

New Global climate changes as a result of increased development of the Arctic territory

DURATION: 2012 – 2013

TARGET COUNTRIES: This activity has global significance because of the correlation between the Arctic development and climate change and is aimed at defining complex security measures in the region to provide safety of people not only living there but the citizens of any country appeared to be at the territory for business or tourism. North sea route opens new prospects for increased rate of human activity. And this demands creation of resilience potential.

PARTNERS INVOLVED :

Coordinating Centre: ECNTRM Moscow, Russian Federation

Other Centres:

Other Partners : Institute of Arctic and Antarctic in Saint Petersburg

OBJECTIVES OF THE PROJECT

Global objective for 2012-2013 :

Guidelines and recommendations on global security measures in the Arctic.

Specific yearly objectives :

2012:

The Arctic is an area of potential large-scale economic activities of production, processing and transportation of mineral raw materials conducted in a sensitive environment. Considerable risks of emergencies exist due to the natural and technical character of these activities. The situation becomes even more serious in the conditions of the climate change because the region is climate influencing.

The project is aimed at preparing the survey on the correlation between increased Arctic development and climate change. The research activity aimed at increasing the level of understanding the problem.

This issue is planned to be discussed at the Workshop "Emergencies preparedness and response in the Arctic" which is to be held in the city of Norilsk, Russian Federation, August 22-25, 2012.

2013:

- To conduct natural and technogenic risks assessment.
- To identify vulnerability.
- Elaborate specific proposals how to prepare for new opportunities and challenges as a result of a changing Arctic.
- To increase awareness among the general public as well as governments of the Arctic and its importance, not only regionally but globally.

EXPECTED RESULTS

2012 : Analyses of the correlation between increased Arctic development and climate change

2013 : Finalizing the survey adding the analytical results and proposals

RESULTS OBTAINED IN 2012

Work package 1 (prepared by ECNTRM, Russian Federation):

Description:

Together with the academic scientists specializing on the problems of the Arctic collect and analyse the appropriate information and prepare the survey. To share the knowledge with the decision-making people and business community.

Associated deliverables:

THE ARCTIC AND WORLD CLIMATE

The Arctic plays a significant role in the global climate system mainly because it acts like an "air conditioner" in formation of the weather not only in the Northern hemisphere but worldwide through heat exchange, ocean water currents and carbon cycling. Thus, apart from significant effects of the Arctic, change in the Arctic cryosphere will affect in many ways the entire globe. Such feedbacks have far-reaching implications on the global climate system, sea level, and population outside Arctic. Besides, the Arctic is economically linked to the entire globe and increased access and activities may have effects locally and within the global context.

Shifts in Arctic sea ice and increased heating will warm the lower atmosphere in the Arctic. This change will affect weather at lower latitudes, particularly in winter. Recent „outbreaks. of cold Arctic air masses over lower latitudes particularly in Eurasia appear to have resulted from weakening of the „polar vortex. which typically traps cold Arctic air near the pole. This variability may reflect an early shift toward altered Arctic, and perhaps northern hemispheric, climatic patterns.

In parallel with the lessening of the temperature gradient between the Arctic and more southerly latitudes, the capacity for northward transport of contaminants is reduced, and thus accumulation in southerly areas is likely to increase. Also, it is very likely that the stores of legacy contaminants within the Arctic are being mobilized by cryospheric degradation. Their release from ice, snow, permafrost, glaciers and ice caps and subsequent re-entry into ecosystems appears to be occurring.

INHABITANTS AND ECONOMIC DEVELOPMENT

The Arctic region occupies 11% of the global surface area. Demographic estimates vary due to Arctic geographical extent and seasonal migration. Population figures vary between 4 million and 9.9 million depending on the geographical definition. Estimation of indigenous population ranges from 400 000 to approximately 1.3 million. Seasonal variation due to work-related migration is particularly applicable in the Russian Federation, which accounts for roughly 75% of all Arctic inhabitants.

The Arctic is characterized by a dispersed settlement pattern with few large cities. About one-third of Arctic residents live in settlements with a population size of less than 5000 and one tenth of the Arctic population lives in one of the five largest cities. The Arctic region is an exporter of raw materials and energy and an importer of final goods and services.

Since their arrival in the Arctic, the indigenous peoples have lived from the renewable resources of the sea (fish, marine mammals), the land (land mammals, birds, berries), and freshwaters (fish). Although not considered in official Arctic gross regional product (GRP) assessments, the contributions from commercial and subsistence fishing, hunting, and herding activities are documented as playing a significant role in the mixed cash-subsistence economies.

The GRP is a measure of the total value of goods and services in a given territory. Comparing the contributions from the primary sector (exploitation of natural resources), the secondary sector (manufacturing and construction), and the tertiary sector (public and private services) to GRP, as well as to the overall Arctic GDP, the tertiary sector is the most dominant. Only in Arctic Russia is the primary sector more dominant. This means that, apart from the Russian Arctic, public services such as education, health, and social work account for a significant part of all economic activities. The largest economies in the Arctic belong to Alaska (United States) and Russia, mainly due to mining and gas- petroleum activity.

Regions where more traditional subsistence activities, such as hunting and fishing, play a more dominant role (e.g., Greenland and northern Canada) have much lower GRP. Similarly, reindeer herding in Russia and Scandinavia is of substantial importance to the livelihoods and lifestyles of reindeer herders but does not contribute greatly to GRP in these regions.

The abundance of renewable and non-renewable resources and the generated share of GDP, varies from region to region. For many Arctic indigenous peoples, the cryosphere is fundamental to their cultures and identities. The cryosphere has traditionally been used as a platform for travelling, and for livelihood activities such as herding, hunting, and fishing. The cryosphere also plays a fundamental role in the life and work of non-indigenous residents, through non-renewable resource extraction; hunting, fishing and recreational activities; and extensive use of seasonal ice roads across wet tundra, rivers, and lakes. These roads provide key transportation routes for relatively inexpensive transport of heavy equipment, foodstuffs, and other supplies for residents and industry. Accessibility afforded by these roads reduces the cost of living in the North.

Arctic residents rely on their extensive traditional and local knowledge and on their observations of the environment and weather when making decisions on: when, where and how to build, travel, or harvest. The documentation and incorporation of traditional and local knowledge is currently central to research on community adaptation to climate change.

PERMAFROST IMPACT ON THE INFRASTRUCTURE

Most settlements in the Arctic are relatively small communities and the majority are located on the coast where permafrost is commonly present. With the expansion of resources development the Arctic population is set to increase, especially in northern Russia where large cities with over 100 000 inhabitants are located in permafrost areas.

Most developments in the Arctic have taken place with an awareness of current permafrost conditions, but projected climate-driven changes in permafrost are likely to affect these and future developments beyond current planning and engineering provisions and can pose a significant challenge to infrastructure, environment, and health in the Arctic.

Coastal Arctic regions have concentrations of industrial facilities associated with oil and gas such as the Pechora Basin in Russia. Damage to pipelines may have dramatic environmental effects, especially when oil or gas is released at the coast or at sea. About 500 pipeline failures are registered annually along the 350 000-km network of pipelines in western Siberia. Over 20% are probably due to deformations and weakening of foundations induced by permafrost thaw.

Infrastructure includes physical facilities with permanent foundations or the essential elements of a community. It includes schools, hospitals, various types of buildings and structures, and facilities such as roads, railways, airports, harbors, power stations, communication systems, and power, water, and sewage lines. Infrastructure forms the basis for local, regional, and national communication and for economic.

SEA ICE AND COASTAL INFRASTRUCTURE

Sea ice is a significant factor influencing the coastal situation. It can both prevent and cause erosion of coast and infrastructure, and plays an important role as a regulating element in coastal sediment dynamics. Sea ice protects the coast from the erosive action of storms and preserves the thermal state of subsea permafrost, the coastal erosion rates along the Arctic coast have increased over the past 30 years. Low-lying coastal plains, which are not tectonically active, are especially vulnerable to coastal erosion. Although rocky coasts predominate in the European and western Russian Arctic and in parts of the Canadian Arctic Archipelago, human settlements are often associated with stony sectors of the coast because these provide more suitable locations for human activities.

Coastal erosion rates vary considerably between and within regions and over time, and erosion presents a significant problem for communities, infrastructure of various types, cultural heritage sites, and in some cases protective coastal landforms. The complex interactions between declining sea ice and other consequences of climate change (rising sea

level, shifting river discharges, run-off, altered sedimentation rates in coastal areas, permafrost degradation) will increasingly affect Arctic coasts, coastal infrastructure and coastal marine ecosystems and potentially human resource use. Major forcing parameters are waves, currents and water levels, and, especially for the Arctic, sea surface temperature, salinity, decreasing sea ice and increasing open water fetch, ground temperatures, and excess ground-ice content. With sea ice forming later in the season, the coast is more exposed to a projected increased number of autumn storms, and to storms with longer fetch. Even a small increase in the intensity of storms and coastal surges is likely to increase infrastructure substantial damage and costs. In addition, a decrease in landfast ice increasingly exposes coastal permafrost to wave action and increased temperatures, leading to thaw. This can have serious consequences for existing infrastructure (e.g., structures or buildings depending on ice-bonded surface for strength could be at risk over the decadal time scale). Although new coastal permafrost may form when sea ice freezes to newly aggraded sediments, it is likely that this permafrost will be unstable because of increased temperatures of the seabed. Rising ground temperatures will increase seasonal thaw depth and enhance coastal erosion processes.

Other hazards involve ice ride-up, ice pile-up and the formation of near shore pressure ridges, primarily as a result of wind action, which may provide a mechanism for near shore scour and landward sediment transport. While the effects are often superficial, they include an example of damaging ride-up of 0.4 m of ice that knocked a lighthouse off its foundation and destroyed standing infrastructure on fishing harbor pier.

Because of the highly episodic and rare occurrence of damaging ice motion, such as ice ride-up and pile-up, little effort has been devoted to mitigate and forecast such hazards and many communities where damage has occurred may not have anticipated the event before it happened. While engineering solutions are available for shore protection, these measures may address one problem but create another by altering the dynamics of erosion and deposition processes.

HUMAN ACTIVITY AND COASTAL CHANGES

Substantial increase of human activity in the Arctic region may impact sea ice which can be considered as a social-ecological system with a variety of processes coupling the physical, biological, and social components. Reduction in sea ice will lead to increased accessibility in the Arctic and, thus, affect in various directions the sea-ice services derived from the ice cover.

Local effects have often been examined in greater detail in the context of environmental impact statements that are part of proposed industrial development in Arctic regions. At the local level, feedbacks are mostly expected in the context of modifications of the coastline that are conducive to enhanced entrainment of sediments into sea ice. Both seasonal ice formation and ice melt at the local and regional level are strongly impacted by the influx of freshwater from terrestrial runoff. Moreover, large-scale river discharge and potential modifications, such as through damming of large rivers can impact stratification and hence impact ice production rates. River discharge was affected by human activities in several areas of the Arctic and dams or water withdrawal for irrigation may significantly change river discharge and thereby have significant impacts on the sea-ice regime.

Modification of freshwater discharge and its impact on ice formation could promote enhanced ice formation in the Arctic with impacts that might reverberate at the global level if, for example, discharge from the large Siberian rivers was reduced substantially.

The distribution of shoals and shallow areas is also a key constraint in stabilizing the land fast ice cover. Hence, coastal development such as dredging of harbors or other areas to mitigate the effects of coastal retreat, or the construction of artificial gravel or ice islands in the context of offshore oil and gas development, can have major impacts on the ice cover in the coastal zone. It may also greatly reduce primary production in the sea ice by increasing the amount of sediment entrained into sea ice, either through enhanced resuspension as a direct or indirect result of offshore activities or through reduction in ice stability enhancing sediment entrainment in a mobile coastal ice environment. While these impacts are only likely to be important on a very confined, local scale in the immediate vicinity of coastal development sites, they can significantly affect use of the ice cover at this scale, both by industry and by coastal communities.

While local effects such as coastal change and river discharge affect land fast ice, human emissions of greenhouse gases, dust and black carbon may result in further reductions in albedo affecting the ice cover on a much wider scale. Hydrocarbon exploration, production and transportation cause considerable emissions to air and are important variables in regional Arctic emission inventories of greenhouse gases used in climate scenarios. The geographic location of emissions of CO₂ has no impact on the warming potential. For particles (black carbon) on the other hand, the location of the emissions is important and increased activity in the Arctic results in an increase in local emissions, with concurrent effects on the surface albedo. Sea-ice retreat will also lead to a shift in patterns and timing of shipping and icebreaker activity. There will be a general increase in ship traffic in new areas, and Arctic marine shipping may adversely impact sea ice through operational discharges and emissions and navigation impacts on sea ice.

However, it is possible that changing ice type and a reduced ice-cover season will limit icebreaking needs. With activities in the Arctic increasing and adding to global impacts on sea ice, feedback effects are likely to play an increasingly important role in the further reduction of sea ice, especially on the local-scale at the Arctic coasts.

OTHER ASPECTS OF CHANGE

Apart from cryospheric changes there also many other factors that shape vulnerability and adaptation to changes in Arctic communities and sectors. Such factors include resource accessibility, allocation, and extraction policies; limited economic opportunities and markets; access constraints; demographics; attitudes and perceptions of change; bidirectional local-to-global linkages; infrastructure; threats to cultural identity and well-being; transfer of local and traditional knowledge; economic and livelihood flexibility; and enabling institutions. These aspects are rarely independent of each other and frequently combine across scales and sectors. In many cases, socio-economic changes are likely to have greater immediate significance than cryospheric changes, which in turn will affect the ability to adapt.

Increased industrial activity challenges migration and grazing on traditional pastures, leading to areas of unused and underused grazing areas. Avoidance of certain reindeer pastures can lead to a reduction in optimal range use, leading to complications with herding, increased costs, and reduced production.

Another example is the projected increase in tourism. While there are potential economic benefits for local communities from increased tourism, such an increase may also negatively affect those communities. Given international pressure for sustainable management of wildlife, indigenous communities that depend on hunting, for example, polar bears (for tourism or subsistence) may have to adopt alternative livelihood. Further expansion of tourist seasons may result in extended use of infrastructure and longer duration of employment and income benefits. Human activities can greatly amplify the effects of climatic variability and change on Arctic societies.

ARCTIC REGION AND GLOBAL WORLD

Arctic cryosphere is closely linked to the rest of the world. These linkages include physical (e.g., Arctic climate system feedbacks globally), chemical (e.g., pollutant transport to the Arctic), biological (e.g., migratory biota and ecosystem connections), and social (e.g., tourism, resource extraction, management, politics).

Global climate changes are influencing on the Arctic cryosphere; at the same time these changes will in turn respond to far-reaching subsequent effects of global consequence.

The cold Arctic region typically acts as a sink for heat, greenhouse gases, particulate aerosols, and contaminants and performs fundamental regulatory functions for global climate systems. Degraded cryospheric components will increasingly act less so with highly uncertain consequences; however, hemispheric and global scale effects are likely. In some cases, these will be responses to Arctic change that affect the globe (i.e., simple outputs), whereas in others they will constitute feedback effects which may further alter global processes (e.g., climate system change, weather pattern change, shifting from sink to source for some greenhouse gases, possibly both CO₂ and methane). Such changes are very likely to affect human society beyond the Arctic.

Cumulative effects with consequences for society on a broader scale include the feedback from changing snow conditions and surface albedo and the release of methane by thawing terrestrial and sub-sea permafrost to the climate system leading to accelerated global warming. Such amplification needs to be included when developing mitigation efforts and in updated models projecting future climate change. In contrast, the increased period of open water on lakes and increased growing season for vegetation will lead to increased evaporation and transpiration, drying of the landscape, and a negative feedback to climate, especially when combined with drainage of tundra water bodies fostered by permafrost degradation, although the balance between these two processes is highly uncertain.

Changes in the Arctic cryosphere coupled with other climate-driven changes have hemispheric and global-scale social effects, which may include the following:

- Enhanced ice outflow (icebergs and ice export) leading to shipping hazards in the North Atlantic.
- Alteration of ocean and river heat and freshwater transport to Arctic environments and alteration of oceanic circulation patterns, affecting ecosystems and impacting fisheries and hunting activities.
- Alteration of the structure and functional relationships within and services received from terrestrial, freshwater, and marine Arctic and sub-Arctic ecosystems, including possible loss of iconic species and altered biodiversity.
- Increased activities in the Arctic leading to increased risk of pollution and increased shipping bringing noise pollution and ballast water that contains contaminants and invasive species.
- Uptake of pollutants via microorganisms into the Arctic food web (e.g., fisheries) that have local and global health impacts.
- Economic opportunities that may provide impetus to national and global economies but must be developed in a sustainable manner.
- Significant contribution to global sea level rise and thus follow-on effects for low-lying coastal regions throughout the world.

CLIMATE CHANGE AND MARINE ASPECTS

Climate change may result in the fluctuation of sea level at local and global scales and represents one of the more serious consequences of climate change, mostly due to the scale of potential effects. Possible rise of sea level is a complex phenomenon resulting from many factors. Climate change affects sea level primarily through water mass changes and through density changes due to changes in temperature and salinity. Global sea levels are also affected by mass losses from non-Arctic glaciers and the Antarctic ice masses. Present mass losses from Arctic glaciers and the Greenland Ice Sheet contribute a total increase of 1.3 mm per year to the rise in global mean sea level. Increasing contributions from the Greenland Ice Sheet and other Arctic glaciers have occurred since 1995. Contributions from other sources (Antarctic Ice Sheet, non-Arctic glaciers) are added to these.

High regional variation in sea-level rise will result from concurrent changes in other factors that include gravity fields, ocean temperatures, freshening, tidal effects and local isostatic rebound or subsidence of land. Rates will also differ, thus impacts may be highly regionalized and realized over varying time scales.

Mean sea-level rise increases possibilities of coastal flooding, erosion, infrastructure damage, environmental impacts on ecosystems, and saltwater intrusions into groundwater. Such effects may be accompanied or exacerbated by local additional effects. Ultimate global effects realized at the century scale and beyond include significant inundation of low-lying coasts and possibly complete submergence of small islands in some areas of the globe, although growth of coral atolls may offset this to some degree.

Ocean circulation is a global phenomenon by which heat and water are transported between the polar and equatorial regions. This circulation is powered in part by density differences among water masses due to differences in temperature and salinity. Inflows to the Arctic resulting from this phenomenon consist of surface (lower salinity, warmer) waters entering from the Pacific via the Bering Strait, and surface (warmer) waters entering from the North Atlantic.

These inflows are counterbalanced by the outflow of Arctic waters primarily through the Canadian Archipelago and along eastern Greenland, mostly as lower salinity, cold and freshened surface flows. Additional deeper outflows of Arctic Ocean water (high salinity, cold) occur in the northeastern area of the Atlantic. The North Atlantic thus has several mixing zones where warm surface currents from the south interact with cold surface and sub-surface currents originating from the north.

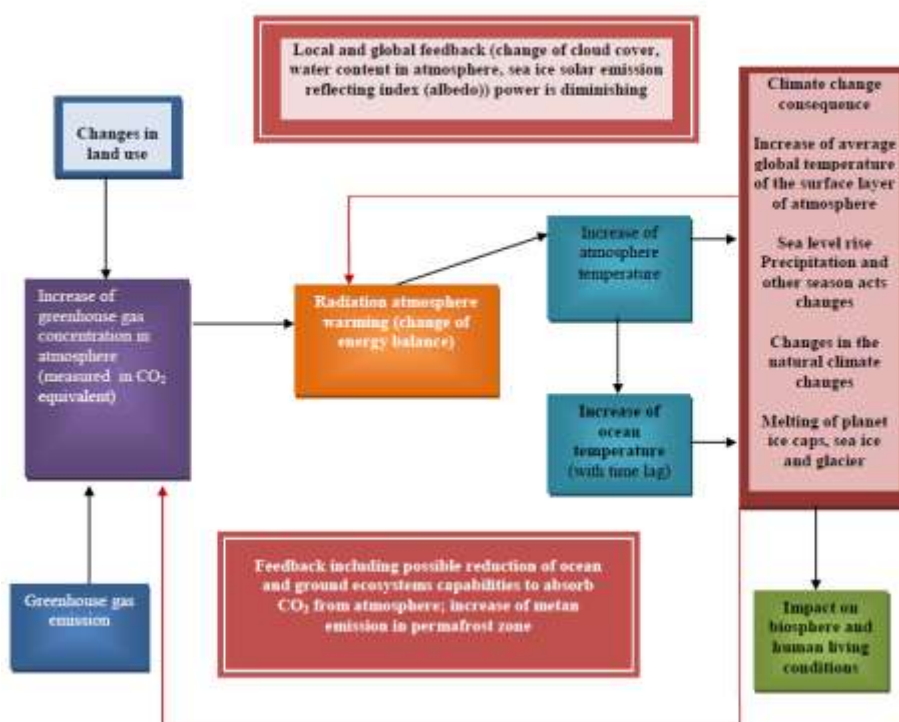
Several changes in the Arctic cryosphere are anticipated to increase freshwater inputs to the Arctic Ocean, thus reducing its salinity (at least in surface waters). These include: increased direct precipitation, possibly increased inputs of low salinity Pacific waters, increased runoff from large Arctic rivers, reduction of ice stores on land, and

degradation of perennial sea ice. The increased input of freshwater will have local effects within the Arctic primarily on coastal shelves, many of which are largely associated with increased stratification.

FEEDBACKS AND IMPLICATIONS

The atmosphere, ocean, and individual components are the major factors affecting the Arctic cryosphere. Many aspects of Arctic climate change are simple responses to a driving force, for example, higher (or lower) air temperatures will alter the ice balance in a particular area. Other changes may involve a feedback whereby a change in one component of the system drives a change in another, which ultimately induces additional change in the original component. Such feedbacks can be positive (i.e., induced change reinforces and exacerbates the original change), whereas others can be negative (i.e., induced change dampens, cancels or reverses the original change).

CLIMATE CHANGE INTERACTION DIAGRAM



Feedbacks are important because they may alter rates of change, magnitudes of change, or even directions of change. Owing to their unpredictable effects and their variable scales (spatial and temporal) of operation, feedbacks also add to the uncertainties of outcomes especially for higher-order consequences of climate and cryospheric change.

Work package 2 (prepared by ECNTRM, Russian Federation):

Description:

Organize the workshop "Emergencies, preparedness and response in the Arctic" with the participation of representatives from high level legislation, Russian State government bodies, Ministries, Coastguard of Russian Federation, state-private companies, scientific community, local government bodies and search and rescue detachments.

Associated deliverables:

Discuss the issue and collect proposals and recommendations for the survey

Russian Federation hosted a 2-days conference on "Emergencies preparedness and response in the Arctic" in the city of Norilsk, Russian Federation on August 23-25, 2012.

Conference participants were more than 90 representatives from different institutions of the Russian Federation: Emercom of Russia, Ministry of Transport of the Russian Federation, Russian Federation Coast Guard Directorate, Federal security service, research institutes, Administration of Krasnoyarsk region and business community of the Russian Federation.

Among foreign delegates were the representatives of USA, Canada, Norway, Denmark and Finland.



There were three plenary sessions:

- Emergency situations in the Arctic. Preparedness and response;
- Economic development of the Arctic regions and the industrial development security problems including mining works security provision.
- Transport security in the Arctic.

More than 20 presentations were made stating the importance of the issues because the number of emergencies and the complexities of emergencies in the Arctic will increase in the near future as a result of continuing climate change and increased development in the Arctic.

Delegates called for the new researches in all the spheres of emergencies preparedness and response both scientific and technological for arctic conditions, shearing the knowledge; implementation of the modern systems of emergencies monitoring and management in the Arctic.

It was acknowledged that the amount of means and forces in the Arctic aimed at protection of people and territories, search and rescue, oil and other hazardous liquid substances spills elimination is not adequate.

Shortage of response forces in some states and necessity of search-and-rescue activity coordination of different countries necessitates strengthening of international collaboration.

As an important step in response improvement Russian Federation is working at the program of establishing Complex Search and Rescue Centres in the Arctic region of the Russian Federation. The purpose of establishing a system of Complex Search and Rescue centres is to provide comprehensive operational assistance to persons in distress in the Arctic regions of the Russian Federation, along the Northern Sea Route and in the adjacent territories of foreign states in accordance with international agreements.

ACTIVITIES PLANNED IN 2013

Working package 1 (prepared by ECNTRM):

Description:

Associated deliverables: