GLOBAL CLIMATE CHANGE AND RISKS OF ARCTIC ACTIVITIES

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Abstract. The Arctic region plays a crucial role in climate management in other parts of the world. Global warming and climate change affect the state of many natural ecosystems and thus – the state of the biosphere as a whole, the biosphere conditions of human existence. The article was analyzed the sources of risks of polar regions due to the warming of the Arctic climate. Modern scientific research related to climate change, which is the determining cause of the warming of the Earth's climate are analyzed. Climate change caused by the industrial development of mankind has taken place too quickly over the past 100 years, and modern society can no longer ignore this problem. There is a risk of further increase in average temperature, so, by 2050, a special danger is the destruction of ice sheets. The author highlighted the risks affecting climate change and among them CO2 is the main anthropogenic factor caused by the burning of fossil fuels. Measures are proposed to solve the problem to continue the sustainable development of the Arctic territories and reduce the degree of risk.

Keywords: world climate change, Arctic region, global risks, development of the Arctic territories, regional risks

1. Introduction

Recently, the world community has been expressing increasing concern about the projected climate change for the 21st century. The main thing in this change is the already begun increase in average temperature both in the atmosphere and in the surface layer, which can have an adverse impact on natural ecosystems and on humans. It is no exaggeration to say that the problem of global warming today is becoming one of the most important problems of human survival.

Due to the unprecedented speed of climate change and fragmented natural environment, modern climate change can lead to the disappearance of large numbers of organisms and a sharp reduction in natural biodiversity.

The global climate change was in the past (for example, in the ice age), and human civilization was the loss of civilization itself, not only because people in the world were not very calm, but also a short place of residence. People live almost all over the earth that nowhere have to move fast in a changing global climate, and I can't stand cities or even the survival of an entire country, like the threat of ever-rising sea levels. The main threat to human civilization associated with climate change is constantly rising water levels, increased frequency and intensity of natural disasters; expansion of dangerous areas of agriculture and food security. [1]
Climate change in the Arctic is dangerous not only for the environment of the region, but also for the world level. The problem of global climate warming in the Arctic region is manifested most clearly because in this region it is getting warmer faster. NASA statistical observations show that over the past 50 years, the Arctic region has warmed most compared to other regions of the globe. It is against this background that this article aims to: (1) to analyze modern scientific research related to climate change; (2) proposing measures to minimize the risks of activities in the Arctic The paper is a theoretical study.

2. Methods
Research methods are systemic and complex analysis, the method of scientific abstraction, formal logic (induction and deduction), classification, evolutionary approach, including theoretical ideas presented in publications.

Nowadays, more and more humanity is concerned about global climate change on Earth. To date, the world scientific community has received irrefutable evidence of the age-old trend of global warming, which serves as an indicator of climate change on Earth [2].

Over the past hundred years, the near-earth temperature of the atmosphere has increased by 0.74 °C. The average temperature in the Northern hemisphere in the second half of the twentieth century was higher than in any 50-year period in the last 500 years and probably the highest in the last 1300 years. The phenomena of global warming are consistent with phenomena confirmed by a huge array of empirical material, such as an increase in the level of the World Ocean, the melting of glaciers and polar ice sheets (especially in the Arctic), a decrease in the area of the earth's surface covered by snow and ice, and an increase in the amount of precipitation in some regions (eastern part North and South America, Northern Europe, North and Central Asia) and reduction in others, expansion of arid zones (Africa, part of South Asia), more frequent tropical cyclones in North Atlantic, etc.

Global warming and climate change affect the state of many natural ecosystems and thus – the state of the biosphere as a whole, the biosphere conditions of human existence.

The Arctic is a region of international cooperation and competition. The rich resources of the Arctic, sea transport corridors, all this creates the basis for the origin of geopolitical confrontation, the economies of the world to achieve their political goals.

In classifying Arctic activity risks by source of occurrence, the following risk groups can be distinguished:
Global and circumpolar countries [3] may include:
• Arctic climate warming;
• technogenic and anthropogenic load;
• protection of life safety in the Arctic;
• insufficient level of development of science and technology.

Risks of circumpolar countries:
• confrontations over issues of control over the Arctic territories;
• confrontations over regulation of Arctic shipping;
• low level of socio-economic development of the Arctic regions.

The Great interest to the world economy could be the Economic assessments of the damage caused by climate change. However, the uncertainty of projections of climate change itself, as well as the complexity of establishing cause-and-effect relationships within the climate system, lead to very different outcomes in models. Thus, according to the Nordhaus model, a warming of 1-2°C can cause damage of 1-1.5% of world GDP, while the Mendelssohn model predicts a slight increase in GDP for this interval. Warming at 5-6°C according to the Mendelssohn model will give a minimum drop in GDP, according to the Nordhaus model, it will be 6-11%, according to the stern model, it will be catastrophic-14-15%. In the previous models, N. Stern believes that a number of serious consequences of
climate change are not taken into account. At the same time, his own model has also been strongly criticized, in particular, for the zero discount rate.

From the presented set of economic estimates, despite their heterogeneity, two important conclusions can be drawn about the possible damage from climate change. First of all, the threshold, which will be followed by a fairly sharp increase in damage, is a temperature increase of about 2°C compared to the pre-industrial era. Exactly this value that has been officially established as the upper limit level of warming, beyond which humanity should not go. However, even it is very conditional which was recognized at the negotiations in Cancun in 2010, where the possibility of revising the permissible threshold for temperature increase in the future was voiced.

Secondly, all models predict that the damage from climate change will be unevenly distributed among the inhabitants of the planet, and the most negative consequences will fall on areas in low latitudes. So, even according to the most optimistic model of Roofing, the damage for African countries even with a warming of 2.5 °C will amount to 4.1% of GDP [4]

The average temperature increase, which is caused by the climate change, is very important by the reason of the own generated other phenomena. These can be listed below:

• Weather extremes become more common, and extrinsicity clearly leads to an increase of interventions; That is, the workload of the persons responsible for their elimination such as firefighters and the associated physical and psychological burden will increase compared to the previous one, leading to faster "wear and tear" of the staffs.

• The low humidity often associated with higher temperatures and it leads to the faster spread of certain fires. The curbing of which is more concentrated in the same interveners, but assuming the same effort as earlier, it means the use of greater human resources. It means the only increase in the physical and psychic load again, which means that it will lead to faster wear and tear of the staff.

• Even though the above are specifically related to the interventions, let us not forget about the fact that the positive temperature extremes are becoming more frequent - even as any other employee
  - can have an effect on the firemen when they are not to fight a fire, but also be prepared to provide standby at the fire department. According to the text above, climate change is not an impulsive burden on the firefighters from a specific direction, but rather generates a complex effect on them, which consists of several components, which can reinforce each other's influence even exponentially. It is obvious that each of the effects of the climate change will require a much more detailed examination later, but in this article the author only focuses on the last, that is, the effects on the firefighters that are equally burdened by the average person's organization.[5]

The main objective of the study was to suggest an approach to move towards quantitative oil risk assessment in the Arctic ecosystem. Accurately implemented risk assessment would help us to prepare for the growing risk of an Arctic oil spill, and to guide management of oil spill related factors. We suggest to use Bayesian theory when moving from qualitative to quantitative risk assessment since it allows the integration of information from different sources and with different accuracy. We built a conceptual BN that describes the most important variables and dependencies among them that need to be taken into account when assessing the overall ecological risks of potential spills. Although quantitative knowledge was not yet formally incorporated, the BN reveals the key compartments in the ecosystem and the variables in the chain from accident to ecological consequences that should be taken into account in an ERA concerning oil transportation in the Arctic. [6]
Research material used in this paper are the final reports from The Finnish Funding Agency for Innovation’s (Tekes) strategic opening SMARCTIC Roadmap to a smart Arctic specialization (Thule-institute, 2014) and The Council of Oulu Region’s funded project Arctic business and research, development and innovation (RDI) -activity in the Northern Ostrobothnia (Hintsala, 2015). In order to illustrate the background of the material, methodological framework of the SMARCTIC project is presented involving the innovation policy roadmapping (IPRM) process and a strong prospective trend (SPT/SP trend) approach in the future analysis. Methodologically, results presented in this paper are based on quite a loose and somewhat eclectic application of content analysis combined with elements of grounded theory approach. It is noteworthy that the writers have been involved in projects forming the source of information here and hence it can be argued that ethnographical touch cannot be avoided. The chosen research strategy was to label, classify, categorize and synthesize material and to find common, descriptive denominators covering the multifaceted theme of the Arctic. [7]

Russia is one of the most important players in the Arctic zone energy shelf with significant economic, security, and political interests in the region. This is primarily because of significant natural resources, in particular oil and gas, on the Russian Arctic territories. Arctic has considerable strategic importance to the national economy. The objective of this paper is to develop the concept of sustainable development of the Russian Arctic zone energy shelf within the framework of the Quintuple Innovation Helix Model which focuses on university-industry-government relations, public and civil society, and the natural environment. The paper presents main characteristics of the Russian Arctic and Arctic’s oil and gas recourses. We determined the strategic importance of the Russian Arctic as a wealth of petroleum and mineral resources. We offered economic and socioecological approach to the Arctic’s sustainable development and paid special attention to the creation of centers of economic growth through the public-private initiatives aimed at knowledge and innovation production and transfer. We estimated social and economic potential of oil and gas shelf projects through the analysis of the possible risks and expectations of main stakeholders. The sustainable development of the Russian Arctic zone energy shelf represents an area of economic, ecological, and social concern, to which the Quintuple Helix innovation model can be applied with greater potential. The Quintuple Helix supports here the formation of a win-win situation between ecology, knowledge, and innovation, creating synergies between economy, society, and democracy, what is the good basis for sustainable development of the Arctic territories and implementation of Arctic Shelf projects.

The scientific understanding of climate change is based on a solid physical-theoretical foundation, and long-term observation and research. By analyzing the accelerated rise of the global climate and its wide-ranging effects on the risk of natural ecosystems and the social economy, and, particularly in view of the stringent targets of 1.5 degrees set by the Paris Agreement to limit global temperature rise, this study contends that climate security has become a new, non-traditional, security issue. The fundamental approach to implementing the objectives of the United Nations Framework Convention on Climate Change (UNFCCC) and the Paris Agreement is to develop clean energy vigorously and to accelerate energy transformation. Furthermore, building a global energy interconnection is emphasized as one of the solutions to promoting energy transformation. [8]

This study presents simulations of the global ocean wave climate corresponding to the surface winds and sea ice concentrations as simulated by five CMIP5 (Coupled Model Intercomparison Project Phase 5) climate models for the historical (1979–2005) and RCP8.5 scenario future (2081–2100) periods. To tackle the numerical complexities associated with the inclusion of the North Pole, the WAVEWATCH III (WW3) wave model was used with a customized unstructured Spherical Multi-Cell grid of ∼100 km offshore and ∼50 km along
coastlines. The climate model simulated wind and sea ice data, and the corresponding WW3 simulated wave data, were evaluated against reanalysis and hindcast data. The results show that all the five sets of wave simulations projected lower waves in the North Atlantic, corresponding to decreased surface wind speeds there in the warmer climate. The selected CMIP5 models also consistently projected an increase in the surface wind speed in the Southern Hemisphere (SH) mid-high latitudes, which translates in an increase in the WW3 simulated significant wave height ($H_s$) there. The higher waves are accompanied with increased peak wave period and increased wave age in the East Pacific and Indian Oceans, and a significant counterclockwise rotation in the mean wave direction in the Southern Oceans. The latter is caused by more intense waves from the SH traveling equatorward and developing into swells. Future wave climate in the Arctic Ocean in summer is projected to be predominantly of mixed sea states, with the climatological mean of September maximum $H_s$ ranging mostly 3–4 m. The new waves approaching Arctic coasts will be less fetch-limited as ice retreats since a predominantly southwards mean wave direction is projected in the surrounding seas.[9]

The literature on adaptation to climate change indicates that limiting global warming to 1.5°C or less would reduce damages relative to higher magnitudes of warming, and require less adaptive effort particularly by lessening the risk of extremes and reducing the potential need for transformative adaptation. Smaller climate change nevertheless poses risks of significant impacts, dislocation and adaptation costs in particularly exposed and vulnerable places. Climate change will also vary across space, and smaller, slower average change will likely still result in larger, rapid change for some systems and places (e.g. the Arctic and oceanic islands). Furthermore, non-linearities and power–law relationships among components of the earth's climate system mean that the potential for passing thresholds where parts of the system exhibit extreme behavior cannot be confidently excluded from a 1.5°C scenario. The potential for overshoot in a climate that eventually equilibrates at 1.5°C or less above pre-industrial also means that anticipatory adaptation planning efforts should not be relaxed. Yet, taken together, the literature suggests that reactive adaptation has a better chance of keeping pace with the lower range of warming in many places and production systems (although not necessarily all), and could reduce though not eliminate the risk of large damages and adaptation costs in exposed and vulnerable places. Anticipatory adaptation investments, however, can be justified even for low levels of climate change and appear less sensitive to the projected magnitude of change in climate, and driven more by uncertainty in future emission and climate trajectories.[10]

The reasons for concern framework communicates scientific understanding about risks in relation to varying levels of climate change. The framework, now a cornerstone of the IPCC assessments, aggregates global risks into five categories as a function of global mean temperature change. We review the framework's conceptual basis and the risk judgments made in the most recent IPCC report, confirming those judgments in most cases in the light of more recent literature and identifying their limitations. We point to extensions of the framework that offer complementary climate change metrics to global mean temperature change and better account for possible changes in social and ecological system vulnerability. Further research should systematically evaluate risks under alternative scenarios of future climatic and societal conditions. [11]

Climate change has been recognised as a major issue for coastal populations. Under this context, the potential socio-economic, environmental and health impacts at local, regional and global scales have received considerable attention by scientists. The knowledge gained feed
official strategic documents, which aim to increase awareness but also propose and apply management and mitigation measures towards reducing risks for human beings and the natural environment. Dependencies between human security, social vulnerability of coastal communities and the occurrence of maritime crime have also been studied. There is a consensus on the need to deepen the understanding of the links between climate change effects and threats to maritime security, but it remains to be seen if existing knowledge on the interplay between climate change impacts, social vulnerabilities and the occurrence of maritime criminality. We further explore the extent to which official documents account for the maritime dimension of climate change security. Despite the existence of an embryonic official discourse linking climate change and maritime security, our analysis reveals significant gaps between the concerns raised by the academic community and what is acknowledged in national and regional official strategic documents. Informing decision-makers and stakeholders about the possible dependencies between climate change and maritime security is thus a crucial step towards improving global ocean governance [12].

This article explores the existing normative system’s regulation of relations between indigenous peoples of the North and industrial companies in Russia. Special attention is given to the issue of responsibility in Arctic development by government, by industrial companies (company policies), and by indigenous small-numbered peoples (customary law). For all those involved in nature management in the Russian North, the potential for overcoming the dangers they face depends on a combination of these normative frameworks. The study is based on legal anthropology methods, which combine ethnographic field research (including participant observation and expert interviews) and analysis of texts of national laws, regulations, internal corporate documents as well as traditional customs. It is grounded in principles of legal pluralism, which allows for the co-existence of multiple legal regimes governing interaction between indigenous people and industrial companies. The article concludes that what is required in the Russian North is full implementation of existing legislation and industrial companies’ social together with environmental commitments, plus an integrated approach that takes into account local legal, ethno-cultural and historical practices, in addition to assessment by ethnological experts in the field of legal anthropology.

The presence of a developed and visible risk management1 (RM) and/or risk governance (RG) system has been highly institutionalised and discoursed in all kinds of modern activities. Based on the case of an oil-producing company operating in the Russian Arctic, the purpose of this paper is to challenge the organising (everything) capability of the risk concept showing that RM may exist between the everything-nothing extremums. By advocating the practice-based approach to organisational RG, the paper studies how the concepts of risk are used (or not used) in handling hazardous activities among different groups of professionals in a nature-exposed context. When following the mainstream of research on risk in the extreme conditions of the Arctic context one would expect the “risk” concept to be present in all practices throughout the company. However, the findings indicate that—apart from practices aimed at building the public sector of the company—the majority of practices carried out daily amid the challenges of the Arctic context do not even allow “risk” into their vocabulary. Instead, due to deeply inherited tacit knowledge of the context and intense entwinement of practices, their uncertainties are seasonally predictable and expected. As a result, RG within the company includes a range of various risk-displacing practices rather than an all-encompassing RM system. [13,14]
Under rapid Arctic warming, the vast amount of labile organic carbon stored in Arctic permafrost soils poses a potentially huge threat. Thawing permafrost will release hundreds of billion tons of soil carbon into the atmosphere in the form of CO2 and CH4 that would further intensify global warming and bring more challenges to human society. In this study, we use the PinC-PanTher model to estimate carbon emissions from thawing permafrost in the circum-Arctic during 2010–2100 followed by the PAGE09 integrated assessment model to evaluate the net economic losses caused by these permafrost carbon emissions. Our results show that in terms of net present value (NPV), the release of CO2 and CH4 from circum-Arctic permafrost will generate estimated net economic losses of US$2.5 trillion (5–95% range: 0.3–11.2 US$ trillion) under the RCP4.5-SPP1 scenario and US$12.7 trillion (5–95% range: 1.6–41.8 US$ trillion) under the RCP8.5-SPP3 scenario between 2010 and 2100, which contribute ~4.9% and ~6.4% respectively of net economic losses of global carbon emissions. [15,16]

The lack of accurate identification of the territories belonging to the Russian Arctic zone is a specific feature. As a result, the problem of statistical observations of circumpolar regions arises. Russian Arctic zone is considered in an article in the format of the threshold spatial socio-economic entity. The identification of the regions included in the Russian Arctic zone is based on the concept of unstable aggregates. The probit regression tools are used to determine the thresholds and to form a threshold aggregates in the study. Equation parameter estimation is performed by a quasi-Newton method. The indicators that reflect a variety of criteria for classifying territories (municipalities) as the Arctic zone (based on not only geographical, but also climatic and biological criteria) were used as the initial data. These calculations allowed forming the list of territories identified as the Russian Federation Arctic zone. [17]

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3. Results
The global problem climate change provokes global and regional risks.

Arctic climate change threatens not only the ecology of the region because the Arctic plays a very important role in the climate of the entire globe.
Melting of Arctic ice with climate warming, according to the National Snow and Ice Data Center, the total oceanic ice cover in the Arctic has decreased by 30% over the past 30 years [20].

Melting ice is multiplied due to the decrease in the reflective surface of the ocean. In other words, if there is less Arctic ice, it melts faster and this is called the "Albedo effect". Thus, in the article Bintanja R. and Van der Linden E. K. (bintanja R., Van der Linden E. C., Royal Netherlands Meteorological Institute (KNMI) 2013) it is noted that climate warming in the Arctic occurs at a rate significantly faster than the rate of temperature growth in other regions. According to Terry V. Callaghan (2012), coordinator of the international Arctic research program INTERACT, the Arctic is an indicator of the ecological health of the planet (because too many global environmental processes are associated with the state of the region). According to the author, by 2050 the Arctic waters will be almost free of ice (in September). It should be noted that according to the research Institute of the Arctic and Henry's Alekseev Antarctic (Rossiyskaya Gazeta, 2014), the Arctic ice may disappear completely by 2030.[21,22]

According to the results of analysis of the literature due to the warming of the Arctic climate, we can distinguish the following:

- decrease in ice cover due to global warming;
- reduction of certain species of flora and fauna;
- reduction of permafrost and, as a consequence, destruction of the infrastructure built on it;
- the decline of the indigenous population.

In the scientific community and politics, there is a concept that climate change is the result of a combination of natural and visible anthropogenic activity, which causes an increase in greenhouse gas emissions and an increase in the temperature of our planet. [23] The IPCC continues this concept. On the basis of the approach adopted in the framework Convention and its Kyoto Protocol, major States and international organizations have advocated the reduction of anthropogenic components of greenhouse gases.

4. Discussion

Due to the active global warming, much attention is paid to the construction of models of climate change in the future because it is important for political and economic decision-making. Models are needed that can predict the effects of climate change within the framework of a common modeling framework [24].

To solve this problem to continue the sustainable development of the Arctic territories, it is necessary to reduce the degree of risks. To do this, the following measures should be taken:

- Increase in the state budget allocated for the development of the Arctic territories, as well as for the regions related to them
- Development of legal and regulatory documents governing the use of natural resources, taking into account the peculiarities of the Arctic climate and terrain
- Upgrade of production facilities
- R&D spending increase
- Development of current and new fields taking into account the peculiarities of the ecological situation of the Arctic region
- Closer monitoring of temperature anomalies in particular in the Arctic plume
- Development of a solution to the problem at a high political level
- Close cooperation with foreign colleagues on climate change issues.

Conclusions

Changes in the Arctic climate lead to increased risks not only at the regional level, but also at the global level. Within the framework of the world and Eurasian civilization, the Arctic occupies an important part and participates in all global processes.
As glaciers melt, the temperature of the water in the ocean, as well as the direction and speed of sea currents change. Industrial development in the Arctic has negatively affected the unique flora and fauna.

In the Arctic, environmental problems are very important and weighty. The development of the Arctic requires scientific study, especially in international cooperation, because the risks of emergencies and man-made disasters are increasing. Effective national environmental legislation is an important requirement for the protection of the Arctic environment.

Various issues need to be addressed: the prevention of marine pollution from various sources, the establishment of marine and coastal protected areas in the Arctic, the prevention of adverse impacts on Arctic living conditions and the participation of Arctic indigenous peoples in the proper use and protection of the environment.

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