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NATAURAL AND TECHNOGENIC THREATS DURING OIL & GAS FIELDS DEVELOPMENT IN THE ARCTIC AND WORLD OCEAN

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As a result of comprehensive research and 50 years of hydrocarbon (HC) resources development in the Arctic Zone of the Russian Federation (AZRF) and the World Ocean revealed a number of natural hazards, which has repeatedly led to emergency and catastrophic situations. Among them there is high level of gas saturation of near surface sediments, often with abnormally high reservoir pressures. Thus gas may be contained in separate reservoirs (gas pockets) and the gas hydrates as well as dissolved in bad water. In recent decades, possibly due to global warming subsoil degassing in the AZRF and sub-Arctic regions has increased. In 2014-2015 about ten giant gas blowouts craters were found onshore AZRF. Researches based on satellite data revealed more than 100 lakes with hundreds and thousands underwater craters (pockmarks). Some lakes are completely or partially dried and craters become onshore. These lakes are mostly situated above the large HC fields, discovered in USSR time.

Sub-vertical fluid dynamic along the borehole (behind-the-casing column) is the global challenge for the exploration and production of HC fields that occur due to poor-quality of cementing in the well construction. On the basis of a comprehensive analysis of the available information, we come to the conclusion that above many of the producing HC fields are formed large technogenic HC deposits, threatening gas and gas-oil mixture blowouts into the water of seas, lakes, rivers and in the atmosphere. This may harm not only the environment in the HC developing areas, but also the global ecosystem of the Earth.

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HYDROLOGICAL EXTREME PROJECTIONS IN THE LENA BASIN: MODELING AND UNCERTAINTY ISSUES

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The ECOMAG regional hydrological model was setup to assess possible impact of climate change on the hydrological regime of great Arctic drainage basin – the Lena river basin. We firstly assessed the reliability of the hydrological model to reproduce the historical streamflow series and analyse the hydrological projections from the climate change scenarios. The impacts were assessed in three 30-year periods: early- (2006-2035), mid- (2036-2065) and end-century (2070-2099) using an ensemble of five GCMs and four Representative Concentration Pathways (RCP) scenarios. Extreme hydrological characteristics (specified as runoff volume above the assigned streamflow thresholds) were derived from the simulated streamflow series. Then we assessed the extreme characteristics' uncertainty, which is caused by the GCM's and RCP's variabilities. We finally estimated signal-to-noise ratio in order to separate the deterministic signal from the stochastic noise cased by the scenario uncertainty. We found that the uncertainty interval becomes larger and the signal becomes undetectable against the background of the noise, when the projection's time horizon increases and the assigned streamflow threshold rises.
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OBSERVED AND PREDICTED CLIMATE CHANGE IN THE ARCTIC BARENTS REGION AND POSSIBLE CONSEQUENCES FOR ENVIRONMENTAL AND SOCIO-ECONOMIC CONDITIONS

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Among anticipated consequences of global warming in the Arctic region is an increased frequency of extreme weather events, which may be considered as natural hazards. Such events include storms, heat/cold outbreaks, flood/droughts etc. For example, in some Arctic areas and in particular in the Barents region (including the Barents Sea and surrounding land areas) warm air intrusions in winter may cause heavy rainfall, which in turn leads to rain-on-snow situation with extremely negative consequences for reindeer herds. There are existing reports on such events already happening with increasing frequency trend (Hansen et al., 2014). The present understanding of how extreme weather events may impact environment and socio-economic conditions around the Arctic is among objectives of extended investigation, currently being done under the aegis of AACA-AMAP international program. Tree specific regions around the Arctic are considered in this study. One of them is the Barents region, as defined above. The accomplished analysis of future climate conditions in the Barents region is based on the imperative of continuous global warming in accordance with the IPCC scenarios (IPCC, 2014). Within these scenarios, the Arctic and specifically the Barents region are expected to experience faster and greater warming than the average one over the planet due to polar amplification. Plausible implications of this trend for environmental and socio-economic conditions in the Barents region are discussed in this presentation.
The work is supported by the RNF grant 14-37-00053.

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NATURAL AND CLIMATIC RISKS IN THE ARCTIC

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Severe natural conditions and current climate change create high risks for the sustainable development of the Arctic region, especially for exploration of the shelf resources. Low temperatures, long cold period, heavy sea ice conditions, icebergs, generate problems for the production and transportation of hydrocarbons. Quick and substantial climate changes in the Arctic add more risks: the thawing permafrost, coastal erosion, sea-level rise, increasing wind and wave activity, etc. Icebergs, pressure ridges and grounded hummocks, large ice fields, strong ice compression, strong ice drift create serious threats for offshore structures and operations on the shelf.

Ensuring safety of the Arctic hydrocarbon production and transportation requires reliable methods of monitoring, detection and forecasting of natural and anthropogenic hazards, which include heavy ice, icebergs, and extreme weather events. Russian Arctic observing system comprises a network of ground-based weather stations, space-based observations, manned and unmanned aircrafts, up-to-date automatic observational tools. This system is allowed to monitor and forecast ice conditions, monitor and prevent the iceberg threat, monitor and assess the climate change in the Arctic. Detailed assessment of the climate impacts in the Arctic develops adaptation tools to the climate change and helps for the decision makers.

PAN-EURASIAN EXPERIMENT (PEEX) PROGRAM OVERWIEV - TOWARDS COORDINATED COHERENT DATA SYSTEMS ENABLING SERVICES FOR THE SOCIETY

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Pan-Eurasian Experiment (PEEX) initiative (https://www.atm.helsinki.fi/peex/) is an international, multi disciplinary, multiscale bottom up initiative established in 2012 (Kulmala et al. 2015, 2016; Lappalainen et al. 2014, 2016, PEEX Science Plan) The main focus of the initiative is to solve interlinked global environmental challenges influencing societies in the Northern Eurasian region. The goal is to solve with comprehensive, continuous observations the scientific questions that are specifically important for the Arctic-boreal region in the coming years, in particular the global climate change and its consequences to nature and the Northern societies. PEEX aims to deliver novel ground based land-atmosphere data for constructing reliable early warning systems (floods, forest fires, droughts), for predicting extreme weather events and estimating the environmental contamination of industrial accidents

One of the concrete tasks of the PEEX is to establish a coordinated, coherent land based PEEX observation network over the Northern Eurasian region in collaboration with European Research infrastructures (ICOS, ACTRIS, ANAEE) and GEOSS-Cold regions ground based component (Alekseychik et al. 2016). The concept of the hierarchical PEEX in situ station network is based on the know-how from 20 year development of the SMEAR-II flagship station measurement theory and techniques (Hari et al. 2016). The backbone of the station network is built on the existing biosphere (ecological) and atmospheric observation networks in collaboration with European, Russian, Chinese and global partners.

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SWEDISH-RUSSIAN-US ARCTIC OCEAN INVESTIGATION OF CLIMATE-CRYOSPHERE-CARBON INTERACTIONS THE SWERUS-C3 PROGRAM

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(The SWERUS-C3 Program) – is a multi-disciplinary program aimed to investigate the linkages between Climate, Cryosphere (sea ice and coastal permafrost) and Carbon release from the sediments, with addition of greenhouse gases (GHG) to the atmosphere. SWERUS-C3 includes principal investigators from Stockholm University, University of Gothenburg, Pacific Oceanographic Institute and P. P. Shirshov Institute of Oceanology of the Russian Academy of Sciences (RAS), National Tomsk Polytechnic University, the International Arctic Research Center (IARC) at University of Alaska, Center for Coastal and Ocean Mapping at University of New Hampshire and Rice University. The program focuses on investigations of the present and historical functioning of the multi-process C3 system of the East Siberian Arctic Ocean (ESAO). This program also includes geohazards connected with abrupt release of methane from sediments. The ESAO is the target area because it is experiencing the fastest rates of climate warming and because of its vast stores of vulnerable carbon. The ESAO hosts 80% of the World`s subsea permafrost with large amounts of C-CH4 currently stored in its shelf and slope sediments and in its coastal and subsea Yedoma permafrost. This yields a likely potential for climate-induced mobilization of these carbon pools into the atmosphere as GHG; a positive feedback to climate warming.

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IIASA ARCTIC FUTURES INITIATIVE AND FINLAND, COUNTRY OF/ON EXTREMES?

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The current situation in the Arctic reflects the complex interplay between environmental and social sustainability, as well as economic development in the midst of human influences such as growing population pressures and the impacts of climate change. Decision makers, of all types and at all scales, need to reconcile continued economic development within the Arctic while safeguarding environmental and socio-cultural values and livelihoods.

The goal of IIASA Arctic Futures Initiative (AFI) is a holistic integrated assessment, including a decision-support process and science diplomacy that contribute to informed decision-making about sustainable development in the Arctic. Holistic is herein defined as international, interdisciplinary, and inclusive.

Within the decision-support process we integrate stakeholder perspectives, geospatial data (socio-economic and biophysical), and governance analyses. This systems analysis approach further involves plausible futures that are designed to balance economic prosperity, environmental protection and societal wellbeing over time frames that address realistic risks.

The AFI will prioritize an integrated Arctic science agenda by engaging relevant local, science, policy, and business communities in a collaborative and inclusive environment.

Deliverables from the integrated assessments, the decision-support process, and the science diplomacy enable to create future options, without advocacy. The outcomes support policy makers by helping them better understand a range of options and alternatives and the potential consequences of implementation based on those options.

This presentation gives an introduction of the AFI. The seed for the Arctic Futures Initiative was planted in a seminar on policy support for research, organized by the Finnish Prime Minister's Office, the Academy of Finland, and IIASA.

This presentation also summarizes some recent work in Finland - country of/on extremes?

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THE CHANGING CLIMATE AND ECONOMICAL POTENTIAL OF THE RUSSIAN ARCTIC

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The political and economical interest to the Arctic region raised the problem of lack in detailed understanding of the complex interrelationship between different components of the Arctic environment and their effects on the economy. Direct transfer of the existent technologies and methods of land use is not always working. Therefore, a number of national and international scientific teams are recently funded to provide the required information and to develop the strategies of the expected expansion of the human activity in the region. One of such teams in the form of the “Arctic Environment Laboratory” (AEL) was established at the Faculty of Geography, M. V. Lomonosov Moscow State University, with the aim to assess the opportunities and the possible problems in the on-going and planned development of the Russian Arctic. AEL is the project granted by the Russian Science Foundation “Environmental changes in the Arctic and their impacts on the human wellbeing and infrastructure”. The project combines the research experience of oceanologists, hydrologists, climatologists, permafrost scientists and economical geographers, which is a challenge but also an advantage in case of success. Due to large variety of the objects of research the combining of the obtained results into a unified system is yet to be completed. However, the obtained results already show that collectively socio-economic and environmental factors promote changes in land use, demographics, and development policies.

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COMPLEX GEOLOGICAL AND GEOPHYSICAL DATA TO SUPPORT THE EXTERNAL BORDER CONTINENTAL SHELF OF THE RUSSIAN ARCTIC

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The Russian Arctic sector remains an area of the Arctic Ocean least investigated with respect to its geological structures including the Arctic Ocean floor. In recent years, geological and geophysical studies are significantly increased particular to the structures of Arctic sedimentary basins in connection with their petroleum resource potential, type, and thickness of the Earth crust. Knowledge of the crustal structure is important for establishing the outer boundary of the continental shelf of the Russian Arctic region in connection with the corresponding claim to the UN commission [1]. In this report, we will try to show based on new geological and geophysical data the key geological Arctic structures and geodynamic evolution of their formation [2].

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