russian economy is an important economic factor, providing financial resources for ecological investments. Among social factors are high Human development index, comparable with that of developed European countries, traditional ecological knowledge of indigenous population, well developed public ecological organizations united in "Ugra ecological consortium". State ecological monitoring, nature conservation and nature management services, advanced public ecological education and regional ecological legislation present important institutional factors supporting transit to "Clean Ugra" brand.

Nowadays common approaches to "green" branding have been developed (Fig.4). We analyze options for "Clean Ugra" using them, but add regional factors mentioned above.

Options for transit to economy "greening" followed by "Clean Ugra" brand formation include the following regionally adapted measures presenting economic, nature management and institutional tools (Fig.5): transit to higher energy consumption efficiency and active exploitation of wind, solar and mini-hydropower stations; "climatically neutral" production(new technologies); development of organic agriculture production (reindeer meat, vegetables, forest berries and medical plants etc.) ecological accounting in GDP assessment; transparency of ecological accounts; forested areas preservation for carbon sequestration; development of "nature favorable" eco-

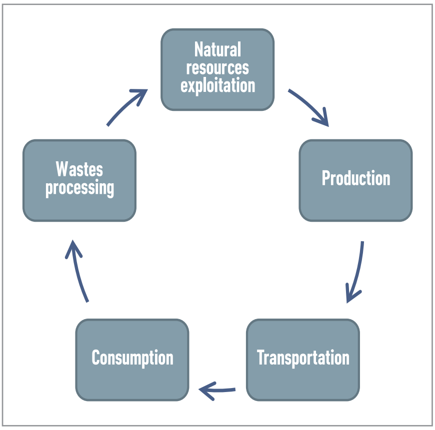

Fig. 4. "Green" branding elements

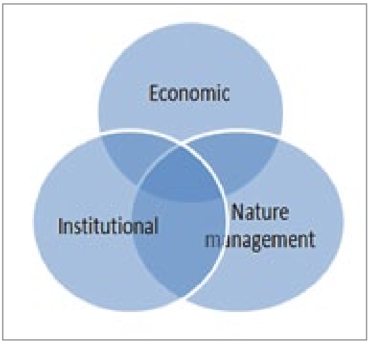

Fig. 5. Principle regionally adapted measures for "Clean Ugra" brand formation

nomic sectors (tourism, recreation traditional nature management), adequate wastes management and ecologically safe oil transportation; development of green infrastructure capable to restore regulatory eco-systems ecological services; modern interpretation of indigenous population traditional ecological know-how; preferences to eco-settlements construction in pioneer development regions; ecological certification, etc.

CONCLUSION

Ugra has all chances to be the first oil extracting region in Russia characterized by "Clean" bran. It will demonstrate options for transit to "green" economy and sustainable development for other similar territories. Administration of Ugra is now elaborating a special program directed at "Clean Ugra" brand development. Primary attention is given to "green" technologies, proper industrial and communal wastes management, nature conservation. "Clean Ugra" brand formation will take time but may be successful if to follow Japanese Kaizen philosophy: gradual improvement of all processes and control of working strategies.

ACKNOWLEDGEMENTS

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Rural development based on natural protection

INTRODUCTION

The development of rural areas based on ecological principles is very important as it provides effective rural development as well as the environmental protection. Such strategic directions are of great importance in connection with fast urbanization growth and desire to use some rural areas in the process of city construction [2]. This research is very important in such administrative regions where nature management is carried out at the municipal level.

METHODS AND OBJECT

This search for new directions of rural development is based on the complex studies, mainly on the special features of natural social and economic resources. The indices characterizing the rural areas and those influencing the development are grouped as follows:

- specific character of natural conditions and resources
- use of agriculture territories
- peculiarities of settlement
- ecotourism
- economic development
- state of ecological situation
- quality of standard living of the population.

Plan of the effective nature management was based on landscape planning and agricultural adaptive development as part of morphological landscape structure. Adaptivity includes consideration of

Fig. 1. Countryside of the Kolomna district

bioclimatic conditions as well as technological agricultural improvement. Here the most important in this ecological development are organic agriculture, husbandry, cottage building, sport tourism, agricultural tourism, ecopathways in forests and natural reserves, building of boarding houses and children camps, a specially protected natural reserves, reconstruction of historic monuments, ecological settlements.

It is necessary to pay greater attention to the formation and preservation of the ecological structures. Kolomna district (Moscow region) was chosen as a model (Fig. 1). It is situated in south-east part of Moscow region. Kolomna is a center of its district, and forms a separate municipal unit. The area of the district is 1112 square kilometers occupying the 18 place in this region.

This district is situated between Moscow and Ryazan at the distant of 80 kilometers from each of these cities. This territory is located on the north-eastern slope of the Middle Russian highland at the place where the Moscow River flows into the Oka (Fig. 2). The afforestation ranges from 30 to 90 percent. The climate is temperate continental and soils are podzol.

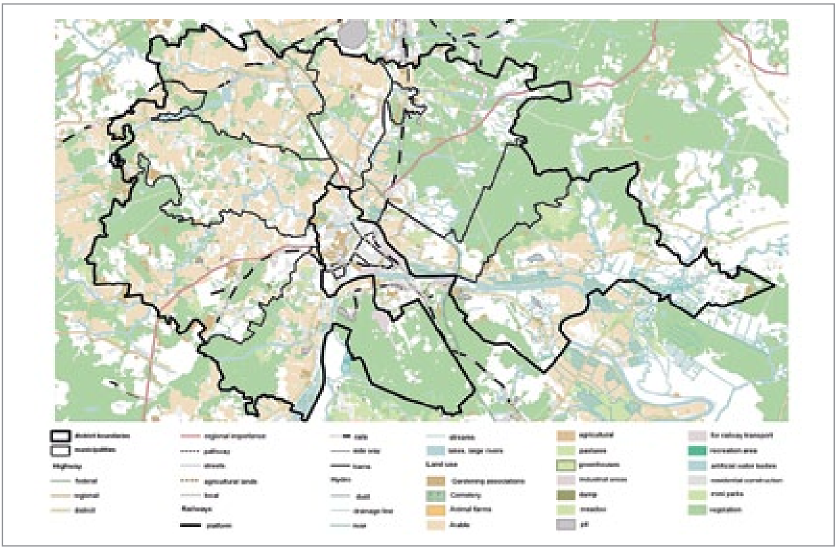

Fig. 2. Territorial structure

RESULTS

Regional agricultural nature management was developed based on the studies of regional history and settlement, economic-geographic situation based on studies of the main ecological problems. The ecological status of the area as a whole can be considered satisfactory, because there are no major polluting industries, but there are local sources of pollution. The most significant problems associated with the development of erosion and karst processes, the development of which is due to lack of the necessary measures for land reclamation. Also dangerous is the increase in the area set aside for storage of municipal solid waste and the development of illegal dumps [1].

One of the most perspective directions will be developed with the orientation on the new technologies and methods, organic agricultural development (high quality fruit and vegetable growth and production of ecologically clean meat and dairy products). This was developed in the agricultural industrial complex " Nepetzino" which provide high quality products for hospitals and children preschools. It is also worth and products mentioning a small enter-

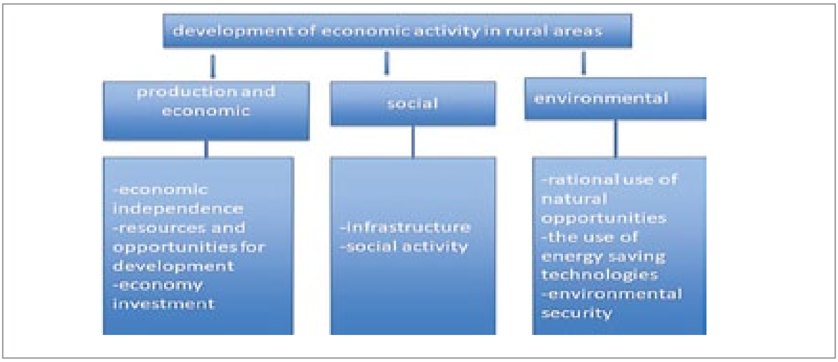

Fig. 3. Development of economic activity in rural areas

prise «Ecovillage» producing clean products, successfully selling its meat dairy.

The complex use of natural and socio-economic resources results in the development of different possibilities of new directions, one of them is agricultural tourism as part of agricultural economy (Fig. 3). Agricultural tourism may be also include fishing and includes work and rest in the farms. There are 41 farms in this territory. Their area amounts to 1,9 ha, 67% being pastures. The first contact zoo in Moscow region appeared in Gorky and serves at the base for rural development of this area.

Recreational development is determined by favorable natural conditions enabling all year round activity along different directions; natural and history — cultural sites; special landscape scenery of Middle Russia and temperate ecology.

Tourism may be developed on the basis of 101 sites of city architecture, 57 historic — cultural monuments, 22 of them being of federal significance. To maintain satisfactory ecology it is necessary to develop ecological tourism on specially protected natural territories. At present specially protected natural territories occupy only 0,3% of the region. It is also worth mentioning the fast development of cottage construction. In summer the population living in the country amounts to 64,8 thousands of people.

The example of successful combination of economic activity aimed at development of modern agricultural enterprises is the fishery «Os-

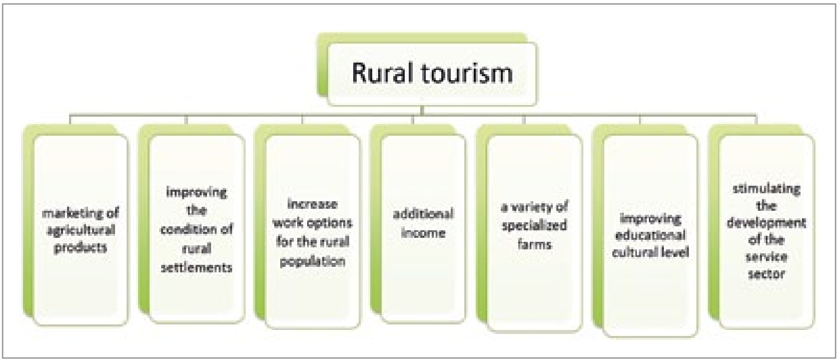

Fig. 4. The positive aspects of the development of rural tourism

enka». Being a model territory it represents example for possible combinations of agriculture, recreational and protection of natural management (Fig.4).

CONCLUSION

Territorial increase of recreational and specially protected environments at the expense of non-developed territories and amelioration of socio-economic conditions, such as the creation of work places will eventually change this area and make it more attractive as a future residential habitat.

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Biological Risk Factors for Aquatic Ecosystems of the Baikal Natural Territory – Investigations within a Project "Lehman–Baikal– 2015"

Ground investigations of coastal aquatic vegetation of Lake Baikal and inland water bodies of th e Baikal Natural Territory (BNT) were among the main goals of the field campaign-2015 within the project "Lehman-Baikal-2015".

The special attention was paid to the problems relating to identifying and studying the mass development in the coastal waters of filamentous algae (including Filamentous macroalgae Spirogyra sp.) and the fast expansion of some invasive species of aquatic vegetation (including Elodea Canadensis Michx.), that have now become a real biological risk factor for aquatic ecosystems of the BNT.

For solving all the main goals and objectives of the project various investigations were carried out: hydrological, hydro-chemical, botanical, landscape, etc., as well as microscopying of filamentous macroalgae and ground hyperspectral spectrometry (Fig.1). About 40 descriptions of individual species and plant communities of coastal aquatic vegetation of Baikal and inland water bodies of the BNT were made in accordance with specially designed blanks of 3 different types. 40 samples of filamentous algae were selected, microsco-

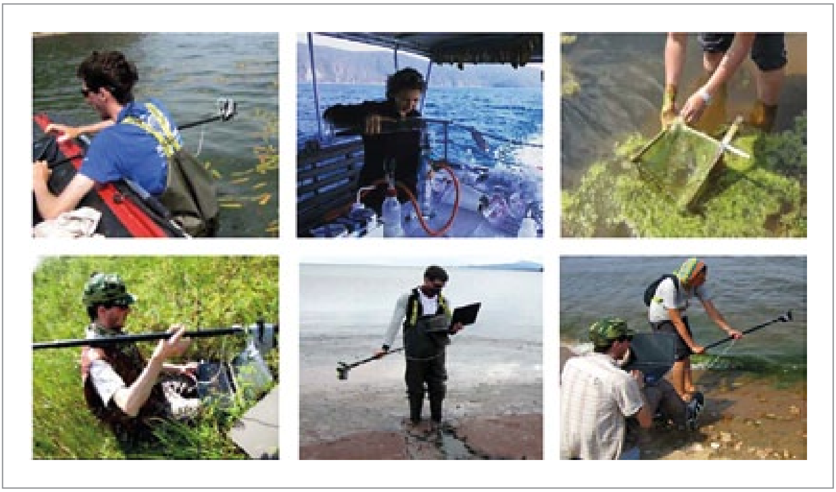


Fig. 1. Some studies conducted during the field work (hydrological, hydro-chemical, botanical and sampling of phytomass, ground hyperspectral spectrometry and etc.)

pyed, their generic assignment were determined and the results were compiled to the album of algae microscopy consisting of 43 pages. More than 120 spectra of individual species and plant communities of coastal aquatic ecosystems on 36 sites were obtained by ground hyperspectral spectrometry with Ocean-Optics-USB-2000 and results were compiled to the album of spectrometry consisting of 108 pages. So the extensive varied data were obtained. For today these data have only a preliminary interpretation and certainly require further processing and analysis.

Elodea Canadensis Michx. — is a perennial aquatic plant native to North America. For Eurasia it is an invasive (introducted) species (fig.3). In Lake Baikal Elodea was first observed at the end of the '70s in the Selenga River shallows. Then it rapidly mastered almost all the bays, gulfs and sors of the Baikal lake. The rapid spread of it is associated with intensive navigation. In subsequent years Elodea started to spread over ponds and streams of Zabaikalie. Thus, a new Baikal-Angara-Selenga transboundary invasive corridor of Elodea canadensis's locality began to form [1].

After implementing the ecosystem Elodea begins rapidly grow up and bloom, sometimes filling more than a third part of water volume. The depth of it penetration may be about 1–3 meters. The formation

Fig. 2. Eutrophication of Lake Kotokel

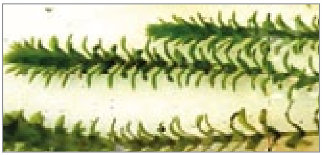


Fig. 3. Elodea Canadensis Michx

Fig. 4. The massive outbreak of the development of blue-green algae Gloeotrichia echinulata in Lake Kotokel in July, 2015

of powerful thickets of Elodea Canadensis usually leads to the depletion of floristic composition of the pond and to the massive development of the genus Cocconeis. Changes in the structural organization of phytocenoses is also reflected in the abundance of invertebrates. After 6-10 years Elodea fully cycles from development to extinction. After the initial phase of rapid bloom comes the decrease of its amount and hundreds of tons of dead grass lie on the bottom of the lake, where it begin to decompose. Decomposition of huge biomass may be a factor of the development of the pond cyanobacteria (blue-green algae), producing the toxin microcystin LR, which becomes the cause of the mass death of fish and a source of toxic human disease so-called ***"Gaffsky disease"*** syndrome (alimentary toxic paraksizmalnoj mioglobonurii). Microcystin by ingestion of aquatic and semi-aquatic animals and humans amazes the skeletal muscles, kidneys and liver, and tends to accumulate in the fatty tissues.

Lake Kotokel (Fig.2) has always been a popular recreation area and also it was a fishery water body of the first category. There are about 40 tourist bases and rest homes on the banks of Kotokel, but most of which are now closed. In July 2008 the severe environmental situation formed here. The consequence of this situation was the series of poisonings among residents of coastal villages (one person died). A ban on the use of the lake Kotokel for recreational, drinking and household purposes was introduced. The cause of the ban was the disease outbreak of enterovirus infection — ***Gaffsky diseases*** associated with swimming in the lake and using of contaminated fish caught in the lake. As the main cause of the incident is considered the introduction in 1986 into the lake nonnative aquatic plant Elodea Canadensis. Currently it has come the full cycle from development to extinction. The result of this process — was the high content of toxic cyanobacteria and microcystin arising from the life activity of blue-green algae which actively developed as a result of decomposition of the Elodea (data 2010-2012). No less significant factor in the development of enterovirus infection, besides eutrophication of the lake, can be considered the other forms of pollution, first of all associated with the previously active recreation development in the coastal zone of the lake.

The employees of the department of environmental management continued for 4 years to monitor the status of some hydrochemical parameters on the lake: the amount of heavy metals (Zn, Cu, Pb), phosphorus mineral (P min), pH, total mineralization, nitrogen form, hardness, calcium, magnesium, bicarbonate anion (alkalinity), chlorides, evaluation and other organic matter. The assessment of the current state of the aquatic ecosystem of the lake Kotokel and controlling the possibility of re-development of Elodea canadensis is an important goal because can contribute to the restoration of recreational potential of Kotokelsky recreational zone.

The situation of previous years — until 2014 — indicates some stability in the state of the aquatic ecosystem of the lake Kotokel. Instances of Elodea met single specimens and were severely depressed. However, in 2015 on the background of sharp decreasing of the water level in the lake a massive outbreak of the development of Cyanobacteria (blue-green algae) ***Gloeotrichia echinulata*** was recorded (fig.4). Mass reproduction of blue-green algae, known as "water bloom" is a phenomenon of ecological order, it has important biological and medical importance. It is accompanied by accumulation in the body of many aquatic organisms and aquatic environment potent toxic substances produced by some species of cyanobacteria, including Gloeotrichia echinulata. Thus in the connection with 2015 situation it is necessary to conduct the regular comprehensive sanitary survey of the lake by the local sanitary-epidemiological service, with obligatory inclusion of microbiological, toxicological and sanitary helminthological researches. It is also desirable to undertake further multidisciplinary more detailed study of the ecosystem of the lake with the involvement of specialists in different fields (hydrobiologists, microbiologists, algologists, limnologists, hydrochemists et al.), which will really appreciate the modern ecological situation in the lake and evaluate the possibilities and prospects for recreational use of the lake based on the modern dynamic trends of its development.

Supposedly a similar threat has been detected in a number of small recreational lakes of BNT. So in 2014, at **Lake Bakany** it was detected a massive development of Elodie Canadensis, but in 2015 only a few instances of algae were observed. Perhaps here lies the risk of recurrence of the environmental situation which occurred a few years ago in the lake Kotokel. In **Slyudyanskie Lakes**, where Elodea in 2005 was absolutely absent, algae accumulation areas were described in 2015. All these facts support the idea about formation of a new Baikal-Angara-Selenga transboundary invasive corridor of Elodea Canadensis [1].

Currently the problem of Elodea Canadensis concerns not only small lakes of BPT, but also large inlets and bays of the lake Baikal. Formation of thick tangles of Elodea on the bottom **shallow Baikal bays** causes pauperization of floristic composition of phytocenoses and have a strong effect on the abundance of invertebrate animals [2]. Elodea also has been found by us during the field campaign-2015 in many shallow bays of Baikal (in Maloye More strait, in a shallow lagoons — Posolsky and Angarsky Sor, in Chivyrkuisky, Mukhor, Barguzinskiy and other bays) (Fig. 5).

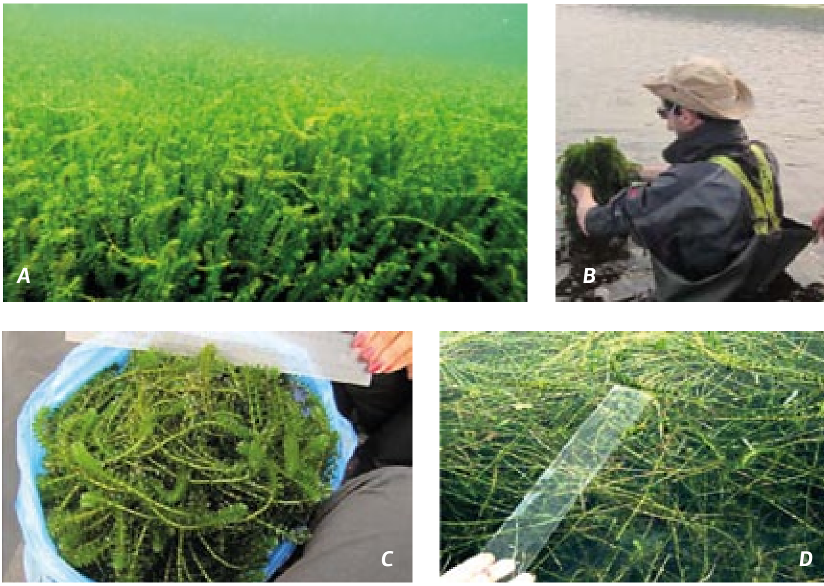


Fig. 5. Elodea Canadensis Michx. in Chivyrkuisky Bay: ***A****- thick tangles of Elodea attached at the bottom of Firtikh Bay (underwater photo);* ***B,C*** *- sampling Elodie on phytomass in Onkogongskaya Bay;* ***D*** *- accumulations of teared off or not rooted Elodea on the water surface in Krutogorsky Bay.*

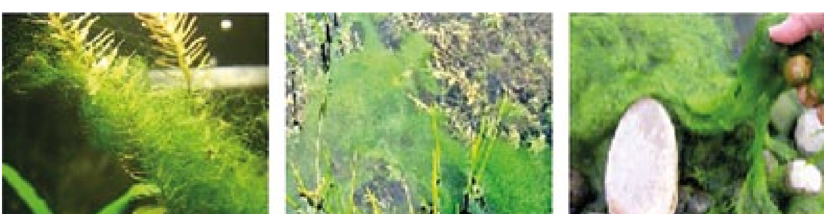
However, today the main threat to Baikal is the active spread of ***Spirogyra sp.*** and other filamentous alga. Mass blooming of Spirogyra sp. is often observed in waters exposed to eutrophication. Previously in the cold waters of Baikal it presence noted only in some bays and gulfs, moreover very rarely. But **in 2010,** the unusual for Baikal mass blooming of Spirogyra was first noted in the southern Baikal. The next years Spirogyra continued to spread, and its distribution area represents is expanding rapidly. In the areas of mass development it forms dense carpet covers the coastal rocks and stones displacing the unique native species of algae, becoming the cause of death of animal species, including gastropod mollusks. When it dying the giant accumulations of decaying algae Spirogyra submitted to strew shore and beaches. It was found that the mass bloom of algae Spirogyra currently occurs almost along the entire east coast of the lake Baikal and almost half of the west coast. It is currently considered as one of the most urgent environmental prob-

Beach Area of Severobaykalsk — decaying Spirogyra (2014)

Beach Area of Severobaykalsk – a huge mass of decaying Spirogyra and dead shellfish (2014) *of decaying Spirogyra and dead shellfish (2014)*

Beach Area of Severobaykalsk — decaying Spirogyra (2015)

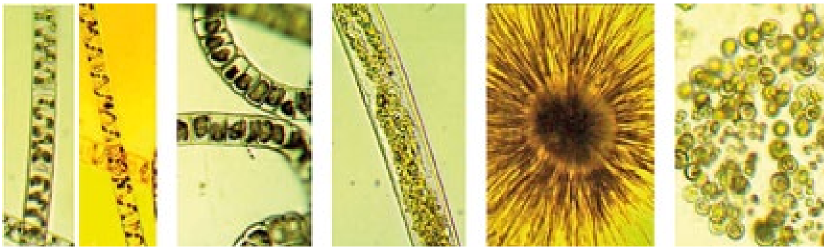
Fig. 6. The most critical situation with active development of Spirogyra has developed in the area near Severobaykalsk



«Clouds» of Spirogyra and other filamentous

Gloeotrichia echinulata (underwater photo), Nostoc pruniforme, Ulotrix zonata

Fig. 7. Filamentous algae in Lake Baikal and small lakes of BNT



Spirogyra sp. | *Ulotrix zonata* | *Cladophora sp.* | *Gloeotrichia echinulata* | *Microcystis sp.*

Fig. 8. Most frequently encountered green algae (Chlorophyta) (including filamentous) and blue-green algae (Cyanobacteriae), which can evoke algal blooms, produce the toxic agents and disimprove the environmental situation in aquatic ecosystems of the BNT (the fragments from the album"Results of algae microscopy")

lems for the Lake Baikal and some authors interpreted it as **"the environmental crisis"** [3, 4].

The more catastrophic situation has developed in the vicinity of **Severobaikalsk city.** During last 3–4 years Beach Area of Severobaykalsk completely lost its recreational attractiveness in connection with the accumulation of a huge mass of decaying Spirogyra in the coastal waters of Lake Baikal and the beach surface (Fig.6). Mass development Spirogyra presumably is associated to exposure to the river Tya untreated waste water of the city.

Active development of other **filamentous algae** was also registered in 2014 and 2015 in almost the entire perimeter of the central and northern part of the lake Baikal and in all studied small inland lakes of the BNT (Fig.7). Apparently this is due to changes in climatic conditions, fluctuations in water level in Baikal, as well as the discharge of poorly treated wastewater.

Sampling and microscopy of filamentous algae to determine the species composition in the areas of it rapid development has shown that in 12 sampling points out of 40 points Spirogyra amounts to 100%, and in 6 sampling points — more than 80% of the total species composition (Fig.8). Microscopy of samples for transferring the results to the department of environmental management (for preparing the album of microscopy) was performed by the researcher of the Institute of Biology at Irkutsk State University O.O. Rusanovskaya.

Conclusion. Conducted researches have shown that mass development in the coastal waters of filamentous algae and the fast expansion of some invasive species of aquatic vegetation is a very widespread phenomenon today, that occupy an extensive water areas. In this connection it is necessary to develop new methods for monitoring the situation, implying not only the land but also a Remote sensing methods. In this context in 2015 the works on ground spectrometry and creation of the library of hyperspectral images of studied species were conducted.

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THE 3rd RUSSIAN-JAPANESE / THE 2nd STEPS COLLABORATION SEMINAR FOR SUSTAINABLE ENVIRONMENT: 3 DAYS IN MOSCOW

1. Delegation from the University of Tokyo at the map of Russia

2. On the eve of the opening of the seminar, the deputy of the State Duma, Prof. M.V. Slipenchuk received guests from Tokyo in the main building of the Russian parliament

3. During the reception of Prof. M.V. Slipenchuk spoke about the work of the Russian parliament in the field of environmental policy and about cooperation between Russia and Japan

4. During a walk around Moscow: Ms Luisa Fernanda Santa Spitia and Mr Satoshi Watanabe

5. Dr. Kumiko Tsujimoto and Prof. Wataru Takeuchi

6. Japanese guests at the Bolshoi Theater

7. Opening of the seminar. Moderators: Dean of the Faculty of Geography Prof. S.A. Dobrolyubov and head of the Department of Nature Management Prof. M.V. Slipenchuk

8,9 At the opening of the seminar were its distinguished guests: Mr. Onishi Kazuyoshi of the Embassy of Japan in Russia and Prof. V.A. Kolosov, President of the International Geographical Union

10 Russian and Japanese moderators of the sessions: Dr N.N. Alekseeva and Prof. S. Sato

11 Dr. A.A. Pakina and Prof. S. Yamoguchi.

12 Prof. Yu. L.Mazurov and Dr. S. Watanabe

13 Dr. K. Hatoyama introduces to the seminar participants a proceedings of the 2nd Russian-Japanese seminar on sustainable environment

14 Report at the seminar: head of the Department of Oceanology, Faculty of Geography, MSU, Corresponding Member of the Russian Academy of Sciences, Prof. S.A. Dobrolyubov

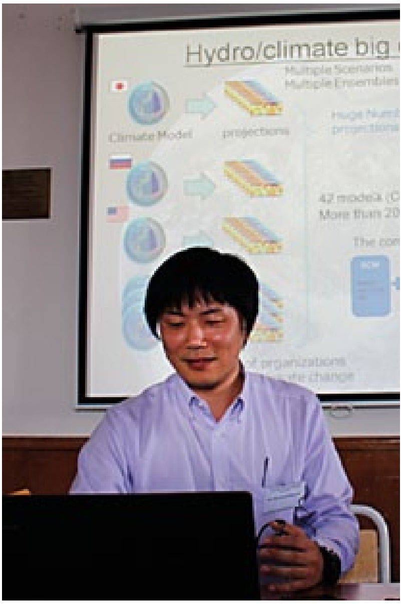
15 Prof. Shinji Sato:report on flooding risk management in urbanized coastal zone.

16 Presentation by Prof. Makoto Shimamura, Director-General, Innovation Center for Meteorological Disaster Mitigation, glaciology and meteorology, NIED

17 Presentation by Dr. Sergey Sokratov, Dept of Cryolithology and Glaciology, MSU

18 Prof. Satoru Yamaguchi. Report on snow and ice research in National Research Institute for Earth Science and Disaster Resilience.

19 The theme of sustainable development was vividly presented in the report of Dr. Yu Maemura

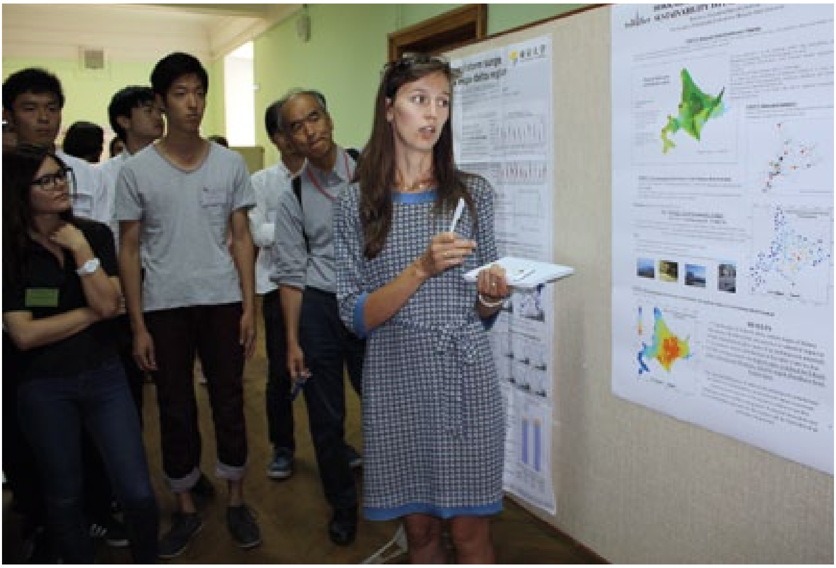


20 Dr. Satoshi Watanabe.

21 Japanese students were very active in professional discussions.

22 Comments from Dr Alla Pakina.

23 Participants of the Poster session.



24 Participants of the Poster session.

25 Participants of the Poster session.

26 Participants of the Poster session

Photos:
A. KLISHINA, I. MARGOLINA,
Yu. MAZUROV , O. YASNOPOLSKAYA

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"NATURE AND ENVIRONMENTAL RISKS AND POLICIES"

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